

MSc Thesis

Effect of Salinity on Cell Wall Composition of *Miscanthus* sp.

Yin Huang

920115370070



WAGENINGEN UNIVERSITY
WAGENINGEN UR

Effect of Salinity on Cell Wall Composition of *Miscanthus sp.*

Yin Huang
January 2016

MSc. Thesis
Bio-based Economy Group
Report no.

WAGENINGEN UNIVERSITY

Supervisors:
Luisa Trindade
Tim van der Weijde

Project leader: Luisa Trindade

DATA FOR INTERNAL USE ONLY
EXTERNAL USE OF DATA IS ONLY PERMITTED
WITH CONSENT OF THE PROJECT LEADER



Acknowledges

To complete this thesis, there were too many thanks to my supervisors, Luisa Trindade and Tim van der Weijde. I am grateful for having the opportunity working in Bio-based Economy Group, and on the topic I have always wanted to get involved with. The selfless supervision, guidance, and advices during the thesis working periods are precious. Also, during this period, I would like to give tributes to Annemarie Dechesne, Eben Haeser Sembiring, Kasper van der Cruijzen, Eyup Oztutuncu, Wei Xiong, Juan Carlos Rivas, Jordi Petit Pedró, and Stefan Petrasch for all their participation in fulfilling my thesis work and life. My thanks at the same time to all the group members in the Biochemical Lab, Bio-based Economy Group, and students in the plant breeding group for the time we enjoyed and the hard time we went through together. Special thanks of mine will go to my dearest families, friends, and Taiwanese people here in Wageningen, who have been my best strengths and encouragement to complete this study. I will cherish forever the skills and experiences I learned and good times I enjoyed with people through this work. My appreciation is beyond words. I wish all the best and great success to all the people in the future.

i. Abstract

Miscanthus, as a perennial rhizomatous C4 grass, is known for high nutrient use efficiency. It has been recognized as a good lignocellulosic biofuel source for its high productivity of which can be harvested up to 30 t / ha / year. Also, the wide spread origin of miscanthus indicated the potentially good adaptability of miscanthus to diverse environments. It is seen as a crop with a high potential to be grown in marginal areas to ease the competition of biofuel crops with food crops.

The increasing salinity of soils is and many marginal soils are saline are threatening issues to agriculture. To survive in the marginal areas and still have desirable biomass means salt tolerance is required. However, in addition to biomass yield, the produced biomass must also be high quality. Biomass quality is highly dependent on its cell wall composition. Cell wall biosynthesis, however, is commonly modified by plants in response to abiotic stress. Consequently, evaluation of how salt stress and salt tolerance interact with cell wall composition is very important

In this study, there were two separate trials; one was with 25 miscanthus genotypes on open field trials in China, and the other was with 12 genotypes in pot trials in greenhouse. The analysis of cell wall composition was conducted by using biochemical analysis and Near-infrared Spectroscopy (NIRS) prediction models. Field trials allowed evaluating growth under realistic field conditions for two years on maturing plants, whereas the pot trials allowed evaluation on salt stress in a controlled environment.

The results indicated that the salt tolerance differed greatly among the genotypes and breeding for miscanthus with good yield under salt stress is possible. It had also shown that the biomass composition in leaves and stems was not affected undesirably since lignin content did not increase. However, some effects were observed, for example, increase in hemicellulose content. Little correlation between biomass compositions with salt tolerance was found and the biomass composition and adaptability hardly had any effect on salt tolerance either. In conclusion, breeding of miscanthus for saline area should encompass both breeding for salt tolerance and for biomass quality for biofuel production as unrelated breeding objectives.

Key words: miscanthus, salt tolerance, cell wall composition, NIRS, biochemical analysis.

ii. Table of Contents

Acknowledges.....	3
i. Abstract.....	4
ii. Table of Contents.....	5
iii. List of Tables.....	7
iv. List of Figures.....	8
v. Acronyms and Abbreviations.....	9
1. Introduction.....	10
1.1. Biofuel.....	10
1.2. Miscanthus as a Bioenergy Crop.....	10
1.3. Abiotic Stress Tolerance.....	11
1.4. Salt Tolerance.....	11
1.5. Biomass Quality for Biofuel Production.....	12
1.6. Salt Stress Affecting on Biomass Quality.....	13
1.7. Knowledge Gap.....	14
1.8. Outline of Thesis.....	14
2. Materials and Methods.....	16
2.1. Plant Materials and Salinity Experiments.....	16
2.1.1. (Chinese) Field Trials:.....	16
2.1.2. Controlled (Pot) Trials:.....	16
2.1.3. Sample Preparation.....	17
2.2. Cell Wall Composition Analysis.....	17
2.2.1. Near-infrared Spectroscopy, Prediction Model, and Scanning of Samples ..	17
2.2.2. Biochemical Analysis.....	18
2.2.2.1. Neutral Detergent Fiber (NDF).....	19
2.2.2.2. Acid Detergent Fiber (ADF).....	20
2.2.2.3. Acid Detergent Lignin (ADL).....	20

2.2.2.4. Calibration and Validation of Prediction Model.....	21
2.2.2.5. Data Analysis	24
3. Result and Discussion.....	25
3.1. Variation in Biomass Yield and Salt Tolerance	25
3.1.1. Field Trials	25
3.1.2. Pot Trials	28
3.2. Variation in Biomass Composition	29
3.2.1. Field Trials	29
3.2.2. Pot Trials	32
3.3. Effect of Salt Stress on Biomass Yield and Composition	34
3.3.1. Field Trials	34
3.3.2. Pot Trials	40
3.4. Correlation of Biomass Composition and Salt Tolerance.....	42
3.4.1. Field Trials	42
3.4.2. Pot Trials	44
4. Conclusion and Future Recommendation.....	45
5. References.....	46
Appendix 1. Calibration data set of Chinese field trials, 84 calibration samples and 16 validation samples.....	51
Appendix 2. Biochemical analyzed data 'Lab' and predicted data 'ANL' of validation set for cell wall composition of Chinese field trials.	56
Appendix 3. The full predicted and analyzed cell wall composition data of Chinese field trials.	66
Appendix 4. The cell wall composition comparison and salt tolerance data of control and stress of Chinese field trials.....	94
Appendix 5. The full analyzed cell wall composition data of Pot trials.	99
Appendix 6. The cell wall composition comparison and salt tolerance data of control and stress of Pot trials.	104

iii. List of Tables

Table 1. Ankom washing buffers and remained cell wall contents after washing.	19
Table 2. Ankom washing buffers and remained cell wall contents after washing.	20
Table 3. Cell wall composition in percentage of cell wall content.	21
Table 4. Comparison of parameters from lab data with predicted data of validation samples.	22
Table 5. Checking of SEP, SEL, and SEP-SEL ratio for model accuracy.	23
Table 6. Biomass composition of 2 years Field trials under Control treatment (Field A) and Salt treatment (Field B).	31
Table 7. Significance of effects (F-value Pr.) of genotypes and treatments on biomass composition of leaf and stem fractions in 2 years Field trials.	32
Table 8. Biomass composition of Pot trials under control treatment and 150mm Salt treatment.	33
Table 9. Significance of effects (F-value Pr.) of genotypes and treatments on biomass composition of leaf and stem fractions in Pot trials.	34
Table 10. Significance (P-value) of correlation between biomass composition and salt tolerance.	43
Table 11. Significance (P-value) of correlation between biomass composition and salt tolerance.	44

iv. List of Figures

Figure 1. Flowchart for the development of prediction models to predict composition using NIRS data (Xu et al., 2013).....	18
Figure 2. The scatter plots of correlation between biochemically analyzed data and model predicted data for cell wall content (NDF%dm) and cell wall composition (Cel%ndf, Hem%ndf, and Lig%ndf) of validation samples.....	23
Figure 3. The bar plot of each genotype yield under Control treatment (Field A) and Salt treatment (Field B) together with salt tolerance, 1 st year Field trials.....	27
Figure 4. The bar plot of each genotype yield under Control treatment (Field A) and Salt treatment (Field B) together with salt tolerance, 2 nd year Field trials.....	27
Figure 5. The bar plot of each genotype yield under Control treatment and 150mm Salt treatment together with salt tolerance, Pot trials.....	29
Figure 6. Box plot of biomass composition of leaves in field A (Control) and B (Salt), 1 st year, Field trials.....	36
Figure 7. Box plot of biomass composition of stems in field A (Control) and B (Salt), 1 st year, Field trials.....	36
Figure 8. Box plot of biomass composition of leaves in field A (Control) and B (Salt), 2 nd year, Field trials.....	37
Figure 9. Box plot of biomass composition of leaves in field A (Control) and B (Salt), 2 nd year, Field trials.....	37
Figure 10. Box plot of biomass composition in leaves in 2 trial years, Field trials.....	38
Figure 11. Box plot of biomass composition in stems in 2 trial years, Field trials.....	38
Figure 12. Box plot of each biomass composition in both plant fractions under control and salinity treatments in 2 trial years, Field trials.....	39
Figure 13. Box plot of biomass composition of leaves in Control and 150mm salinity treatment, Pot trials.....	41
Figure 14. Box plot of biomass composition of stems in Control and 150mm salinity treatment, Pot trials.....	41
Figure 15. Box plot of each biomass composition in both plant fractions under control and salinity treatments, Pot trials.....	42
Figure 16. Correlation between adaptability on hemicellulose content and salt tolerance and in stems, Field trials.....	43
Figure 17. Correlation between adaptability on lignin content and salt tolerance and in leaves, Pot trials.....	44

v. Acronyms and Abbreviations

ADF	: Acid Detergent Fiber
ADF%dm	: Total acid detergent fiber
ADL	: Acid Detergent Lignin
ADL%dm	: Total acid detergent lignin
ANOVA	: Analysis of variant
Cel	: Cellulose
Cel%dm	: Total cellulose
CWC	: Cell Wall Composition
DMC	: Dry Matter Content
GH	: Global H (standardized Mahalanobis distance)
Hem	: Hemicellulose
Hem%dm	: Total hemicellulose
NDF	: Neutral Detergent Fiber
NDF%dm	: Total neutral detergent fiber
NH	: Neighborhood H
NIRS	: Near-infrared Spectroscopy
Sac	: <i>Miscanthus sacchariflorus</i>
SD	: Standard Deviation
SEL	: Standard error of lab biochemically analyzed data
SEP	: Standard error of model predicted data
Sin	: <i>Miscanthus sinensis</i>

1. Introduction

1.1. Biofuel

The high demand on petroleum fuels and great amount of greenhouse gas emission have pushed the world to develop sustainable energy in these decades. Biofuels, processed from organic material of recent biological origin, seem to be promising alternative liquid fuels (Ragauskas et al., 2006). However, most studied and commercialized 1st generation biofuels have been controversial to be unsustainable. They are produced from simple sugars derived from food products and may lead to even more net greenhouse gas emissions in the production process than fossil fuels (Demirbas, 2011). To avoid the potential stress of competing for arable lands with food commodities, raising food prices, and increasing greenhouse gas, 2nd generation biofuels were developed (Sims et al., 2010).

2nd generation biofuels are produced from non-edible lignocellulosic biomasses, such as woody crops, agricultural residues, by-products, dedicated feedstocks, or organic waste (Nigam and Singh, 2011). Bioethanol seems to be the most practical 2nd generation biofuel product (Sims et al., 2010). To produce bioethanol, it takes several pretreatment and enzymatic saccharification processes to convert cellulose and hemicellulose into fermentable C6 or C5 sugars and the yeasts will ferment the sugars into ethanol (Chiaramonti et al., 2012). Consequently, better extraction efficiency of fermentable sugars from cell walls of plants is believed to help popularize the biofuel (Schubert, 2006).

1.2. Miscanthus as a Bioenergy Crop

Miscanthus is considered as one of the most promising biomass crops for the production of 2nd generation bioethanol. It is a perennial rhizomatous C4 grass (Clifton-Brown et al., 2008). It originates from the eastern part of Asia and occurs in temperate and subtropical zones (Hodkinson et al., 2002a). Miscanthus is characterized by high yields of lignocellulosic biomass, a productive life time for at least 10-15 years, low moisture content at harvest, wide geographical adaptability and high water and nitrogen-use efficiencies (Chen and Renvoize, 2006; Chou and Chung, 1974).

Since the 1970's, miscanthus has been studied as a biomass crop worldwide (Anzoua et al., 2011; Lewandowski and Schmidt). It has potential of being carbon neutral biofuel resource which means it produces almost no net emission of carbon from the bioenergy system (Heaton et al., 2004; Zanchi et al., 2012). Miscanthus is now being commercially used in

some European countries as a "clean, affordable, environmentally friendly energy cropping system" (Lewandowski and Schmidt, 2006).

M. x giganteus ($2n=3x=57$) is a sterile triploid crossed between *M. sacchariflorus* ($2n=4x=76$), and *M. sinensis* ($2n=2x=38$) (Hodkinson et al., 2002b). *M. x giganteus* has great potential for biomass yield compared with other genotypes and is non-invasive (Brosse et al., 2012). It is currently the most productive crop and one of the most promising biomass crops (Beale et al., 1999). Combining with the tolerance to abiotic stresses, low inputs and consistently high yields make *M. x giganteus* more profitable than biofuel mandates without competition between food and fuel can be expected. However, genetic diversity of *M. x giganteus* is very low due to its sterility, which severely limits breeding technologies, unless use genetic mutation induction (Greef et al., 1997). However, a large extent of genetic variation exists in the miscanthus genepool, which is represented in the wide geographical spread of miscanthus species in their region of origin. Most important for biomass production in Europe are considered *M. sinensis* and *M. sacchariflorus*. Therefore, in the experiments conducted, these species were studied for abiotic stress tolerance.

1.3. Abiotic Stress Tolerance

When suffering from stress, plants would be prevented from optimal functions, which is yield loss in agriculture. Abiotic stresses refer to stresses perceived from non-living environments (Vinebrooke et al., 2004). Plants, as sessile organisms, have various complex mechanisms of abiotic stresses tolerance when confronted with unfavorable environments (Peleg and Blumwald, 2011). Some existed environments are with extreme conditions as abiotic stress for many plants, and such environments are spreading due to human activities. Abiotic stress tolerant plants could be the solutions to the issue by making use these lands in severe condition and helping in expanding the growing fields in marginal areas.

It is even more important for the bioenergy crop to have abiotic stress tolerance. For bioenergy crops, it is essential to be abiotic stress tolerant for utilizing the marginal soils avoiding competence over arable lands with food crops.

1.4. Salt Tolerance

Increased salinization has kept on impacting arable land worldwide, and up to 50% arable land loss by the middle of 21st century is expected (Mahajan and Tuteja, 2005). This is the

reason that salt tolerance is the most important trait for growing on marginal soils and also for dealing with the salinization of current arable lands (Mahajan and Tuteja, 2005).

High salinity affects most aspects of the plants' physiology and metabolism; therefore, is one of the most severe abiotic stresses (Youngs and Somerville, 2012). It causes disruption of ionic equilibrium, Na^+ poison to cell metabolism with deleterious effect on enzymes, osmotic imbalance, reduction in photosynthesis, and production of reactive oxygen species (Ashraf and Wu, 1994; Mahajan and Tuteja, 2005). In the past 2 decades, there are considerable improvements in salt tolerance of important crop species found mainly relied on phenotypic expression evaluation (Cheeseman, 1988). So far, several major mechanisms have been distinguished to adapt ion homeostasis to salt stress, as synthesis of compatible solutes or osmoprotectants, adapting hydraulics, excision ions to less essential parts, and damage control: ROS scavenging (Ashraf and Wu, 1994).

Researches about salt tolerance in miscanthus have been conducted in several places and mainly in China (DY, 2011). It is found that *Miscanthus x giganteus* is moderately salt tolerant (Ezaki et al., 2008; Xi, 2000). In the experiment conducted by Sun et al., some accessions of *Miscanthus sinensis* showed tolerance to high salt concentrations in the soil (Sun et al.). The salt tolerant accessions have normal morphological (total leaf area and number of tillers) and physiological (chlorophyll content, A, gs, and $\Delta F/F'm$) performances. The authors also reported that early stage screening is applicable. However, for screening for salt tolerant germplasm and for elucidating physiological mechanisms in miscanthus, further field researches and study under representative saline environments are necessary (Brosse et al., 2012; Sun et al., 2014).

Researches for genomic resource for miscanthus are in the early stage due to the size and complexity of genomes, and maker tools are very little (Ma et al., 2012). Although some transcriptome gene assemblies were sequences based on short-reads, further sequencing for miscanthus genomes are still required. For salinity tolerance, only some genes of transcriptome of miscanthus have been found having high similarity with sorghum, maize, and Arabidopsis in salt responsive protein (Barling et al., 2013). However, it is yet ready for breeding for high salt tolerance miscanthus with marker-assisted-selection. (Ma et al., 2012).

1.5. Biomass Quality for Biofuel Production

Salt tolerance is indeed an important and valuable trait for miscanthus to reduce the competition with food crop on arable fields. However, to be a good biofuel resource, not

only the tolerance to salt stress is important. The composition of the biomass after harvesting is equally essential because it directly influence the quality of the biomass for conversion into biofuel.

Bioethanol produced from lignocellulosic biomass represents the best choice in temperate regions if key technical hurdles can be eliminated (Yuan et al., 2008). Current processes for lignocellulosic bioethanol include pretreatment, saccharification (hydrolysis), and fermentation. The major obstacle is that biomass recalcitrance makes complicated structure in cell walls which is hard for biorefining and releasing fermentable sugars (Ragauskas et al., 2014; Williams et al., 2006). The lignocellulose recalcitrance is mainly derived by the structure of the plant cell wall matrix of cross-linked polysaccharide networks, glycosylated proteins, and lignin (Chan et al., 2013; Zhao et al., 2012). In conclusion, better quality lignocellulosic biofuel biomass means biomass with traits for more efficient biorefining process as lower cell wall lignin content (El Hage et al., 2010; Yuan et al., 2008). Cellulose, hemicellulose, and lignin are the three main components of the cell wall, which makes up most of all plant biomass. Cellulose, taking up 40 to 60 % of the cell wall, is the main resource for biofuels production while hemicellulose, taking up 20 to 40 % of the cell wall, is the other with techniques still being improved to make it economical. Lignin, with 10 to 30 % of the cell wall, which is an aromatic polymer, is hard for bioenergy usage (Brosse et al., 2012; Youngs and Somerville, 2012). The ratio between cellulose, hemicellulose and lignin, plays a crucial role in optimizing for biofuels. There are clear differences in cell wall composition among miscanthus species and genotypes. Although *M. x giganteus* has great potential for biomass yield, has relatively high lignin content, much higher than *M. sacchariflorus* or *M. sinensis* types, which indicates low biomass quality for biofuel production (Villaverde et al., 2009).

1.6. Salt Stress Affecting on Biomass Quality

There are multiple studies and examples of stressors causing lignin content increase or lead to chemical composition change in the plant cell walls. Complex genetic and physiological controls are believed to contribute to these composition transformations in the plant bodies (Rogers and Campbell, 2004). In studies of maize, rice and sugarcane, it has been shown that cell walls in several parts of the plants are modified when the plant encounters salinity stress (Fan et al., 2006). The reconstruction of the cell walls often associates to the increase of biosynthesis of lignin which helps in the tolerance to high salinity (Degenhardt and Gimmler, 2000; Tenhaken, 2014). In some salt sensitive rice variety, salt stress cause stunted plant growth with the biosynthesis of cell wall including lignification (Dionisio-Sese and Tobita,

1998). Salinity also has shown effects on the development and morphology of maize with increasing width of the lignified region of Kasparian strip in primary roots (Karahara et al., 2004). There are high degrees of genetic similarity between miscanthus and maize, rice and sugarcane, so that possibly similar phenomena will be observed in miscanthus. (Clifton-Brown et al., 2008; Głowacka, 2011; Hernández et al., 2001; Singh et al., 2008).

However, if biomass composition would have negative effect on biofuel production when miscanthus is adapted to saline soils, the tolerance will not be desirable. This is the reason why potential cell wall compositional modifications in response to salt stress are important to be elucidated for bioenergy crop production in saline soils. Complex genetic network has been found relating to different enzymes towards the cell wall compositional modifications mechanism (Rogers and Campbell). It is commonly controlled with transcriptional regulation, but there are many different regulators involving. Some mechanisms regulating lignification have been found by altering lignin deposition with mutants in plant species (El Hage et al., 2009). This is not the intention in this thesis to investigate on how or which transcription factors or enzymes are causing the differences since the background information of the mechanism are too early to be utilized.

1.7. Knowledge Gap

It is important to understand the composition and structure of the lignin of miscanthus cell walls for effective utilization. However, only very few researches have been done in conducting to cell wall composition modification towards salt stress in the soil currently. It has been observed that lignin forms in the root regions of miscanthus when Al stress occurs (Ezaki et al., 2008). Still, detail structural characterization of miscanthus lignin has not yet been abundantly reported since 2nd generation of biofuel production on miscanthus is also in a rather early stage. The situation has been made even harder when the little information on miscanthus cell wall composition transformation under salt stress had sometimes contradictory results.

1.8. Outline of Thesis

With the objective to develop miscanthus varieties that have a good biomass quality for fuel production and together with high salinity tolerance, two different experiments were conducted. These experiments aimed to investigate the variation in salt tolerance and the relations between biomass quality and salt stress or salt tolerance. First, stem and leaf

samples of 25 miscanthus accessions from two separate field trials for two years in China were analyzed for cell wall composition. One field was with high salt content and the other was the control with normal soil condition.

Second, stem and leaf samples of a controlled salt stress experiment were analyzed for cell wall composition. 12 genotypes were grown in pots in the greenhouse, with either saline soil or normal soil. The genotypes of this experiment were selected for high salt tolerance based on results of a hydroponic experiment with over 50 genotypes.

Later on, the collected samples were analyzed and put in statistic inspection together with the field condition to see if the salt stress does have effect on cell wall composition. The ultimate aim of the whole experiment is to select for high quality biomass with high salt tolerance.

The two experiments were conducted following the specific objectives:

1. Is there an effect of salt stress on cell wall composition / biomass quality for biofuel production?
2. Does cell wall composition affects salt tolerance?
3. Can we select miscanthus varieties with a high salt tolerance and high quality biomass for biofuel production?

2. Materials and Methods

2.1. Plant Materials and Salinity Experiments

2.1.1. (Chinese) Field Trials:

25 miscanthus accessions were evaluated in two field trials. 20 accessions were wild accessions occurring in saline areas in East-China (genotypes named with CN-) and 5 accessions were from the germplasm resources in Europe (genotypes named with OPM) (Appendix 3.). In total the test included 22 *M. sacchariflorus*, 2 Hybrid (OPM-8 and OPM-6), and 1 *M. X giganteus* accessions (OPM-9). Trials were applied on two separate open fields in Dongying, China as different treatments. Field A was with normal soil condition as control and field B was with high salt content soils. There were three plot replicates of each genotype put in a completely randomized block. The plots were in size of 4 m² and with planting density of 2 plants in per m². The plants were harvested in the first and second year at the end of October, after full senescence and before the winter storm that would cause complete defoliation. Both fractions of stem and leaf were later analyzed for cell wall composition. Final collected samples should be in total 600 samples (Genotypes*Treatment*Biological replicates*Year*Fraction = 25*2*3*2*2=600) for analysis. But real samples were less due to loss through the field trial period.

2.1.2. Controlled (Pot) Trials:

12 miscanthus accessions were selected and micropropagated from the OPTIMISC project with hydroponic experiment to conduct this selecting for high salt tolerance. 10 *M. sinensis*, 1 Hybrid (OPM-7) and 1 *M. X giganteus* (OPM-9) were used (Appendix 5.). Trials were applied on two different types of salt content soil in pots. One was with 150mM saline soil and the other was with normal soil condition as control. There were four replicates for each treatment and the trial was conducted in a greenhouse. Plant materials were harvested while still green, not fully matured. Both fractions of stem and leaf were later analyzed for cell wall composition. In every trial, four replicates are pooled into two pools for the material to be enough for analysis. As a result, final analyzed samples were in total 96 samples (Genotypes*Treatment*Pools*Fraction = 12*2*2*2).

2.1.3. Sample Preparation

Harvested plant materials were separated as leaf and stem. After drying for three days at 70 degree Celsius, the materials were cut into chips and grinded with a hammer mill and a 1 mm screen to get fine powder for further analysis (Haffner et al., 2013). From the field experiment 14 samples were too small in biomass quantity to be analyzed and were excluded.

2.2. Cell Wall Composition Analysis

For reaching the cell wall composition of the plant samples, two methods were developed and applied according to the sample size and characteristics. One is biochemically analysis, which is time consuming but highly accurate. The other faster method is by prediction model built with Near-infrared Spectroscopy scanning and biochemically analyzed calibration samples. These two methods were both applied according to the sample size of the trials. Details are described in later sections.

In the Chinese field trials (Field trials), because the sample size was too large, it would not be efficient to apply biochemical analysis for all samples to get cell wall composition data. So, all Field trials samples were scanned with the NIRS and combined with biochemical analysis data for building up a prediction model. Although the sample size of pot trials was small enough for all analyzed biochemically, all samples were scanned as well for possibility of enriching the data base.

2.2.1. Near-infrared Spectroscopy, Prediction Model, and Scanning of Samples

Near-infrared spectroscopy (NIRS) is a fast and multi-constituent analysis method. The detector quickly gets the absorbance of samples by measuring the diffuse transmittance, diffuse reflectance, and trans-reflectance (Reich, 2005). Through building up a multivariate calibration model with the required parameters, the NIRS helps in providing fast chemical composition details matching the detected spectra of the scanned objects.

The building up of multivariate calibration model includes four steps: i) Selection of ~100 representative samples for calibration model; ii) Scanning through NIRS, acquiring the spectra and reference values through software 'Mosaic Solo (NIRS DS2500)'; iii) Relating the

spectra values to the biochemical analyzed values with software 'WinISI Project Manager'; vi) Validation of the model theoretically should be done with ~20 new random samples. The process of the model development is shown in the following Figure 1.

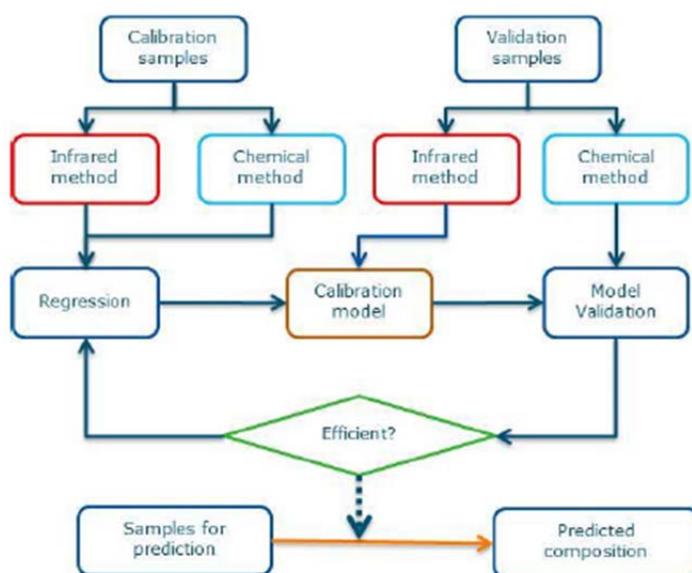


Figure 1. Flowchart for the development of prediction models to predict composition using NIRS data (Xu et al., 2013).

In total, 100 samples were selected for biochemical analysis. 84 of these samples were used for updating and calibrating, including all 40 outliers from the prediction model and 44 randomly selected samples. The last randomly selected 16 were used for prediction model validation.

2.2.2. Biochemical Analysis

In the biochemical analysis for Field trials, three replicates of each sample and control sample were weighted for each analysis. For Pot trials, all 24 samples were analyzed. Only two replicates of each sample and control sample were weighted for each analysis due to the little amount of the sample material.

The biochemical analysis of cell wall composition was conducted gravimetrically. Grinded powdery materials of selected samples were scaled, and filling in each ANKOM F57 filter bag of 0.49 to 0.50 grams with an analytical balance (Adesogan, 2005).

Weighted bags with samples filling in were put into 103°C oven for overnight drying to get the dry matter content percentage. Following Formula 1 was used to calculate DMC. 0.001736 is the empty bag correction factor.

$$\text{Formula 1: DMC (\%)} = \frac{\text{Total dry weight (Bag and Sample)} - \text{Original bag weight} - 0.001736}{\text{Original sample weight}} \times 100\%$$

Using an 'ANKOM 2000 Fiber Analyzer' with different washing buffers, neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) components could determine cellulose, hemicellulose, and acid-insoluble lignin contents gravimetrically, shown in Table 1 (ANKOM Technology Corporation, Fairpoint, NY).

Table 1. Ankom washing buffers and remained cell wall contents after washing.

Buffer	Remaining Cell Wall Content		
NDF	Cellulose	Hemicellulose	Lignin
ADF	Cellulose	Lignin	
ADL	Lignin		

2.2.2.1. Neutral Detergent Fiber (NDF)

NDF buffer contains sodium dodecyl sulfate, ethylenediamine-tetraacetic acid disodium salt dehydrate, sodium tetraborate decahydrate, sodium phosphate dibasic, and triethylene glycol. Heat-stable bacterial alpha amylase and sodium sulfite, Na₂SO₃, was added to the analyzer together with the NDF buffer and the pre-weighted sample bags were incubated at 100°C in Ankom NDF program. After twice rising with alpha amylase solution and once in acetone for 10 minutes, samples were dried overnight in 103°C oven. NDF buffer washes away all the biomass except the cell wall contents including cellulose, hemicellulose and lignin. The cooled down samples were weighted and %NDF of dry matter could be calculated as in Formula 5.

$$\text{Formula 5: NDF\%dm} = \frac{\text{Total weight after NDF treatment} - \text{Original bag weight} + 0.0048}{\text{Dried sample weight}} \times 100\%$$

2.2.2.2. Acid Detergent Fiber (ADF)

ADF buffer contains cetyltrimethylammonium bromide (CATB) and sulfuric acid. After the incubation under 100°C in Ankom ADF program, samples were rinsed with hot demi water and later on acetone for 10 minutes. Samples were dried overnight in 103°C oven, cooled, and weighed. ADF buffer wash off the cell wall contents except cellulose and lignin. %ADF was calculated following Formula 6.

$$\text{Formula 6: ADF\%dm} = \frac{\text{Total weight after ADF treatment} - \text{Original bag weight} + 0.00031}{\text{Dried sample weight}} \times 100\%$$

2.2.2.3. Acid Detergent Lignin (ADL)

ADL buffer is 72% sulfuric acid. Samples done with ADF incubation were afterwards used for ADL incubation. Samples were shaken at 90 rpm for 3 hours to wash off everything except lignin content in the cell walls. Samples were rinsed in demi water until the acidity went down and pH value reached between 6 and 7. Then samples were rinsed in acetone for 10 minutes and dried overnight in 103°C. %ADL was weighted and calculated with Formula 7.

$$\text{Formula 7: ADL\%dm} = \frac{\text{Total weight after ADL treatment} - \text{Original bag weight} - 0.00467}{\text{Dried sample weight}} \times 100\%$$

As in Table 2, the detergent fiber contents could be used for calculating Cellulose concentrations in total dry weight, Cel%dm, Hemicellulose concentrations in total dry weight, Hem%dm, and Lignin concentrations in total dry weight, Lig%dm.

Table 2. Ankom washing buffers and remained cell wall contents after washing.

	Cell Wall Concentration (%dm)
NDF%dm - ADF%dm	Hemicellulose%dm
ADF%dm - ADL%dm	Cellulose%dm
ADL%dm	Lignin%dm

In order to present the true percentage of each cell wall composition element analyzed to the whole cell wall part in the plant, following parameters were used in the final result. Cellulose concentrations in total cell wall, Cel%ndf, Hemicellulose concentrations in total cell wall, Hem%ndf, and Lignin concentrations in total cell wall, Lig%ndf, were calculated with NDF%dm (Formula 2, 3, and 4) and shown in Table 3.

Formula 2:
$$\text{Cel\%ndf} = \frac{\text{ADF\%dm} - \text{ADL\%dm}}{\text{NDF\%dm}} \times 100\%$$

Formula 3:
$$\text{Hem\%ndf} = \frac{\text{NDF\%dm} - \text{ADF\%dm}}{\text{NDF\%dm}} \times 100\%$$

Formula 4:
$$\text{Lig\%ndf} = \frac{\text{ADL\%dm}}{\text{NDF\%dm}} \times 100\%$$

Table 3. Cell wall composition in percentage of cell wall content.

Cell Wall Concentration (%ndf)	
NDF%ndf - ADF%ndf	Hemicellulose%ndf
ADF%ndf - ADL%ndf	Cellulose%ndf
ADL%ndf	Lignin%ndf

All analyses were performed in replicates, Field trials three replicates and Pot trials two replicates, both in leaf and stem fractions. The standard deviation and the relative standard deviation of the biochemical analysis data were also calculated. To be accurate and valuable, the relative standard deviation values of each sample should be lower than 15%; otherwise the sample would be reanalyzed.

2.2.2.4. Calibration and Validation of Prediction Model

Calibration models are built by correlating scanned spectral values to the biochemically obtained parameters of the selected 84 samples. Principal component analysis (PCA) is then applied to make sure the factors describe the variations of the data points precisely. Two important statistical values were applied in PCA. First, Global H, which shows difference of a sample from the average of all samples, center of the spectral hypersphere. The other one is the Neighborhood H (NH), which indicates the closeness of neighboring samples included in the dataset. Outlines are with either GH values higher than 3.0 or NH values higher than 1.0 (Olinger et al., 2001). The prediction model should contain as less outlier as possible to make accurate prediction.

After the model has been built, prediction values of the validation samples will be put together with biochemical analyzed result to statistically check the accurateness of the model (Haffner et al., 2013).

Later on, in order to check the quality of developed models, R-square values were checked whether it's close to 1. By checking standard deviation of the predicted data to be lower than 5 times of standard deviation of the biochemical analyzed lab data was the other method. The approximate rule shouldn't be applied when the standard error in the lab is very low since the standard error of prediction model will not or only have little decrease. So, if the standard error of prediction model is lower than 2, the model would be assumed accurate.

By using the parameters NDF%dm, ADF%dm, ADL%dm, Cel%ndf, Hem%ndf, and Lig%ndf of the calibration set, the prediction models was built to get the cell wall composition of all Field Trials. All the biochemically analyzed data of calibration set and validation set are in Appendix 1.

The developed model was validated with the validation samples and shown in Appendix 2. Before using the predicted data set to predict the cell wall composition of the whole Field trials, the quality of the prediction model was checked with the validation samples. Parameter R-square value is the squared correlation coefficient between lab-analyzed and model-predicted values of the validation samples (Table 4.).

Table 4. Comparison of parameters from lab data with predicted data of validation samples.

Parameter	Sample No.	Mean	SD	Est. Min	Est. Max	RSQ
NDF%dm	16	70.97	8.1	59.07	85.36	0.979
ADF%dm	16	41.28	8.88	29.41	60.14	0.985
ADL%dm	16	5.78	2.27	3.62	11.24	0.88
Cel%ndf	16	49.07	3.93	42.54	56.11	0.889
Hem%ndf	16	42.34	6.24	29.39	51.12	0.917
Lig%ndf	16	8.09	1.856*	6.22	12.57	0.707

Note: SD = Standard deviation; EST= Estimated; RSQ = R-square, R²

Cell wall content (NDF%dm) and cell wall composition (Cel%dm, Hem%dm, Lig%dm, Cel%ndf, Hem%ndf, and Lig%ndf)

Still, when the correlation is high, there is chance the standard error of the predicted data would be large if a large bias exists or the slope of the correlation is unequal to 1. So, the ratio of standard error of predicted data to standard error of lab chemical analyzed data should also be checked to be lower than 5 or the standard error of predicted data is lower than 2 when standard error of lab chemical analyzed data is already very low (Table 5.). The high correlations can be seen in the Figure 2. with the trend lines. All in all, the prediction model has been proved to be able to give accurate prediction.

Table 5. Checking of SEP, SEL, and SEP-SEL ratio for model accuracy.

Parameter	SEP	SEL	Remark
NDF%dm	1.82	0.94	SEP<2*SEL
ADF%dm	1.33	0.92	SEP<2*SEL
ADL%dm	0.85	0.21	SEP<4*SEL
Cel%ndf	1.45	0.46	SEP<4*SEL
Hem%ndf	1.77	0.63	SEP<3*SEL
Lig%ndf	1.37	0.23	SEP<6*SEL

Note: SEP = Standard error of predicted data, SEL = Standard error of lab chemical analyzed data.

Cell wall content (NDF%dm) and cell wall composition (Cel%dm, Hem%dm, Lig%dm, Cel%ndf, Hem%ndf, and Lig%ndf)

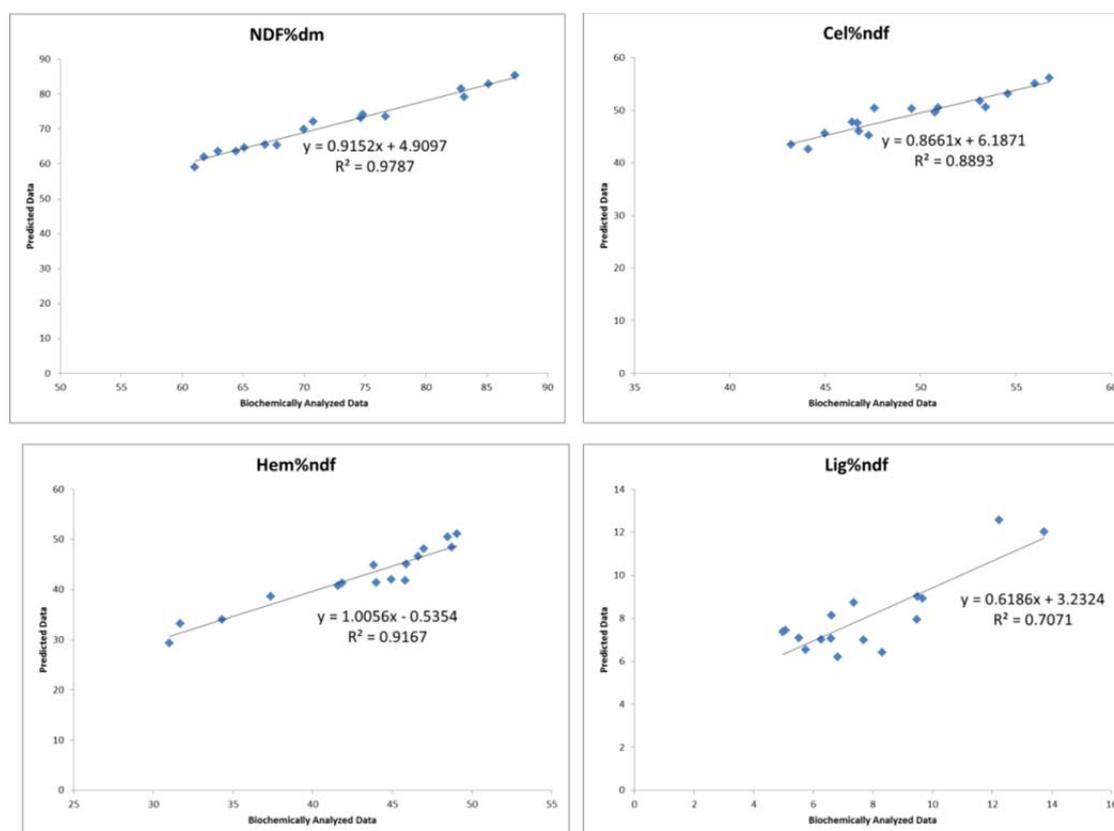


Figure 2. The scatter plots of correlation between biochemically analyzed data and model predicted data for cell wall content (NDF%dm) and cell wall composition (Cel%ndf, Hem%ndf, and Lig%ndf) of validation samples.

2.2.2.5. Data Analysis

After the raw data were collected, the cell wall composition was described through the following parameters: Cel%ndf, Hem%ndf, and Lig%ndf. These parameters were obtained as in formula 5, 6, and 7 in the previous sections. The transformed cell wall composition data were then acquired and together analyzed with NDF%dm by using software 'Genstat 17th Edition'. ANOVA analysis was performed to assess the effect of salinity stress on cell wall composition in accessions. Also, the effect of cell wall composition and adaptability (Formula 8.) on salt tolerance (Formula 9.) was also checked with correlation analyses of each accession.

Formula 8: Adaptability = CWC of Salt Treated Sample – CWC of Control Sample

Formula 9: Salt Tolerance = $\frac{\text{Yield under Salt Stress}}{\text{Yield without Salt Stress}} \times 100\%$

3. Result and Discussion

3.1. Variation in Biomass Yield and Salt Tolerance

3.1.1. Field Trials

Yields of whole plants under control varied in wide range among the 25 genotypes used in Field trials of the 1st year trial (Control, Figure 3). In the 1st trial year, the yields ranged from the lowest of ~10 gram/m² of OPM-9 to the highest of ~325 gram/m² of OPM-8. The three genotypes with most yields were genotype OPM-8, yield of ~325 gram/m², OPM-6, yield of ~280 gram/m², and CN-35, yield of ~255 gram/m². OPM-8 and OPM-6 are both hybrids from European OPMISTIC project, CH-35 is *M. sacchariflorus* originated from China. OPM-9 was with worst yield for only ~10 gram/m² of yield.

In the 2nd trial year, the yield still had wide range. The range greatly shifted to higher value in average was from ~1250 gram/m² to ~325 gram/m² (Control, Figure 4.). There were 3 genotypes of *M. sacchariflorus* having yield from 200 to 400 gram/m², 5 genotypes of *M. sacchariflorus* from 400 to 600 gram/m², 3 genotypes of *M. sacchariflorus* and 1 of Hybrid from 600 to 800 gram/m², 8 genotypes of *M. sacchariflorus* and 1 of Hybrid from 800 to 1000 gram/m², and 3 genotypes of *M. sacchariflorus* had ~1200 gram/m². Genotypes CN-33, CN-27, and OPM-1 had the highest yields of around ~1200 gram/m². Overall, *M. sacchariflorus* were with the highest yields comparing to the other species. The result is reasonable since the *M. sacchariflorus* were tetraploid.

Comparing together the yield of 2 years of Field trials, the yields range changed significantly. Yields of 1st year were rather low. The best yields of the 1st year was only ~325 gram/m² (Control, Figure 3.), while in 2nd year, the best yield reached ~1250 gram/m², and the worst yield were still ~300 gram/m² (Control, Figure 4.), which is almost the same as the best yield of the previous year. In the 1st year, OPM-8, OPM-6, and CN-35 were with highest yields, but the 2nd year, CN-33, CN-27, and OPM-1 had most yields. For commercial or breeding use, yields of the fully matured plants should be considered, so further investigation on the potential genotypes should be conducted.

The great increase in yields of *Miscanthus* in the 2nd year were due to they are perennial plants, which in most climates reach full maturity in the 3rd year after establishment (Allison et al., 2011). Also, since the differences between genotypes were significant, the yields of 1st year young plants and the yield increase in 2nd year also performed very differently. Among

all the genotypes, the yield of OPM-9, of *M. × giganteus*, was remarkably low. It is the only genotype being used for commercial biofuel production for its good yield. The low yield of *M. × giganteus* in this experiment might be due to the largely different climate of Northern China compared to Europe. It has been observed that within the three replicates, only one of them survived and still with very low yield.

The salt tolerance, in this report, is by definition standing for how many percentage of biomass yield one genotype could avoid decreasing (comparing to the origin yield) under salt stress treatment (Formula 9.). The arrangements of the genotypes were given according to the salt tolerance in Figure 3 and 4.

Looking into the salt tolerance of 1st year trials, the range of genotypes were from 0% to 40% (Control, Figure 3.). The higher yield the control plant has the lower the salt tolerant the genotype is. OPM-9 was the genotype with 0% of salt tolerance since no plant survived under salt stress. 11 genotypes of *M. sacchariflorus* and 2 hybrids showed salt tolerance from 5% to 15%, 7 genotypes of *M. sacchariflorus* presented 15% to 25% of salt tolerance, 4 genotypes of *M. sacchariflorus* were with 25% to 35% of salt tolerance, and 2 genotypes of *M. sacchariflorus* were with 25% to 35% of salt tolerance, and 2 genotypes of *M. sacchariflorus* performed 35% to 40% of salt tolerance. It has been observed that the yields under salt stress were approximately the same, but the yield in control condition varied a lot. This is the cause of great difference in salt tolerance. The genotypes with highest salt tolerance were OPM-3, ~35% of salt tolerance, and CN-8, 40%.

For the 2nd year, salt tolerance ranged from 10% to 105% (Control, Figure 4.). In comparison to 1st year, the increase in salt tolerance of each genotype was obvious. OPM-9 had ~10% of salt tolerance, 13 genotypes of *M. sacchariflorus* and 2 hybrids showed salt tolerance from 20% to 40%, 6 genotypes of *M. sacchariflorus* presented 40% to 60% of salt tolerance, 2 genotypes of *M. sacchariflorus* were with 60% to 80% of salt tolerance, and 1 genotypes of *M. sacchariflorus* were ~105% of salt tolerance. The genotype with best salt tolerance was CN-8, whose yield under stress was even higher than under control.

The rankings of salt tolerance in the two trial years were the same (Control, Figure 3. and 4.) with OPM-9 being the lowest and CN-8 was the highest. The yields in the 2nd year increased greatly both in control condition and under salt stress, so did the salt tolerance. Seeing from the result, the salt tolerance improved a lot due to the maturity of the plants, and further inspection on the plants in the same trial should be conducted for proving the effects of plants maturities.

The inspection over the genotypes showed high variation, which is good to know that they can provide very diverse characteristics. Although the tolerance of OPM-1 was not the highest, it achieved the highest yield under salt stress in the 2nd year. The character of high salt tolerance and good yield provides evidence that yield and salt tolerance are not mutually exclusive among natural variants of miscanthus and indicated OPM-1 as a potential good candidate for breeding. Also, CN-8 is considered an interesting candidate for research into the mechanism of salt tolerance, as it showed a salt tolerance higher than 100%.

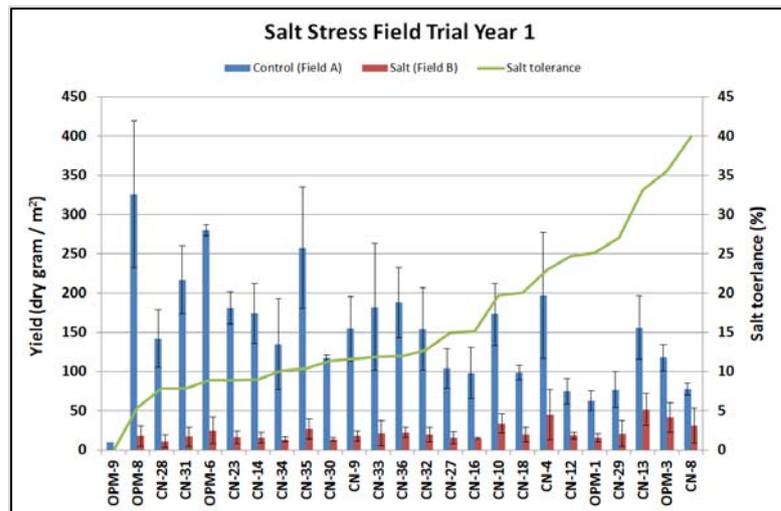


Figure 3. The bar plot of each genotype yield under Control treatment (Field A) and Salt treatment (Field B) together with salt tolerance, 1st year Field trials.

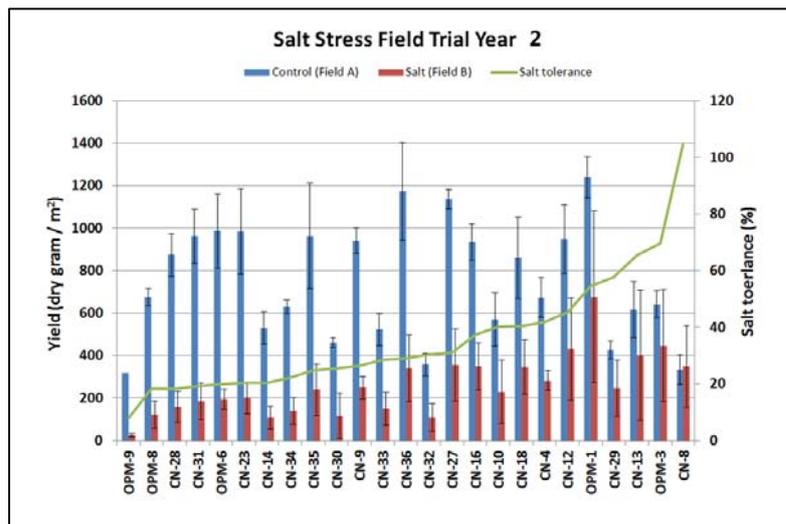


Figure 4. The bar plot of each genotype yield under Control treatment (Field A) and Salt treatment (Field B) together with salt tolerance, 2nd year Field trials.

3.1.2. Pot Trials

In Pot trials, the yields didn't vary that much in large scale in between 12 genotypes overall, probably because these genotypes were all selected for being salt tolerant (Control, Figure 5.). It ranged from 7 to 24 gram/m². 1 genotype of *M. sinensis* had lower than 10 gram/m² of yield, 5 genotypes of *M. sinensis* and 1 genotype of *M. giganteus* were with yield 10 to 15 gram/m², 2 genotypes of *M. sinensis* and 1 hybrid had yield of 15 to 20 gram/m², 2 genotypes of *M. sinensis* had higher than 20 gram/m². OPM-31 had least yields of ~7 gram/m² and OPM-56 had most yields of ~24 gram/m².

The variation of plant yields of the Pot trials were rather small comparing to the Field trials. Main reason caused this phenomena was that plant size of trials were different when they were harvested. Plants were still young, small, and green when harvested in the Pot trials, younger than 1-year-old. On contrast, plants in Field trials were kept on the ground over the winter before harvested. They were at least 1-year-old. Different maturity here were again being proved had great influence on the yield. The Pot trials have been seemed as a nice method of pre-breeding, but the plant maturity should be higher to see the difference.

The salt tolerance of Pot trials ranged from ~60% to ~150%. 6 genotypes of *M. sinensis* and 1 hybrid had salt tolerance ranged from 60% to 80%, 3 genotypes of *M. sinensis* were with 80% to 100% salt tolerance, 1 genotypes of *M. sinensis* and 1 genotype of *M. giganteus* had higher than 140% of salt tolerance. OPM-86 had lowest tolerance of ~60% and OPM-48 had best tolerance of ~150%.

Within the 12 genotypes, the salt tolerance varied in a larger range than yield. Most genotypes had salt tolerance from 60% to 90%, but OPM-9 and OPM-48 had rather high salt tolerance reaching 140%. The result indicated the good possibility for OPM-09 and OPM-48 as candidates for salt tolerant breeding.

A very special observation has been made on OPM-9, *M. giganteus*. Comparing the performances of OPM-9 in the Field trials and Pot trials, it was significantly different. In the Field trials, OPM-9 performed worst in both yield and tolerance in both years. In contrast, it's the genotype with the 2nd best performance in salt tolerance though the yield is still not the highest one. The trials in the pots met the expectation of how OPM-9 should perform since it's the commercial used genotype, but didn't show in the Field trials. Speculation is that it is possible due to the difference of climates. Since it's the genotype originated from Europe, the climate of northern China might suppress the growth or even caused the plant to die.

Further trials in the open fields should be conducted to have confirmation of the hypothesis and better understanding.

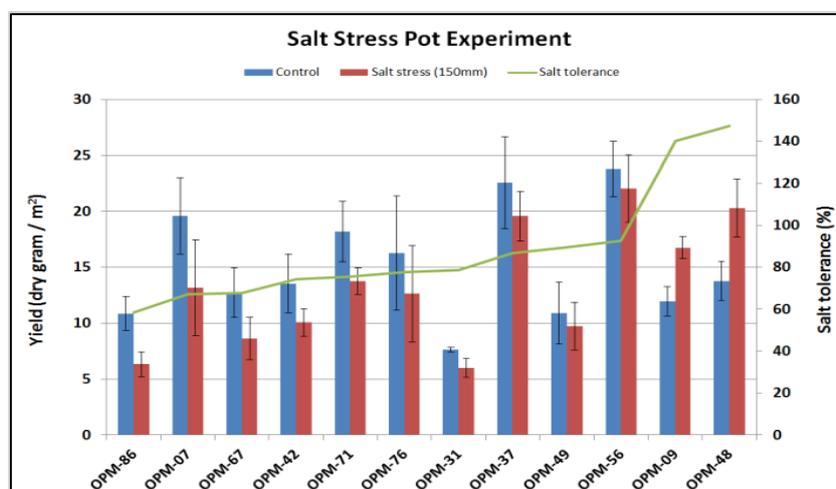


Figure 5. The bar plot of each genotype yield under Control treatment and 150mm Salt treatment together with salt tolerance, Pot trials.

3.2. Variation in Biomass Composition

3.2.1. Field Trials

In leaf fraction of control plants in 1st year Field trials, the cell wall content varied from 58.2%dm to 64.1%dm, cellulose content varied from 41.91%ndf to 46.71%ndf, hemicellulose content varied from 45.64%ndf to 51.65%ndf, and lignin content varied from 6.219%ndf to 7.362%ndf (Control, Table 6.). The variance of cell wall content was 2.871, of cellulose was content 1.176, of hemicellulose content was 2.108, and of lignin content was 0.101. The variance of biomass composition of leaf fraction was not very high among the genotypes in the control group in 1st year. The differences of biomass composition between genotypes were significant according to the statistics analysis (Genotype, Table 7.).

Biomass composition of stem fraction in the 1st year Field trials were of cell wall content ranging from 58.4%dm to 74.39%dm, cellulose content ranging from 27.33%ndf to 25.51%ndf, hemicellulose content ranging from 40.6%ndf to 46.84%ndf, and lignin content ranging from 7.597%ndf to 10.1%ndf (Control, Table 6.). The variance of cell wall content was 19.55, of cellulose content was 1.375, of hemicellulose content was 3.17, and of lignin content was 0.375. Among the genotypes, the cell wall content varied quite much than all the other cell wall contents. The differences of biomass composition between genotypes

were significant according to the statistics analysis (Genotype, Table 7.).

Leaf fraction of plants in the 2nd year Field trials had cell wall content from 70.82%dm to 77.95%dm, cellulose content from 68.71%ndf to 75.03%ndf, hemicellulose content from 38.88%ndf to 43.07%ndf, and lignin content from 6.688%ndf to 9.14%ndf (Control, Table 6.). The variance of cell wall content was 3.001, of cellulose content was 0.532, of hemicellulose content was 0.892, and of lignin content was 0.26. The differences of biomass composition between genotypes were significant according to the statistics analysis (Genotype, Table 7.).

In the 2nd year of Field trials, stem fraction in plants had range of cell wall content from 76.1%dm to 88.8%dm, cellulose content from 52.89%ndf to 56.36%ndf, hemicellulose content from 30.06%ndf to 35.22%ndf, and lignin content ranged from 9.258%ndf to 12.27%ndf (Control, Table 6.). The variance of cell wall content was 10.87, of cellulose content was 0.879, of hemicellulose content was 1.775, and of lignin content was 0.615. The differences of biomass composition between genotypes were significant according to the statistics analysis (Genotype, Table 7.).

When looking into the biomass composition of 2 years trials together (Control, Table 6.), for leaf fraction, the average of cell wall content increased by ~13%dm with the variance increased for ~0.2. Of cellulose content, ~7%ndf and variance decreased for ~0.65. Of hemicellulose content, it decreased ~8.4%ndf on average, and variance decreased for ~1.2. Of lignin content, on average, it increased ~0.86%ndf, and the variance increased for ~0.16. In the stem fractions, the average of cell wall content increased by ~16.9%dm and variance decreased for ~8.7; the average of cellulose content ~27.5%ndf and variance decreased for ~0.5; the average of hemicellulose content decreased ~11.4%ndf and variance decreased for ~2; the average of lignin content increased ~2.85%ndf and variance decreased for ~2.

The biomass composition did have obvious change after 1 year of growth and could be seen by looking into the average change between 2 years. Not many variances differences had been seen except the variance of cell wall content in stem. This indicated the differences of these cell wall compositions among these genotypes didn't changed that much as the plants became more mature, and this conclusion had also been made in the other research (Allison et al., 2011). The variance of cell wall content dropped by 8.7%ndf, which indicated that the similarity of the cell wall content in the 2nd year were much higher than the 1st year. This might be caused by the increase of plant maturity, and can be seen also comparing the yields of control plants in 1st and 2nd years (Al-Hakimi and Hamada, 2001).

Comparing the biomass composition in different plant fractions (Control, Figure 3. and 4.),

the average differences in biomass compositions indicated obviously that in stem fraction, cell wall and lignin contents were higher, while cellulose content was a lot lower and hemicellulose content was only slightly lower. The lower cellulose content might be the strategy of facing the salt stress, which has also been seen in wheat or tobacco (Al-Hakimi and Hamada, 2001). It might be that the degrading of cellulose helps in raising the water potential inside the plants to balance with the water potential outside the plants. After 1 year later, in stem fraction, cell wall and lignin content were still higher, but cellulose content was becoming higher and hemicellulose content was lower. The obvious change of cellulose and hemicellulose contents was suspected to have relations with the physiological change or growth. Genotypic variances differences had been shown also. Variances of all 5 biomass composition parameters are at least slightly higher in the stem fractions among the genotypes. The cell wall content was with the biggest difference in variance between 2 plant fractions. The higher variances indicated that the biomass composition differed more in stems rather in leaves, especially the cell wall content.

Table 6. Biomass composition of 2 years Field trials under Control treatment (Field A) and Salt treatment (Field B).

Field	Year	Component	Unit	Treatment	Leaf					Stem					
					Ave.	Min.	Max	Range	Variance	Ave.	Min.	Max	Range	Variance	
Field	year 1	Cell wall content	%dm	Control (Field A)	61.34	58.23	64.1	5.871	2.871	65.08	58.4	74.39	15.98	19.55	
			%dm	Salt (Field B)	59.91	56.67	63.32	6.648	3.275	64.06	58.48	72.51	14.02	16.75	
	Cellulose	%ndf	Control (Field A)	43.66	41.91	46.71	4.801	1.176	27.33	25.51	30.3	4.786	1.375		
		%ndf	Salt (Field B)	44.05	41.81	46.82	5.01	1.444	27.01	24.14	30.48	6.339	2.268		
	Hemicellulose	%ndf	Control (Field A)	49.48	45.64	51.65	6.012	2.108	43.62	40.6	46.84	6.238	3.17		
		%ndf	Salt (Field B)	48.91	45.57	50.9	5.333	2.152	46.31	43.41	49.12	5.716	3.082		
	Lignin	%ndf	Control (Field A)	6.74	6.219	7.362	1.143	0.101	8.525	7.597	10.1	2.508	0.375		
		%ndf	Salt (Field B)	6.394	5.531	7.263	1.732	0.156	7.496	6.518	8.44	1.922	0.265		
	Field	year 2	Cell wall content	%dm	Control (Field A)	74.1	70.82	77.95	7.134	3.001	81.95	76.1	88.8	12.7	10.87
				%dm	Salt (Field B)	71.25	68.71	75.03	6.32	2.092	79.08	73.87	87.7	13.83	13.43
Cellulose		%ndf	Control (Field A)	50.57	48.97	51.95	2.983	0.532	54.84	52.89	56.36	3.462	0.879		
		%ndf	Salt (Field B)	49.68	48.26	51.09	2.831	0.515	52.56	50.66	55	4.342	1.397		
Hemicellulose		%ndf	Control (Field A)	41.29	38.88	43.07	4.196	0.892	32.24	30.06	35.22	5.162	1.775		
		%ndf	Salt (Field B)	42.85	41.2	44.59	3.391	0.894	36.79	34.01	38.99	4.975	1.805		
Lignin		%ndf	Control (Field A)	7.599	6.688	9.14	2.452	0.26	11.37	9.258	12.27	3.01	0.615		
		%ndf	Salt (Field B)	6.954	5.889	7.699	1.81	0.156	9.404	8.205	10.66	2.459	0.658		

Cell-wall-content%dm = Total neutral detergent fiber content percentage of the whole plant biomass;

Cellulose%ndf = Total cellulose content percentage of cell wall; Hemicellulose%ndf = Total

hemicellulose content percentage of cell wall; Lignin%ndf = Total lignin content percentage of cell wall.

Table 7. Significance of effects (F-value Pr.) of genotypes and treatments on biomass composition of leaf and stem fractions in 2 years Field trials.

Trait	Component	Year 1 Leaf	Year 1 Stem	Year 2 Leaf	Year 2 Stem
		F.pr.	F.pr.	F.pr.	F.pr.
Cell wall content	Genotype	<.001	<.001	<.001	<.001
	Treatment	<.001	<.001	<.001	<.001
	Genotype.Treatment	0.03	0.217	0.116	0.267
Cellulose	Genotype	<.001	<.001	<.001	<.001
	Treatment	0.002	<.001	<.001	0.003
	Genotype.Treatment	0.096	0.118	0.204	0.208
Hemicellulose	Genotype	<.001	<.001	<.001	<.001
	Treatment	0.002	<.001	<.001	0.186
	Genotype.Treatment	0.108	0.221	0.911	0.444
Lignin	Genotype	<.001	<.001	<.001	<.001
	Treatment	<.001	<.001	<.001	<.001
	Genotype.Treatment	0.164	0.126	0.624	0.85

Cell-wall-content = Total neutral detergent fiber content percentage of the whole plant biomass;
 Cellulose = Total cellulose content percentage of cell wall; Hemicellulose = Total hemicellulose content percentage of cell wall; Lignin = Total lignin content percentage of cell wall.

3.2.2. Pot Trials

In Pot trials, leaf fraction of plants had cell wall content ranging from 59.02%dm to 72.07%dm, cellulose content ranging from 38.71%ndf to 48.24%ndf, hemicellulose content ranging from 46.8%ndf to 55.99%ndf, and lignin content ranging from 4%ndf to 7.083%ndf (Control, Table 8.). The variance of cell wall content was 17.82, cellulose content was 5.315, hemicellulose content was 6.125, and lignin content was 0.647. The differences of biomass composition between genotypes were significant according to the statistics analysis (Genotype, Table 9.).

Stem fraction in plants of Pot trials had range of cell wall content from 64.15%dm to 78.11%dm, cellulose content from 46.64%ndf to 54.77%ndf, hemicellulose content from 39.08%ndf to 47.61%ndf, and lignin content ranged from 4.238%ndf to 7.026%ndf (Control, Table 8.). The variance of cell wall content was 22.11, of cellulose content was 4.244, of hemicellulose content was 4.95%dm, and of lignin content was 0.63%dm. The differences of biomass composition between genotypes were significant according to the statistics analysis (Genotype, Table 9.).

To see the biomass composition on average (Control, Table 8.), in stem fraction, cell wall content was ~6%dm higher, cellulose content was ~6.8%ndf higher, hemicellulose content was ~7%ndf lower, and lignin content was ~0.3%ndf higher. And comparing the variances between 2 plant fractions in Pot trials (Control, Table 8.), variance of cell wall content was

higher in stems, but of cellulose content, hemicellulose, and lignin contents were slightly lower in stems. The results of the variances showed that the biomass composition performed more differently among genotypes in cell wall content of stems in the Pot trials, while the other biomass composition didn't differ that much.

Putting together the Field trials and Pot trials and seeing both fractions of leaves and stems, it showed the same trends overall. The trends indicated that in both fractions, cell wall content and lignin content were higher and hemicellulose content was lower. But trends of cellulose content were not totally in consistent in Field trials and Pot trials. The difference appeared in the 1st year Field trials, the cellulose content was higher in the leaf fractions while in the 2nd year and in the Pot trials they were lower in leaves. It might be because the plants in the 1st Field trials happened to severe flooding stress and cellulose was reduced for increasing the water potential inside the plants. Of all cell wall composition parameters, except the cell wall content, variances were lower in the Field trials. But of cell wall content, the variances were high in stems in both trials. On the other hand, the variation of leaves was only high in Pot trials. The assumption for this phenomena is that the plants in Pot trials were rather young (still green) when harvested, but in the Field trials the harvested plants had all been through 1 year growth (from green to brown).

Table 8. Biomass composition of Pot trials under control treatment and 150mm Salt treatment.

Component	Unit	Treatment	Leaf					Stem				
			Ave.	Min.	Max	Range	Variance	Ave.	Min.	Max	Range	Variance
Pot Cell wall content	%dm	Control	64.78	59.02	72.07	13.05	17.82	70.75	64.15	78.11	13.96	22.11
	%dm	Salt (150mm)	65.67	59.06	70.48	11.43	10.88	70.6	63.43	76.12	12.7	15.56
Cellulose	%ndf	Control	44.89	38.71	48.24	9.525	5.315	51.63	46.64	54.77	8.131	4.244
	%ndf	Salt (150mm)	44.47	41.27	46.45	5.174	2.042	49.03	45.33	52.34	7.008	5.077
Hemicellulose	%ndf	Control	50	46.8	55.99	9.186	6.125	42.94	39.08	47.61	8.533	4.95
	%ndf	Salt (150mm)	50.42	47.11	52.21	5.098	2.452	45.73	40.28	50.03	9.748	9.358
Lignin	%ndf	Control	5.112	4	7.083	3.083	0.647	5.433	4.238	7.026	2.788	0.63
	%ndf	Salt (150mm)	5.108	3.631	6.74	3.108	1.078	5.235	4.273	8.636	4.363	1.468

Cell-wall-content%dm = Total neutral detergent fiber content percentage of the whole plant biomass;

Cellulose%ndf = Total cellulose content percentage of cell wall; Hemicellulose%ndf = Total

hemicellulose content percentage of cell wall; Lignin%ndf = Total lignin content percentage of cell wall

Table 9. Significance of effects (F-value Pr.) of genotypes and treatments on biomass composition of leaf and stem fractions in Pot trials.

Trait	Component	Leaf	Stem
		F.pr.	F.pr.
Cell wall content	Genotype	<.001	<.001
	Treatment	0.082	0.833
	Genotype.Treatment	0.107	0.729
Cellulose	Genotype	<.001	0.024
	Treatment	0.275	0.001
	Genotype.Treatment	0.016	0.063
Hemicellulose	Genotype	<.001	0.004
	Treatment	0.226	0.003
	Genotype.Treatment	<.001	0.15
Lignin	Genotype	<.001	<.001
	Treatment	0.979	0.564
	Genotype.Treatment	0.056	0.315

Cell wall content = Total neutral detergent fiber content percentage of the whole plant biomass;
 Cellulose = Total cellulose content percentage of cell wall; Hemicellulose = Total hemicellulose
 content percentage of cell wall; Lignin = Total lignin content percentage of cell wall.

3.3. Effect of Salt Stress on Biomass Yield and Composition

3.3.1. Field Trials

In 1st year of trials, the biomasses were much less in the salt treated group than in the control group. The yield of the group under salt treatment ranged from 0 gram/m² to 50 gram/m², while the yields of the control groups had in average 80% more of the yields (Figure 3.). The effect of salt stress on biomass yield is obvious and significant.

In the leaves of 1st year trials, the effects of salt stress on all biomass composition were significant (Table 7.). Comparing to the control group, in the leaves of salt treated plants, the cell wall content was less by ~1.5%ndf, the cellulose content was more with ~0.4%ndf, hemicellulose content was less by ~0.6%ndf, and lignin content was less by ~0.35%ndf. In all the biomass composition, only cellulose content was higher when treated with salt treatment (Table 6. and Figure 6.).

In the fraction of stems in the 1st year trials, the effects of salt stress on all biomass composition were significant (Table 7.). In comparison to the control group, the cell wall

content was lower for ~1%dm, the cellulose content was lower for ~0.3%ndf, hemicellulose content was higher for ~2.7%ndf, and lignin content was lower for ~1%ndf. In all the biomass composition, only hemicellulose content didn't decrease when treated with salt treatment (Table 6. and Figure 7.).

Biomass of the 2nd year trials were still much less in the salt treated group than in the control group though the yield has been a lot higher than the 1st year trials. The yield of the group under salt treatment in average reached 60% of the yields from control groups (Figure 3.). The salt stress treatments indicated the significant influence on decreasing the biomass yields.

In the 2nd year trials, salt stress caused also significant effect on the biomass compositions of the leaves. The group with treatment had lower cell wall content for ~2.85%dm, lower cellulose content for ~0.9%ndf, higher hemicellulose content for ~1.55%ndf, and lower lignin content for ~0.65%ndf. In all the biomass composition, only hemicellulose content was higher in the salt treated plants than in the control group (Table 6. and Figure 8.).

Stem fractions of the 2nd year trials in the salt treated groups showed significant differences with the control groups (Table 7.). After growing on the salty field, the cell wall content was less by ~2.85%dm, the cellulose content was less by ~2.3%ndf, hemicellulose content was more by ~4.55%ndf, and lignin content was less by ~2%ndf. In all the biomass composition, every parameter decreased except hemicellulose content (Table 6. and Figure 9.).

Significant differences between 2 trial years were also observed. In the 2nd trial year, in leaf and stem fractions, cell wall content, cellulose content, and lignin content significantly increased, while hemicellulose content significantly decreased than the contents in the 1st year trials. In the comparison between the 2 trial years, with statistical analysis, it was clear that the different plant maturity caused the change (Figure 10. and 11.).

Also, seeing overall the biomass between leaves and stems in both 2 trial years, the differences were in the same trend. In stems, cell wall content, cellulose content, and lignin content were higher, while hemicellulose content were higher in the leaves (Table 6. and Figure 12.). In the 2nd trials year, the distance between different fractions of biomass composition in average was larger than in the 1st year (Figure 12.).

Under salt treatments the trend of how biomass composition differed from control of plants had shown quite similarity in 2 trial years both in leaves and stems (Figure 12.): 1) Decrease in cell wall content (NDF%dm); 2) Decrease in cellulose content (Cel%ndf); 3) Increase in

hemicellulose content (Hem%ndf); 4) Decrease in lignin content (Lig%ndf). Only in leaves of 1st year trials, the cellulose content was higher and hemicellulose content was no difference in the group under salt stress. Still, these trends indicated positive biomass composition transformation since hemicellulose content had trend of increase and Lignin content had trend of decrease.

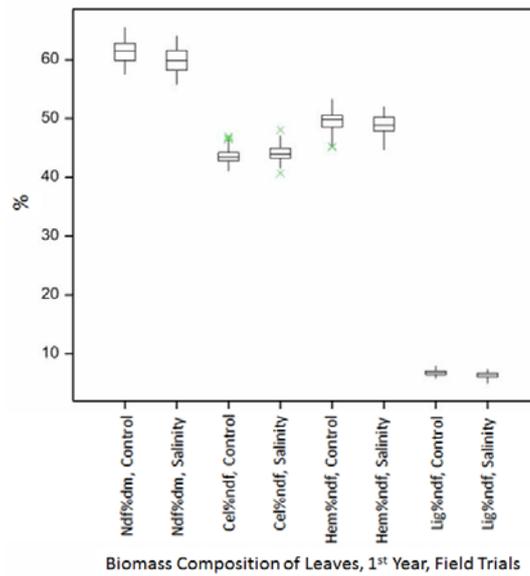


Figure 6. Box plot of biomass composition of leaves in field A (Control) and B (Salt), 1st year, Field trials. NDF%dm = Total neutral detergent fiber; Cel%ndf = Total cellulose content in cell wall; Hem%ndf = Total hemicellulose content in cell wall; Lig%ndf = Total lignin content in cell wall.

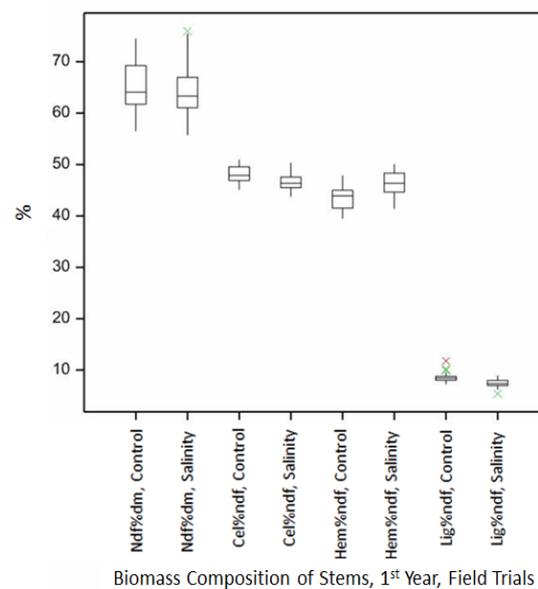


Figure 7. Box plot of biomass composition of stems in field A (Control) and B (Salt), 1st year, Field trials. NDF%dm = Total neutral detergent fiber; Cel%ndf = Total cellulose content in cell wall; Hem%ndf = Total hemicellulose content in cell wall; Lig%ndf = Total lignin content in cell wall.

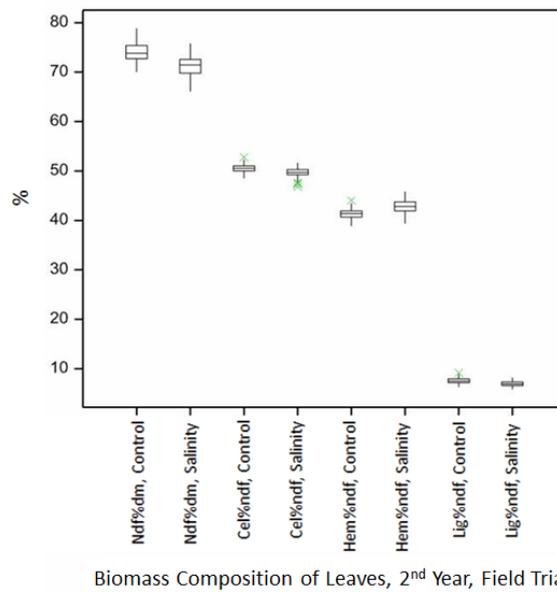


Figure 8. Box plot of biomass composition of leaves in field A (Control) and B (Salt), 2nd year, Field trials. NDF%dm = Total neutral detergent fiber; Cel%ndf = Total cellulose content in cell wall; Hem%ndf = Total hemicellulose content in cell wall; Lig%ndf = Total lignin content in cell wall.

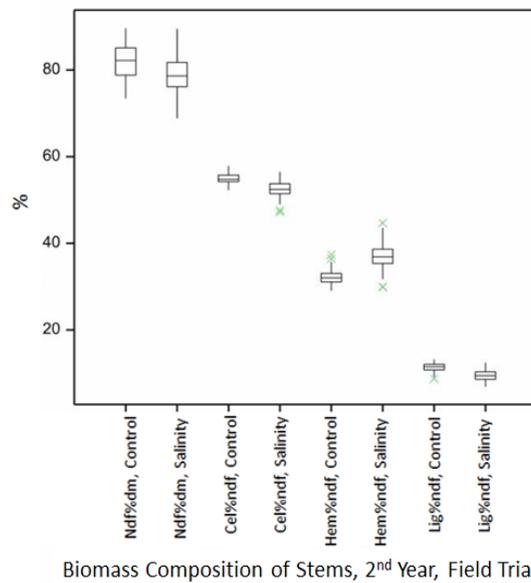


Figure 9. Box plot of biomass composition of leaves in field A (Control) and B (Salt), 2nd year, Field trials. NDF%dm = Total neutral detergent fiber; Cel%ndf = Total cellulose content in cell wall; Hem%ndf = Total hemicellulose content in cell wall; Lig%ndf = Total lignin content in cell wall.

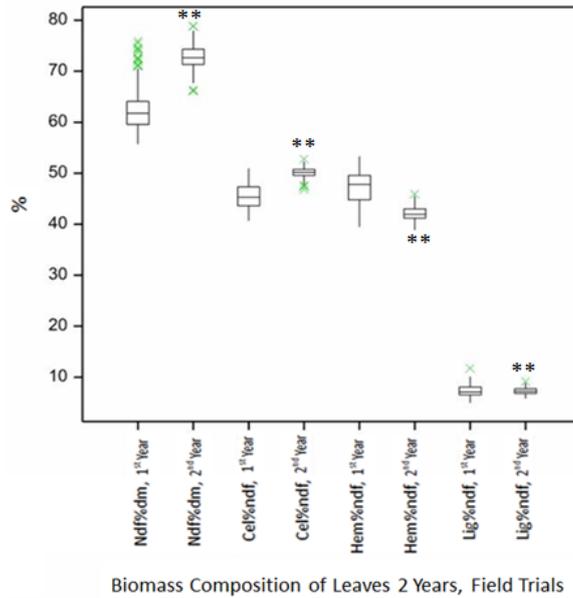


Figure 10. Box plot of biomass composition in leaves in 2 trial years, Field trials.

Note: * Difference from 1st year plants is significant at the 0.05 level (F-value Pr.) ** Difference from 1st year plants is significant at the 0.01 level (F-value Pr.).

NDF%dm = Total neutral detergent fiber; Cel%ndf = Total cellulose content in cell wall; Hem%ndf = Total hemicellulose content in cell wall; Lig%ndf = Total lignin content in cell wall.

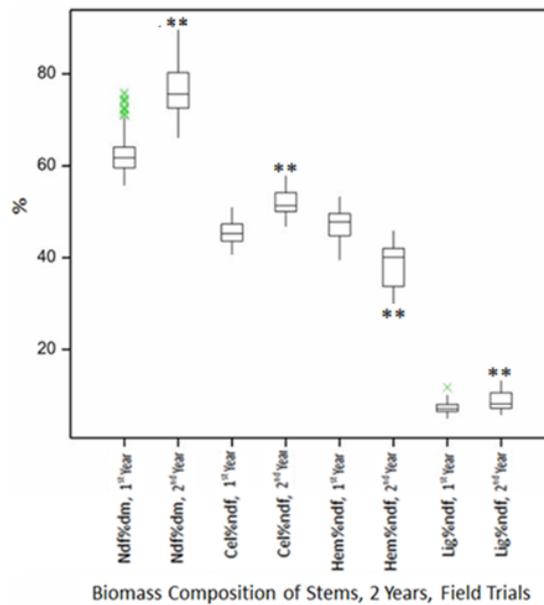


Figure 11. Box plot of biomass composition in stems in 2 trial years, Field trials.

Note: * Difference from 1st year plants is significant at the 0.05 level (F-value Pr.) ** Difference from 1st year plants is significant at the 0.01 level (F-value Pr.).

NDF%dm = Total neutral detergent fiber; Cel%ndf = Total cellulose content in cell wall; Hem%ndf = Total hemicellulose content in cell wall; Lig%ndf = Total lignin content in cell wall.

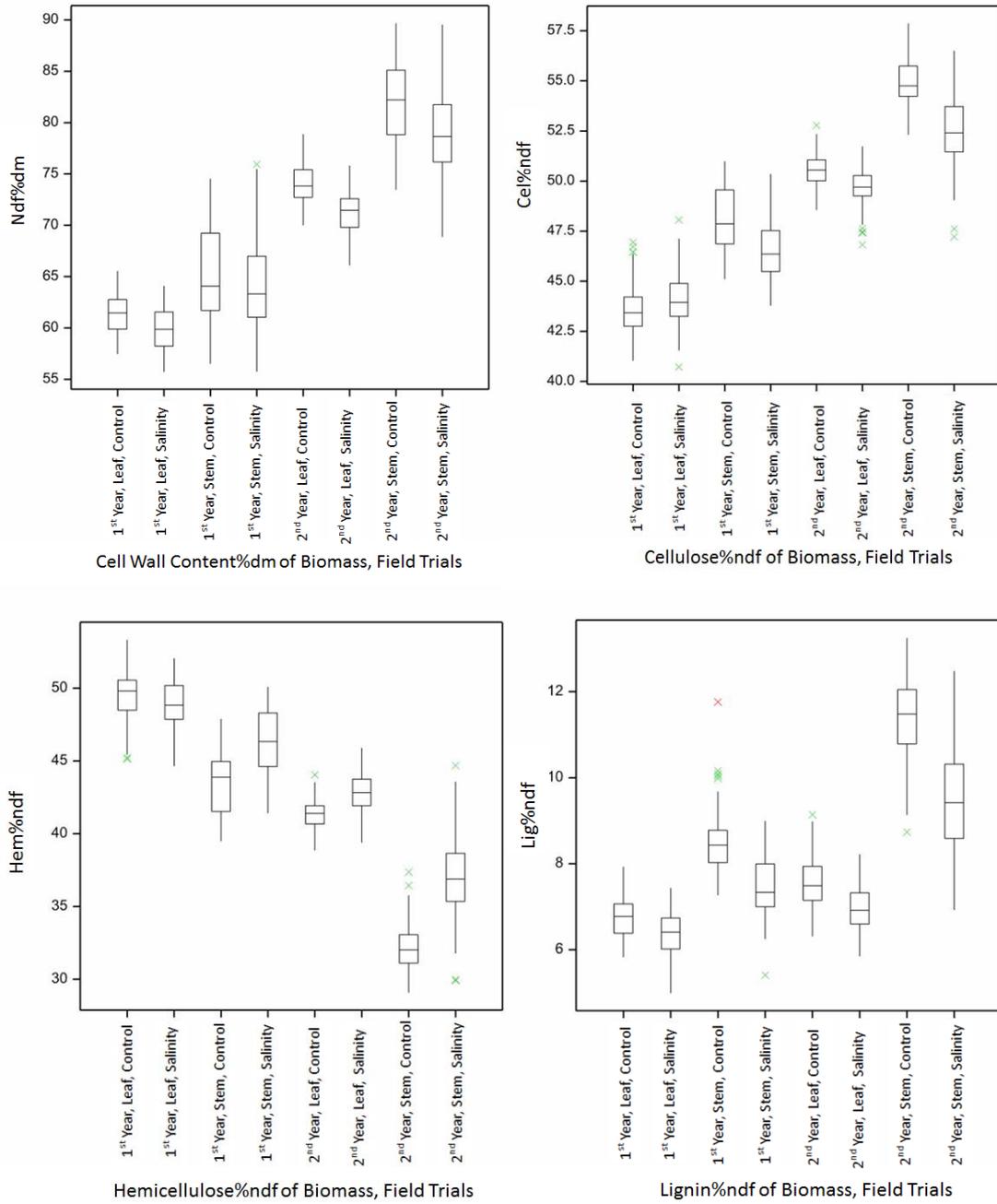


Figure 12. Box plot of each biomass composition in both plant fractions under control and salinity treatments in 2 trial years, Field trials.

NDF%dm = Total neutral detergent fiber; Cel%ndf = Total cellulose content in cell wall; Hem%ndf = Total hemicellulose content in cell wall; Lig%ndf = Total lignin content in cell wall.

3.3.2. Pot Trials

In Pot trials, the biomass yield in 10 out of 12 genotypes was reduced in the salt treated group than in the control group, but only 3 out of these 10 genotypes were significantly different (Figure 5.). The yields of 2 genotypes OPM-09 and OPM-48 were even higher than the control groups in the group under salt treatment. The salt stress didn't really depress the yields of these 12 genotypes in the Pot trials. This was expected because these genotypes were selected from a hydroponic test to be highly salt tolerant.

In the leaves of Pot trials, the effects of salt stress on all biomass composition were not significant at all (Table 9.). Still, comparing to the control group, in the leaves of salt treated plants, the cell wall content was less by $\sim 0.15\% \text{dm}$, the cellulose content was less by $\sim 2.6\% \text{ndf}$, hemicellulose content was more by $\sim 2.8\% \text{ndf}$, and lignin content was less by $\sim 0.2\% \text{ndf}$. In all the biomass composition, only hemicellulose content was higher when treated with salt treatment (Table 8. and Figure 13.).

In the fraction of stems in the Pot trials, only the effects of salt stress on cellulose content and hemicellulose content were significant (Table 9.). In viewing the comparison to the control group, the cell wall content was higher for $\sim 0.9\% \text{dm}$, the cellulose content was lower for $\sim 0.4\% \text{ndf}$, hemicellulose content was higher for $\sim 0.4\% \text{ndf}$, and lignin content was lower for $\sim 0.005\% \text{ndf}$. In all the biomass composition, only in cellulose showed significant lower content and in hemicellulose showed significant higher content with the treatment of salt stress than with the control condition (Table 9. and Figure 14.). Effects of salinity treatment on fractions of stems were more significant than the in the leaves (Table 9. and Figure 15).

Putting together the results for Field trials and Pot trials, they are still showing the same changing trends in the biomass composition between control and salt stressed groups. Also, to see fraction differences in leaves and stems, cell wall content and cellulose content were higher in the stems, and hemicellulose were lower in the stems, while the lignin content showed no big differences in both plant fractions (Figure 15.). These trends were the same as in the Field trials though they were not as significant. The guesses for the results of pot trials are that: first, treatment of the salt was too mild, and caused no significant effect on the biomass composition change; second, it might be that the plant materials used for analysis were all too young (most were harvested green) to show any differences while in the Field trials the plants were harvested after turned brown. There is also a third guess, with a bold speculation, that the genotypes in the pot trials were all salt tolerant. However, the third guess couldn't be proved since the only genotype which was used in both two trials had no

plant alive in the Field trials for comparing.

Although the significance of salt stress in Pot trials only existed in two groups, the overall trend in all biomass composition were in consistent to the performance in the Field trials, with lower content in cell wall, cellulose, lignin, and in the contrast higher content in the hemicellulose. The results are positive for looking into biomass composition transformation of plants under salt stress showing surprisingly lignin decrease and hemicellulose increase.

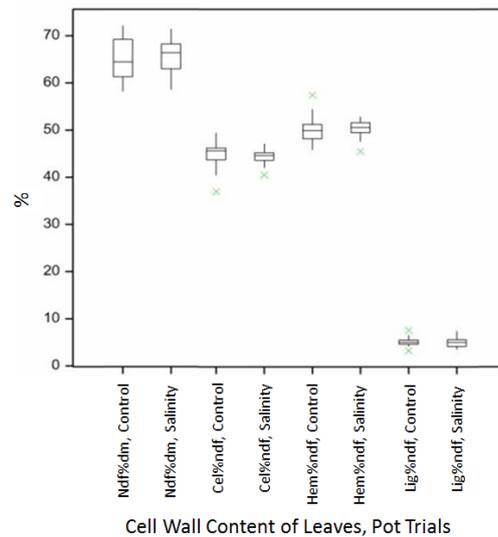


Figure 13. Box plot of biomass composition of leaves in Control and 150mm salinity treatment, Pot trials. NDF%dm = Total neutral detergent fiber; Cel%nfd = Total cellulose content in cell wall; Hem%nfd = Total hemicellulose content in cell wall; Lig%nfd = Total lignin content in cell wall.

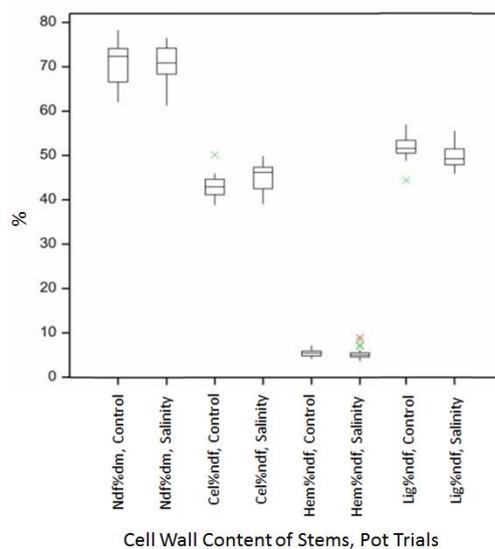


Figure 14. Box plot of biomass composition of stems in Control and 150mm salinity treatment, Pot trials. NDF%dm = Total neutral detergent fiber; Cel%nfd = Total cellulose content in cell wall; Hem%nfd = Total hemicellulose content in cell wall; Lig%nfd = Total lignin content in cell wall.

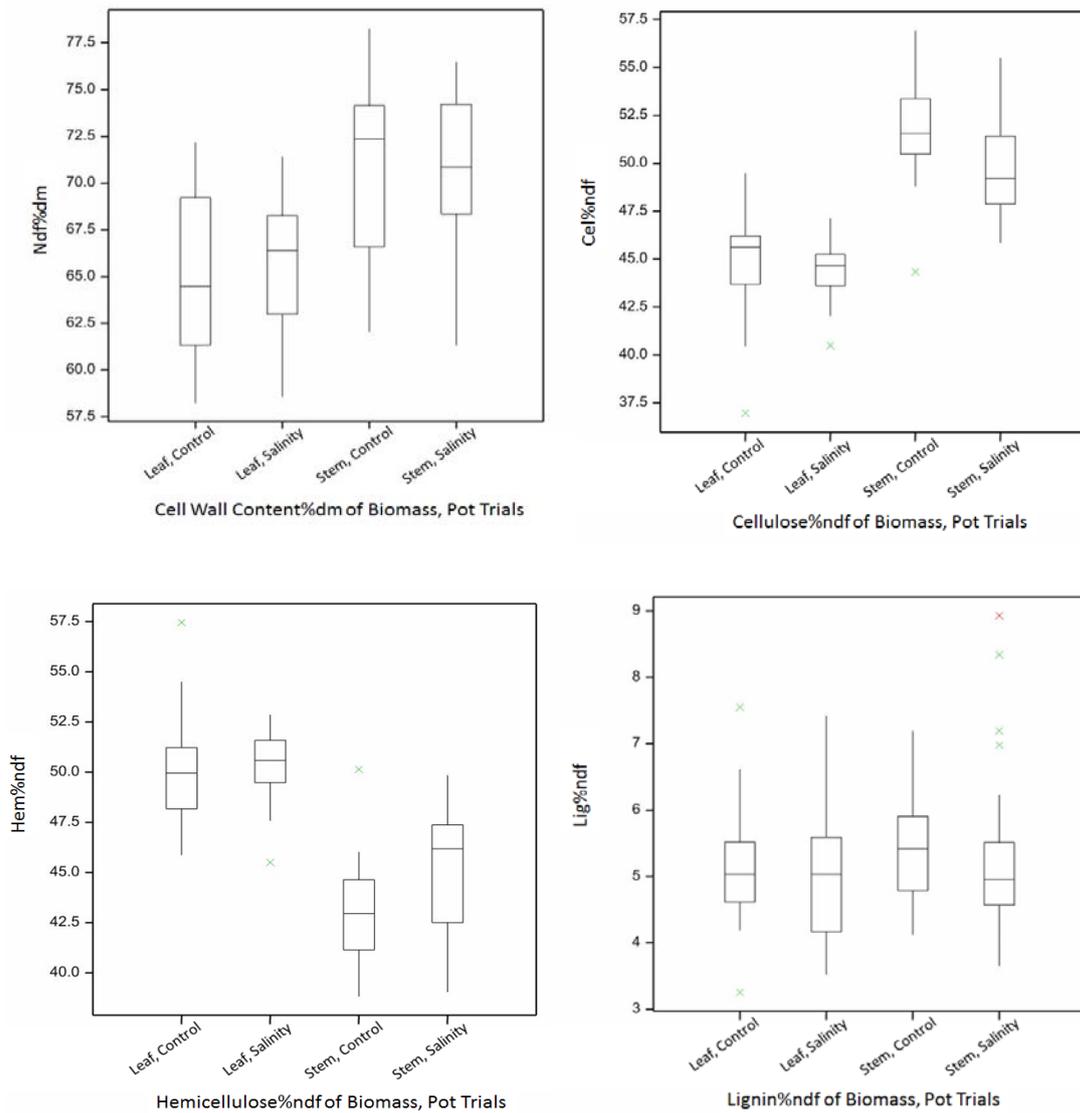


Figure 15. Box plot of each biomass composition in both plant fractions under control and salinity treatments, Pot trials.

NDF%dm = Total neutral detergent fiber; Cel%ndf = Total cellulose content in cell wall; Hem%ndf = Total hemicellulose content in cell wall; Lig%ndf = Total lignin content in cell wall.

3.4. Correlation of Biomass Composition and Salt Tolerance

3.4.1. Field Trials

There was only one significant correlation being found of all biomass composition and adaptability (how different biomass composition had transformed) with salt tolerance in the

Field trials (Table 10.). The significant correlation was between the adaptability of adjusting hemicellulose content in the stem and the salt tolerance. The correlation coefficient was -0.2972, which indicated that as the plants had much less hemicellulose content under salt stress than under control, the more salt tolerant they would be (Figure 16). This was the only found correlation among all the genotypes in the Field trials. Although the correlation is quite weak, this is the possible evidence that more tolerant genotypes are, fewer changes in cell wall composition would be due to treatment comparing with the susceptible genotypes.

Table 10. Significance (P-value) of correlation between biomass composition and salt tolerance.

Trait	Component	Leaf P-value	Stem P-value
Cell wall content	Control	0.7692	0.8517
	Adapability	0.7907	0.9544
Cellulose	Control	0.5148	0.9336
	Adapability	0.8361	0.9986
Hemicellulose	Control	0.5699	0.6271
	Adapability	0.6669	0.0425*
Lignin	Control	0.8976	0.1572
	Adapability	0.1885	0.6011

Note: * Correlation is significant at the 0.05 level (2-tailed)

Cell wall content = Total neutral detergent fiber content percentage of the whole plant biomass;

Cellulose = Total cellulose content percentage of cell wall; Hemicellulose = Total hemicellulose content percentage of cell wall; Lignin = Total lignin content percentage of cell wall.

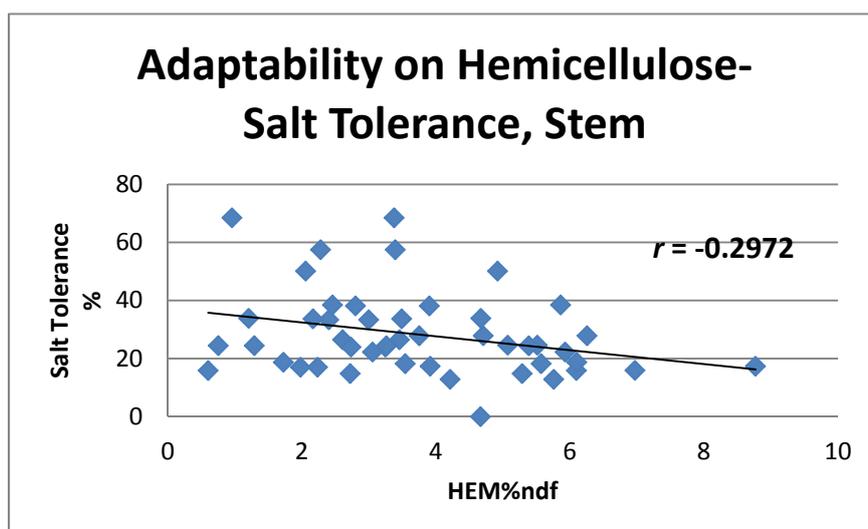


Figure 16. Correlation between adaptability on hemicellulose content and salt tolerance and in stems, Field trials

Hem%ndf = Total hemicellulose content in cell wall.

3.4.2. Pot Trials

The only correlation which was significant was between lignin content and salt tolerance in leaves of the Pot trials (Table 11.). The correlation was a positive correlation between the leaves of these 12 genotypes in the Pot trials. The correlation coefficient was 0.61, which meant that the more lignin content in leaves of the plants, the more salt tolerant the plants were (Figure 16).

Table 11. Significance (P-value) of correlation between biomass composition and salt tolerance.

Trait	Component	Leaf P-value	Stem P-value
Cell wall content	Control	0.2901	0.4610
	Adapability	0.5860	0.2295
Cellulose	Control	0.8812	0.3326
	Adapability	0.4270	0.2674
Hemicellulose	Control	0.6317	0.3746
	Adapability	0.3005	0.5555
Lignin	Control	0.0336*	0.9875
	Adapability	0.2358	0.0949

Note: * Correlation is significant at the 0.05 level (2-tailed)

Cell wall content = Total neutral detergent fiber content percentage of the whole plant biomass;

Cellulose = Total cellulose content percentage of cell wall; Hemicellulose = Total hemicellulose content percentage of cell wall; Lignin = Total lignin content percentage of cell wall.

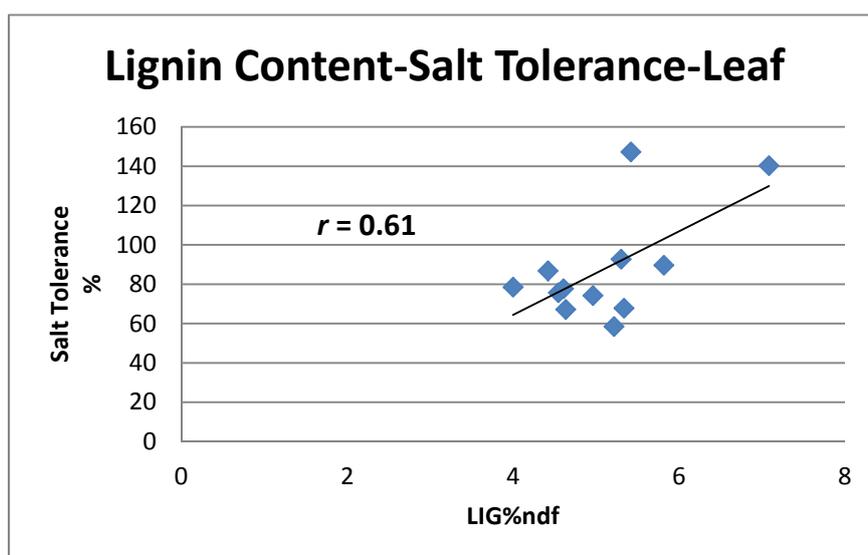


Figure 17. Correlation between adaptability on lignin content and salt tolerance and in leaves, Pot trials

Lig%ndf = Total lignin content in cell wall.

4. Conclusion and Future Recommendation

Overall, salt stress caused the decrease in the yields, but some genotypes showed potentials to have good salt tolerances. Also, since salt tolerance differed greatly among the genotypes, breeding for miscanthus with good yield under salt stress is possible.

The effects of plant maturities on biomass yield, biomass composition, and salt tolerance are significant. For the use, investigation, or trial tests, plants should be harvested after reaching the full maturity to present the best potentials.

With the comparison between Field and Pot trials, it is concluded that the result found in Field trials was more relevant than the result found in the Pot trials. Still, the similar trends of Pot trials as trends of Field trials were nice indication of how the plants would perform when eliminating the effects from the environments.

According to Field trials, in leaves and stems, cell wall content, cellulose content, lignin content dropped, but hemicellulose content increased. Some trends (decrease in cellulose and increase in hemicellulose) presented in both field trials and pot trials, but some trends (cell wall content and lignin) were different. The result indicated that biomass composition in leaves and stems didn't transformed undesirably as expected since there was no sign of lignin content increasing, but hemicellulose content increased. Although significant changes were present, they were really quite mild. Still, this would be a nice conclusion that the effect of salt stress has little effect on biomass quality for bioethanol production.

The mild and weak correlation between biomass compositions with salt tolerance indicated that biomass composition and adaptability had not much effect on salt tolerance. Therefore, there is little reason to expect an effect of CWC or adaptability on salt tolerance. In conclusion, breeding of miscanthus for saline area should encompass both breeding for salt tolerance and for biomass quality for biofuel production.

5. References

- Adesogan, A. 2005. Effect of bag type on the apparent digestibility of feeds in ANKOM Daisy II incubators. *Animal Feed Science and Technology*. 119:333-344.
- Al-Hakimi, A., and A. Hamada. 2001. Counteraction of salinity stress on wheat plants by grain soaking in ascorbic acid, thiamin or sodium salicylate. *Biologia Plantarum*. 44:253-261.
- Allison, G.G., C. Morris, J. Clifton-Brown, S.J. Lister, and I.S. Donnison. 2011. Genotypic variation in cell wall composition in a diverse set of 244 accessions of *Miscanthus*. *Biomass and Bioenergy*. 35:4740-4747.
- Anzoua, K.G., T. Yamada, and R.J. Henry. 2011. *Miscanthus*. In *Wild crop relatives: genomic and breeding resources*. Springer. 157-164.
- Ashraf, M., and L. Wu. 1994. Breeding for Salinity Tolerance in Plants. *Critical Reviews in Plant Sciences*. 13:17-42.
- Barling, A., K. Swaminathan, T. Mitros, B.T. James, J. Morris, O. Ngamboma, M.C. Hall, J. Kirkpatrick, M. Alabady, and A.K. Spence. 2013. A detailed gene expression study of the *Miscanthus* genus reveals changes in the transcriptome associated with the rejuvenation of spring rhizomes. *BMC genomics*. 14:864.
- Beale, C.V., J.I. Morison, and S.P. Long. 1999. Water use efficiency of C 4 perennial grasses in a temperate climate. *Agricultural and Forest Meteorology*. 96:103-115.
- Brosse, N., A. Dufour, X. Meng, Q. Sun, and A. Ragauskas. 2012. *Miscanthus*: a fast-growing crop for biofuels and chemicals production. *Biofuels, Bioproducts and Biorefining*. 6:580-598.
- Chan, J.M., S. Bauer, H. Sorek, S. Sreekumar, K. Wang, and F.D. Toste. 2013. Studies on the vanadium-catalyzed nonoxidative depolymerization of *Miscanthus giganteus*-derived lignin. *ACS Catalysis*. 3:1369-1377.
- Cheeseman, J.M. 1988. Mechanisms of salinity tolerance in plants. *Plant Physiology*. 87:547-550.
- Chen, S., and S. Renvoize. 2006. *Miscanthus*. *Flora of China*. 22:581-583.
- Chiamonti, D., M. Prussi, S. Ferrero, L. Oriani, P. Ottonello, P. Torre, and F. Cherchi. 2012. Review of pretreatment processes for lignocellulosic ethanol production, and development of an innovative method. *Biomass and Bioenergy*. 46:25-35.
- Chou, C.-H., and Y.-T. Chung. 1974. The allelopathic potential of *Miscanthus floridulus* mm.
- Clifton-Brown, J., Y.-C. Chiang, and T.R. Hodkinson. 2008. *Miscanthus*: genetic

- resources and breeding potential to enhance bioenergy production. *Genetic Improvement of Bioenergy Crops*:273-294.
- D Vinebrooke, R., K. L Cottingham, M.S. Norberg, S. I Dodson, S. C Maberly, and U. Sommer. 2004. Impacts of multiple stressors on biodiversity and ecosystem functioning: The role of species co-tolerance. *Oikos*. 104:451-457.
- Degenhardt, B., and H. Gimmler. 2000. Cell wall adaptations to multiple environmental stresses in maize roots. *Journal of Experimental Botany*. 51:595-603.
- Demirbas, A. 2011. Competitive liquid biofuels from biomass. *Applied Energy*. 88:17-28.
- Dionisio-Sese, M.L., and S. Tobita. 1998. Antioxidant responses of rice seedlings to salinity stress. *Plant Science*. 135:1-9.
- DY, N. 2011. Preliminary evaluation on salinity tolerance of *Miscanthus sinensis* Anderss and *M. sacchariflorus* (Maxim.) Benth of China. *Acta Arestia Sinica*. 19:803-808.
- El Hage, R., N. Brosse, L. Chrusciel, C. Sanchez, P. Sannigrahi, and A. Ragauskas. 2009. Characterization of milled wood lignin and ethanol organosolv lignin from miscanthus. *Polymer Degradation and Stability*. 94:1632-1638.
- El Hage, R., N. Brosse, P. Sannigrahi, and A. Ragauskas. 2010. Effects of process severity on the chemical structure of *Miscanthus* ethanol organosolv lignin. *Polymer Degradation and Stability*. 95:997-1003.
- Ezaki, B., E. Nagao, Y. Yamamoto, S. Nakashima, and T. Enomoto. 2008. Wild plants, *Andropogon virginicus* L. and *Miscanthus sinensis* Anders, are tolerant to multiple stresses including aluminum, heavy metals and oxidative stresses. *Plant Cell Reports*. 27:951-961.
- Fan, L., R. Linker, S. Gepstein, E. Tanimoto, R. Yamamoto, and P.M. Neumann. 2006. Progressive inhibition by water deficit of cell wall extensibility and growth along the elongation zone of maize roots is related to increased lignin metabolism and progressive stelar accumulation of wall phenolics. *Plant Physiology*. 140:603-612.
- Głowacka, K. 2011. A review of the genetic study of the energy crop *Miscanthus*. *Biomass and Bioenergy*. 35:2445-2454.
- Greif, J., M. Deuter, C. Jung, and J. Schondelmaier. 1997. Genetic diversity of European *Miscanthus* species revealed by AFLP fingerprinting. *Genetic Resources and Crop Evolution*. 44:185-195.
- Haffner, F.B., V.D. Mitchell, R.A. Arundale, and S. Bauer. 2013. Compositional analysis of *Miscanthus giganteus* by near infrared spectroscopy. *Cellulose*. 20:1629-1637.

- Heaton, E.A., S.P. Long, T.B. Voigt, M.B. Jones, and J. Clifton-Brown. 2004. Miscanthus for renewable energy generation: European Union experience and projections for Illinois. *Mitigation and Adaptation Strategies for Global Change*. 9:433-451.
- Hernández, P., G. Dorado, D. Laurie, A. Martin, and J. Snape. 2001. Microsatellites and RFLP probes from maize are efficient sources of molecular markers for the biomass energy crop Miscanthus. *Theoretical and Applied Genetics*. 102:616-622.
- Hodkinson, T.R., M.W. Chase, D.M. Lledó, N. Salamin, and S.A. Renvoize. 2002a. Phylogenetics of Miscanthus, Saccharum and related genera (Saccharinae, Andropogoneae, Poaceae) based on DNA sequences from ITS nuclear ribosomal DNA and plastid trnL intron and trnL-F intergenic spacers. *Journal of Plant Research*. 115:381-392.
- Hodkinson, T.R., M.W. Chase, and S.A. Renvoize. 2002b. Characterization of a genetic resource collection for Miscanthus (Saccharinae, Andropogoneae, Poaceae) using AFLP and ISSR PCR. *Annals of Botany*. 89:627-636.
- Karahara, I., A. Ikeda, T. Kondo, and Y. Uetake. 2004. Development of the Casparian strip in primary roots of maize under salt stress. *Planta*. 219:41-47.
- Lewandowski, I., and U. Schmidt. 2006. Nitrogen, energy and land use efficiencies of miscanthus, reed canary grass and triticale as determined by the boundary line approach. *Agriculture, Ecosystems and Environment*. 112:335-346.
- Ma, X.-F., E. Jensen, N. Alexandrov, M. Troukhan, L. Zhang, S. Thomas-Jones, K. Farrar, J. Clifton-Brown, I. Donnison, and T. Swaller. 2012. High resolution genetic mapping by genome sequencing reveals genome duplication and tetraploid genetic structure of the diploid Miscanthus sinensis. *PloS one*. 7:e33821.
- Mahajan, S., and N. Tuteja. 2005. Cold, salinity and drought stresses: an overview. *Archives of Biochemistry and Biophysics*. 444:139-158.
- Nigam, P.S., and A. Singh. 2011. Production of liquid biofuels from renewable resources. *Progress in Energy and Combustion Science*. 37:52-68.
- Olinger, J.M., P.R. Griffiths, and T. Burger. 2001. Theory of diffuse reflection in the NIR region. *Practical Spectroscopy Series*. 27:19-52.
- Peleg, Z., and E. Blumwald. 2011. Hormone balance and abiotic stress tolerance in crop plants. *Current Opinion in Plant Biology*. 14:290-295.
- Ragauskas, A.J., G.T. Beckham, M.J. Bidy, R. Chandra, F. Chen, M.F. Davis, B.H. Davison, R.A. Dixon, P. Gilna, and M. Keller. 2014. Lignin valorization: improving lignin processing in the biorefinery. *Science*. 344:1246843.
- Ragauskas, A.J., C.K. Williams, B.H. Davison, G. Britovsek, J. Cairney, C.A. Eckert, W.J. Frederick, J.P. Hallett, D.J. Leak, and C.L. Liotta. 2006. The path forward for

- biofuels and biomaterials. *Science*. 311:484-489.
- Reich, G. 2005. Near-infrared spectroscopy and imaging: basic principles and pharmaceutical applications. *Advanced Drug Delivery Reviews*. 57:1109-1143.
- Rogers, L.A., and M.M. Campbell. 2004. The genetic control of lignin deposition during plant growth and development. *New Phytologist*. 164:17-30.
- Schubert, C. 2006. Can biofuels finally take center stage? *Nature Biotechnology*. 24:777-784.
- Sims, R.E., W. Mabee, J.N. Saddler, and M. Taylor. 2010. An overview of second generation biofuel technologies. *Bioresource Technology*. 101:1570-1580.
- Singh, P., A. Suman, P. Tiwari, N. Arya, A. Gaur, and A. Shrivastava. 2008. Biological pretreatment of sugarcane trash for its conversion to fermentable sugars. *World Journal of Microbiology and Biotechnology*. 24:667-673.
- Sun, Q., T. Yamada, and T. Takano. 2014. Salinity Effects on Germination, Growth, Photosynthesis, and Ion Accumulation in Wild Anderss. Populations. *Crop Science*. 54:2760-2771.
- Tenhaken, R. 2014. Cell wall remodeling under abiotic stress. *Frontiers in Plant Science*. 5.
- Villaverde, J.J., J. Li, M. Ek, P. Ligeró, and A. de Vega. 2009. Native lignin structure of *Miscanthus x giganteus* and its changes during acetic and formic acid fractionation. *Journal of Agricultural and Food Chemistry*. 57:6262-6270.
- Vinebrooke, R., K. L Cottingham, M.S. Norberg, S. I Dodson, S. C Maberly, and U. Sommer. 2004. Impacts of multiple stressors on biodiversity and ecosystem functioning: The role of species co-tolerance. *Oikos*. 104:451-457.
- Williams, C.K., R. Templer, R. Murphy, D.J. Leak, G. Britovsek, J. Cairney, J.P. Hallett, C.L. Liotta, C.A. Eckert, and T. Tschaplinski. 2006. The path forward for biofuels and biomaterials. *Science*. 311:484-489.
- Xi, Q. 2000. Investigation on the distribution and potential of giant grasses in China: *Triarrhena, Miscanthus, Arundo, Phragmites and Neyraudia*. *Cuvillier Verlag*.
- Xu, F., J. Yu, T. Tesso, F. Dowell, and D. Wang. 2013. Qualitative and quantitative analysis of lignocellulosic biomass using infrared techniques: a mini-review. *Applied Energy*. 104:801-809.
- Youngs, H., and C. Somerville. 2012. Development of feedstocks for cellulosic biofuels. *F1000 Biology Reports*. 4:10.
- Yuan, J.S., K.H. Tiller, H. Al-Ahmad, N.R. Stewart, and C.N. Stewart Jr. 2008. Plants to power: bioenergy to fuel the future. *Trends in Plant Science*. 13:421-429.
- Zanchi, G., N. Pena, and N. Bird. 2012. Is woody bioenergy carbon neutral? A comparative assessment of emissions from consumption of woody bioenergy and fossil fuel. *GCB Bioenergy*. 4:761-772.

Zhao, X., L. Zhang, and D. Liu. 2012. Biomass recalcitrance. Part I: the chemical compositions and physical structures affecting the enzymatic hydrolysis of lignocellulose. *Biofuels, Bioproducts and Biorefining*. 6:465-482.

Appendix 1. Calibration data set of Chinese field trials, 84 calibration samples and 16 validation samples.

84 Calibration Data									
Plot	NDF%dm	ADF%dm	ADL%dm	Cel%dm	Hem%dm	Lig%dm	Cel%ndf	Hem%ndf	Lig%ndf
A1Lplot06	61.95	31.5	3.99	27.51	30.45	3.99	44.41	49.15	6.44
A1Lplot13	64	31.72	4	27.72	32.28	4	43.31	50.43	6.26
A1Lplot16	59.45	29.76	5.61	26.15	34.56	3.61	40.66	53.73	5.61
A1Lplot17	61.96	32.82	6.11	28.75	33.78	4.07	43.16	50.73	6.11
A1Lplot31	63.86	32.01	6.49	27.54	36.82	4.46	40.02	53.5	6.49
A1Lplot41	57.82	28.58	6.06	24.8	33.95	3.79	39.65	54.29	6.06
A1Lplot48	62.64	34.74	4.32	30.42	27.9	4.32	48.57	44.54	6.89
A1Lplot63	60.59	32.62	3.98	28.64	27.97	3.98	47.27	46.16	6.56
A1Lplot68	59.99	31.28	4.17	27.11	28.71	4.17	45.19	47.86	6.95
A1Splot01	66.63	39.43	7.38	32.05	27.2	7.38	48.1	40.82	11.08
A1Splot03	66.68	38.52	6	32.52	28.16	6	48.77	42.23	9
A1Splot05	59.61	33.23	4.71	28.52	26.39	4.71	47.84	44.26	7.89
A1Splot08	70.19	41.55	6.37	35.18	28.64	6.37	50.13	40.8	9.07
A1Splot13	60.16	33.44	4.76	28.68	26.72	4.76	47.67	44.42	7.91
A1Splot23	76.38	43.08	5.42	37.66	33.3	5.42	49.3	43.6	7.1
A1Splot26	69.66	41.06	6.29	34.77	28.6	6.29	49.91	41.05	9.03
A1Splot27	68.14	41.15	6.44	34.72	26.99	6.44	50.95	39.61	9.44
A1Splot34	59.79	34.11	6.57	27.54	25.68	6.57	46.06	42.95	10.99

A1Splot39	57.07	29.60	4.28	25.32	27.48	4.28	44.36	48.15	7.50
A1Splot42	58.09	30.65	4.40	26.25	27.44	4.40	45.19	47.24	7.57
A1Splot50	61.94	34.75	5.14	29.61	27.19	5.14	47.8	43.9	8.29
A1Splot52	57.53	29.59	3.90	25.68	27.95	3.90	44.64	48.57	6.79
A1Splot53	58.90	32.14	4.81	27.33	26.76	4.81	46.41	45.43	8.16
A1Splot58	56.08	28.61	4.42	24.19	27.47	4.42	43.13	48.98	7.89
A1Splot72	60.82	34.89	6.17	28.72	25.93	6.17	47.22	42.63	10.14
A1Splot74	64.76	37.86	7.26	30.60	26.90	7.26	47.25	41.53	11.22
A2Lplot12	77.16	46.02	5.55	40.47	31.14	5.55	52.45	40.36	7.19
A2Lplot64	73.12	43.05	5.81	37.24	30.08	5.81	50.93	41.13	7.94
A2LPlot73	75.72	43.63	4.93	38.7	32.09	4.93	51.1	42.38	6.51
A2Lplot74	73.35	41.29	5.56	35.73	32.06	5.56	48.71	43.71	7.58
A2Splot40	85.91	59.9	11.6	48.29	26.01	11.6	56.22	30.28	13.51
A2Splot42	77.59	50.57	8.48	42.09	27.02	8.48	54.25	34.82	10.93
A2Splot44	90	56.78	7.48	49.3	33.22	7.48	54.77	36.91	8.32
A2Splot56	87.82	61.17	11.97	49.2	26.64	11.97	56.02	30.34	13.64
A2Splot59	78.36	54.24	11.08	43.17	24.12	11.08	55.09	30.78	14.13
A2Splot64	81.31	56.14	10.22	45.92	25.17	10.22	56.48	30.95	12.57
B1Lplot04	60.44	31.19	4.23	26.95	29.25	4.23	44.6	48.4	7.01
B1Lplot11	58.81	30.11	5.61	26.54	33.58	3.58	41.66	52.72	5.61
B1Lplot20	55.73	30.46	4.2	26.26	25.27	4.2	47.12	45.34	7.54
B1Lplot22	58.38	28.89	2.95	25.95	29.49	2.95	44.45	50.51	5.04

B1Lplot29	55.62	30.29	4.26	26.03	25.33	4.26	46.8	45.53	7.66
B1Lplot30	59.72	28.15	3.99	24.16	31.58	3.99	40.45	52.87	6.67
B1Lplot38	58.08	30.4	4.51	25.89	27.68	4.51	44.58	47.66	7.76
B1Lplot50	55.9	29.02	4.72	24.3	26.88	4.72	43.47	48.09	8.44
B1Lplot53	59.21	30.97	4.41	26.56	28.24	4.41	44.86	47.69	7.45
B1Lplot54	60.77	31.58	7.94	26.33	34.53	5.25	39.83	52.23	7.94
B1Lplot64	56.12	29.59	3.36	26.23	26.53	3.36	46.74	47.27	5.99
B1Lplot66	57.70	29.53	3.22	25.75	28.17	3.22	44.63	48.82	5.59
B1Lplot73	64.24	34.74	3.30	31.44	29.50	3.30	48.94	45.92	5.14
B1Lplot74	58.35	30.82	3.51	27.31	27.53	3.51	46.81	47.18	6.01
B1Lplot75	60.63	32.09	3.08	29.01	28.53	3.08	47.85	47.06	5.08
B1Splot02	69.29	41.25	6.47	34.77	28.04	6.47	50.19	40.47	9.34
B1Splot04	61.05	32.42	5.87	26.55	28.62	5.87	43.49	46.89	9.62
B1Splot05	60.04	31.30	4.52	26.77	28.74	4.52	44.59	47.87	7.53
B1Splot14	62.88	33.98	4.35	29.62	28.90	4.35	47.11	45.97	6.92
B1Splot17	63.62	32.99	4.46	28.53	30.63	4.46	44.84	48.15	7.01
B1Splot26	66.25	35.56	5.08	30.48	30.7	5.08	46	46.33	7.67
B1Splot28	67.55	37.86	4.86	33.01	29.69	4.86	48.86	43.95	7.19
B1Splot32	65.8	36.2	5.43	30.77	29.6	5.43	46.76	44.99	8.25
B1Splot36	76.4	44.73	5.79	39.91	38.49	4.82	47.96	46.25	5.79
B1Splot38	61.34	31.21	4.26	26.96	30.13	4.26	43.95	49.12	6.94
B1Splot40	60.19	30.36	3.26	27.1	29.83	3.26	45.02	49.55	5.42

B1Splot46	58.33	29.29	3.49	26.90	29.04	3.49	46.12	49.78	5.98
B1Splot51	63.18	31.85	3.98	27.87	31.32	3.98	44.12	49.58	6.30
B1Splot59	60.70	29.35	4.65	24.70	31.35	4.65	40.69	51.64	7.67
B1Splot73	70.25	34.52	3.08	31.44	35.73	3.08	44.75	50.86	4.38
B2Lplot25	73.76	39.55	4.11	35.43	34.21	4.11	48.04	46.38	5.58
B2Lplot37	71.64	43.2	5.14	38.06	28.45	5.14	53.12	39.7	7.17
B2Lplot63	67.59	35.93	4.56	31.37	31.66	4.56	46.41	46.85	6.74
B2Lplot74	67.68	37.67	5.24	32.43	30.01	5.24	47.91	44.35	7.74
B2Splot01	75.75	50.31	8.2	42.11	25.44	8.2	55.59	33.58	10.82
B2Splot06	80.53	54.42	9.2	45.22	26.11	9.2	56.16	32.42	11.42
B2Splot08	75.41	49.06	9.20	39.86	26.35	9.20	52.86	34.94	12.20
B2Splot25	75.76	48.39	8.56	39.83	27.37	8.56	52.57	36.13	11.3
B2Splot27	71.46	45.38	6.93	38.45	26.09	6.93	53.80	36.51	9.70
B2Splot41	80.56	51.2	8.32	42.89	29.35	8.32	53.24	36.44	10.32
B2Splot45	82.21	51.8	8.4	43.4	30.41	8.4	52.79	36.99	10.21
B2Splot46	72.75	44.66	6.58	38.08	28.09	6.58	52.35	38.61	9.05
B2Splot47	77.55	49.32	8.24	41.08	28.23	8.24	52.97	36.4	10.63
B2Splot51	74.12	44.06	6.08	37.98	30.06	6.08	51.24	40.56	8.2
B2Splot54	72.15	44.16	6.78	37.38	27.99	6.78	51.81	38.8	9.4
B2Splot57	86.36	49.08	5.44	43.64	37.27	5.44	50.53	43.16	6.3
B2Splot66	70.85	38.99	6.06	32.93	31.86	6.06	46.47	44.97	8.55
B2Splot68	69.31	40.18	5.55	34.64	29.12	5.55	49.97	42.02	8

16 Validation Data									
A1Lplot25	61.03	31.09	4.16	26.92	29.94	4.16	44.12	49.07	6.82
A1Lplot57	64.42	34.39	4.25	30.13	30.04	4.25	46.78	46.63	6.60
A1Splot48	69.96	40.67	5.15	35.51	29.30	5.15	50.76	41.87	7.37
A1Splot64	66.77	37.51	6.32	31.18	29.26	6.32	46.70	43.83	9.47
A2Lplot28	70.73	41.32	3.53	37.79	29.41	3.53	53.42	41.58	4.99
A2Lplot36	74.81	41.90	3.79	38.10	32.91	3.79	50.93	44.00	5.07
A2Splot18	87.28	60.21	10.68	49.53	27.07	10.68	56.75	31.01	12.23
A2Splot34	85.15	58.17	11.70	46.47	26.98	11.70	54.58	31.69	13.74
B1Lplot05	61.76	32.76	3.55	29.21	29.01	3.55	47.29	46.97	5.74
B1Lplot15	62.91	32.41	5.23	27.19	30.50	5.23	43.21	48.48	8.31
B1Splot21	65.08	33.36	4.08	29.28	31.72	4.08	44.98	48.74	6.27
B1Splot49	67.77	36.67	5.21	31.46	31.10	5.21	46.42	45.88	7.69
B2Lplot14	74.63	41.10	4.12	36.98	33.53	4.12	49.55	44.93	5.52
B2Lplot21	76.67	41.56	5.08	36.48	35.11	5.08	47.58	45.80	6.62
B2Splot13	83.12	54.59	8.04	46.55	28.53	8.04	56.00	34.32	9.67
B2Splot39	82.88	51.90	7.87	44.03	30.98	7.87	53.13	37.38	9.50

Appendix 2. Biochemical analyzed data 'Lab' and predicted data 'ANL' of validation set for cell wall composition of Chinese field trials.

NDF%dm vs. NDF%dm							
SEP:		1.816			Num. Samples:	16	
Means:		72.186	70.972	Std. Devs:	8.751	8.095	
Bias:		1.214*			Bias Limit:	0.6	
SEP(C):		1.395*			SED(C) Limit:	1.3	
Slope:		1.069			RSQ:	0.979	
Ave. Global H:	1.394			Ave. Neigh. H:	0.111		
Pos.	Sample No.	Lab	ANL	Residual	Bias	GH1	NH1
1	A2Splot18	87.28	85.363	1.917	0.703	1.346	0.131
2	A2Splot34	85.15	82.884	2.266	1.052	0.788	0.149
3	B2Splot13	83.12	79.22	3.900*	2.686	0.964	0.163
4	B2Splot39	82.88	81.491	1.389	0.175	0.915	0.257
5	B2Lplot21	76.67	73.542	3.128*	1.914	1.638	0.064
6	A2Lplot36	74.81	74.16	0.65	-0.564	1.608	0.081
7	B2Lplot14	74.63	73.115	1.515	0.302	1.481	0.054
8	A2Lplot28	70.73	72.063	-1.333	-2.547	1.981	0.1
9	A1Splot48	69.96	69.86	0.1	-1.114	1.709	0.133
10	B1Splot49	67.77	65.342	2.428	1.214	1.301	0.078
11	A1Splot64	66.77	65.556	1.214	0	1.111	0.17

12	B1Splot21	65.08	64.677	0.403	-0.81	1.505	0.09
13	A1Lplot57	64.42	63.639	0.781	-0.432	1.14	0.043
14	B1Lplot15	62.91	63.6	-0.69	-1.904	1.713	0.15
15	B1Lplot05	61.76	61.972	-0.212	-1.426	1.658	0.066
16	A1Lplot25	61.03	59.066	1.964	0.75	1.452	0.051
ADF%dm vs. ADF%dm							
SEP:		1.328			Num. Samps:	16	
Means:		41.851	41.277	Std. Devs:	9.416	8.884	
Bias:		0.574			Bias Limit:	0.6	
SEP(C):		1.237			SED(C) Limit:	1.3	
Slope:		1.052			RSQ:		0.985
Ave. Global H:	1.394			Ave. Neigh. H:	0.111		
Pos.	Sample No.	Lab	ANL	Residual	Bias	GH1	NH1
1	A2Splot18	60.21	60.139	0.071	-0.503	1.346	0.131
2	A2Splot34	58.17	55.458	2.712*	2.138	0.788	0.149
3	B2Splot13	54.59	52.104	2.486	1.912	0.964	0.163
4	B2Splot39	51.9	49.426	2.474	1.9	0.915	0.257
5	B2Lplot21	41.56	41.876	-0.316	-0.889	1.638	0.064
6	A2Lplot36	41.9	41.818	0.082	-0.492	1.608	0.081
7	B2Lplot14	41.1	40.768	0.332	-0.241	1.481	0.054

8	A2Lplot28	41.32	41.388	-0.068	-0.641	1.981	0.1
9	A1Splot48	40.67	41.423	-0.753	-1.327	1.709	0.133
10	B1Splot49	36.67	35.71	0.96	0.387	1.301	0.078
11	A1Splot64	37.51	36.803	0.707	0.133	1.111	0.17
12	B1Splot21	33.36	33.623	-0.263	-0.837	1.505	0.09
13	A1Lplot57	34.39	35.969	-1.579	-2.153	1.14	0.043
14	B1Lplot15	32.41	31.464	0.946	0.373	1.713	0.15
15	B1Lplot05	32.76	33.053	-0.293	-0.867	1.658	0.066
16	A1Lplot25	31.09	29.411	1.679	1.106	1.452	0.051
Cel%dm vs. Cel%dm							
SEP:		1.263			Num. Samps:	16	
Means:		36.051	35.368	Std. Devs:	7.335	6.515	
Bias:		0.683*			Bias Limit:	0.6	
SEP(C):		1.098			SED(C) Limit:	1.3	
Slope:		1.12			RSQ:		0.989
Ave. Global H:	1.394			Ave. Neigh. H:	0.111		
Pos.	Sample No.	Lab	ANL	Residual	Bias	GH1	NH1
1	A2Splot18	49.53	47.914	1.616	0.933	1.346	0.131
2	A2Splot34	46.47	44.321	2.149	1.467	0.788	0.149
3	B2Splot13	46.55	43.626	2.924*	2.241	0.964	0.163
4	B2Splot39	44.03	41.753	2.277	1.594	0.915	0.257

5	B2Lplot21	36.48	36.947	-0.467	-1.15	1.638	0.064
6	A2Lplot36	38.1	37.454	0.646	-0.037	1.608	0.081
7	B2Lplot14	36.98	36.804	0.176	-0.507	1.481	0.054
8	A2Lplot28	37.79	36.776	1.014	0.331	1.981	0.1
9	A1Splot48	35.51	34.821	0.689	0.006	1.709	0.133
10	B1Splot49	31.46	31.781	-0.321	-1.004	1.301	0.078
11	A1Splot64	31.18	31.131	0.049	-0.634	1.111	0.17
12	B1Splot21	29.28	29.636	-0.356	-1.039	1.505	0.09
13	A1Lplot57	30.13	30.48	-0.35	-1.033	1.14	0.043
14	B1Lplot15	27.19	27.913	-0.723	-1.405	1.713	0.15
15	B1Lplot05	29.21	28.757	0.453	-0.23	1.658	0.066
16	A1Lplot25	26.92	25.769	1.151	0.468	1.452	0.051
Hem%dm vs. Hem%dm							
SEP:		1.608			Num. Samps:	16	
Means:		30.337	29.358	Std. Devs:	2.204	1.866	
Bias:		0.979*			Bias Limit:	0.6	
SEP(C):		1.318*			SED(C) Limit:	1.3	
Slope:		0.948			RSQ:		0.644
Ave. Global H:	1.394			Ave. Neigh. H:	0.111		
Pos.	Sample No.	Lab	ANL	Residual	Bias	GH1	NH1
1	A2Splot18	27.07	24.825	2.245	1.266	1.346	0.131

2	A2Splot34	26.98	27.138	-0.158	-1.137	0.788	0.149
3	B2Splot13	28.53	26.259	2.271	1.292	0.964	0.163
4	B2Splot39	30.98	30.15	0.83	-0.149	0.915	0.257
5	B2Lplot21	35.11	31.002	4.108*	3.129	1.638	0.064
6	A2Lplot36	32.91	30.921	1.989	1.01	1.608	0.081
7	B2Lplot14	33.53	30.995	2.535*	1.556	1.481	0.054
8	A2Lplot28	29.41	29.827	-0.417	-1.396	1.981	0.1
9	A1Splot48	29.3	29.211	0.089	-0.89	1.709	0.133
10	B1Splot49	31.1	29.739	1.361	0.382	1.301	0.078
11	A1Splot64	29.26	29.267	-0.007	-0.986	1.111	0.17
12	B1Splot21	31.72	31.814	-0.094	-1.073	1.505	0.09
13	A1Lplot57	30.04	29.04	1	0.021	1.14	0.043
14	B1Lplot15	30.5	30.781	-0.281	-1.26	1.713	0.15
15	B1Lplot05	29.01	29.092	-0.082	-1.061	1.658	0.066
16	A1Lplot25	29.94	29.665	0.275	-0.704	1.452	0.051
ADL%dm vs. ADL%dm							
SEP:		0.849			Num. Samps:	16	
Means:		5.797	5.783	Std. Devs:	2.516	2.266	
Bias:		0.014			Bias Limit:	0.6	
SEP(C):		0.876			SED(C) Limit:	1.3	
Slope:		1.042			RSQ:		0.88

Ave. Global H:	1.394			Ave. Neigh. H:	0.111		
Pos.	Sample No.	Lab	ANL	Residual	Bias	GH1	NH1
1	A2Splot18	10.68	11.241	-0.561	-0.575	1.346	0.131
2	A2Splot34	11.7	10.538	1.162	1.148	0.788	0.149
3	B2Splot13	8.04	7.021	1.019	1.005	0.964	0.163
4	B2Splot39	7.87	7.693	0.177	0.163	0.915	0.257
5	B2Lplot21	5.08	5.563	-0.483	-0.497	1.638	0.064
6	A2Lplot36	3.79	4.902	-1.112	-1.126	1.608	0.081
7	B2Lplot14	4.12	4.731	-0.611	-0.625	1.481	0.054
8	A2Lplot28	3.53	4.622	-1.092	-1.106	1.981	0.1
9	A1Splot48	5.15	5.921	-0.771	-0.785	1.709	0.133
10	B1Splot49	5.21	4.589	0.621	0.607	1.301	0.078
11	A1Splot64	6.32	4.924	1.396	1.382	1.111	0.17
12	B1Splot21	4.08	4.563	-0.483	-0.497	1.505	0.09
13	A1Lplot57	4.25	4.634	-0.384	-0.398	1.14	0.043
14	B1Lplot15	5.23	3.872	1.358	1.344	1.713	0.15
15	B1Lplot05	3.55	4.102	-0.552	-0.566	1.658	0.066
16	A1Lplot25	4.16	3.62	0.54	0.526	1.452	0.051
Cel%ndf vs. Cel%ndf							
SEP:		1.453			Num. Samps:	16	
Means:		49.512	49.068	Std. Devs:	4.282	3.932	

Bias:		0.445			Bias Limit:	0.6	
SEP(C):		1.429*			SED(C) Limit:	1.3	
Slope:		1.027			RSQ:		0.889
Ave. Global H:	1.394			Ave. Neigh. H:	0.111		
Pos.	Sample No.	Lab	ANL	Residual	Bias	GH1	NH1
1	A2Splot18	56.75	56.112	0.638	0.193	1.346	0.131
2	A2Splot34	54.58	53.125	1.455	1.01	0.788	0.149
3	B2Splot13	56	55.002	0.998	0.554	0.964	0.163
4	B2Splot39	53.13	51.73	1.4	0.956	0.915	0.257
5	B2Lplot21	47.58	50.349	-2.769*	-3.214	1.638	0.064
6	A2Lplot36	50.93	50.477	0.453	0.008	1.608	0.081
7	B2Lplot14	49.55	50.28	-0.73	-1.174	1.481	0.054
8	A2Lplot28	53.42	50.565	2.855*	2.41	1.981	0.1
9	A1Splot48	50.76	49.597	1.163	0.718	1.709	0.133
10	B1Splot49	46.42	47.706	-1.286	-1.731	1.301	0.078
11	A1Splot64	46.7	47.494	-0.794	-1.239	1.111	0.17
12	B1Splot21	44.98	45.571	-0.591	-1.036	1.505	0.09
13	A1Lplot57	46.78	45.945	0.835	0.39	1.14	0.043
14	B1Lplot15	43.21	43.426	-0.216	-0.661	1.713	0.15
15	B1Lplot05	47.29	45.16	2.13	1.685	1.658	0.066
16	A1Lplot25	44.12	42.544	1.576	1.131	1.452	0.051

Hem%ndf vs. Hem%ndf							
SEP:		1.77			Num. Samps:	16	
Means:		42.636	42.341	Std. Devs:	5.945	6.244	
Bias:		0.295			Bias Limit:	0.6	
SEP(C):		1.802*			SED(C) Limit:	1.3	
Slope:		0.912			RSQ:		0.917
Ave. Global H:	1.394			Ave. Neigh. H:	0.111		
Pos.	Sample No.	Lab	ANL	Residual	Bias	GH1	NH1
1	A2Splot18	31.01	29.385	1.625	1.329	1.346	0.131
2	A2Splot34	31.69	33.263	-1.573	-1.868	0.788	0.149
3	B2Splot13	34.32	34.012	0.308	0.013	0.964	0.163
4	B2Splot39	37.38	38.65	-1.27	-1.566	0.915	0.257
5	B2Lplot21	45.8	41.807	3.993*	3.698	1.638	0.064
6	A2Lplot36	44	41.401	2.599*	2.304	1.608	0.081
7	B2Lplot14	44.93	42.051	2.879*	2.584	1.481	0.054
8	A2Lplot28	41.58	40.774	0.806	0.511	1.981	0.1
9	A1Splot48	41.87	41.311	0.559	0.264	1.709	0.133
10	B1Splot49	45.88	45.133	0.747	0.452	1.301	0.078
11	A1Splot64	43.83	44.846	-1.016	-1.312	1.111	0.17
12	B1Splot21	48.74	48.424	0.316	0.021	1.505	0.09
13	A1Lplot57	46.63	46.617	0.013	-0.282	1.14	0.043
14	B1Lplot15	48.48	50.475	-1.995	-2.291	1.713	0.15

15	B1Lplot05	46.97	48.186	-1.216	-1.511	1.658	0.066
16	A1Lplot25	49.07	51.12	-2.05	-2.345	1.452	0.051
ADL%ndf vs. ADL%ndf							
SEP:		1.367			Num. Samps:	16	
Means:		7.851	8.089	Std. Devs:	2.522	1.856*	
Bias:		-0.238			Bias Limit:	0.6	
SEP(C):		1.391*			SED(C) Limit:	1.3	
Slope:		1.143			RSQ:		0.707
Ave. Global H:	1.394			Ave. Neigh. H:	0.111		
Pos.	Sample No.	Lab	ANL	Residual	Bias	GH1	NH1
1	A2Splot18	12.23	12.568	-0.338	-0.1	1.346	0.131
2	A2Splot34	13.74	12.022	1.718	1.956	0.788	0.149
3	B2Splot13	9.67	8.912	0.758	0.996	0.964	0.163
4	B2Splot39	9.5	9.017	0.483	0.721	0.915	0.257
5	B2Lplot21	6.62	8.124	-1.504	-1.266	1.638	0.064
6	A2Lplot36	5.07	7.449	-2.379	-2.141	1.608	0.081
7	B2Lplot14	5.52	7.082	-1.562	-1.324	1.481	0.054
8	A2Lplot28	4.99	7.365	-2.375	-2.137	1.981	0.1
9	A1Splot48	7.37	8.726	-1.356	-1.118	1.709	0.133
10	B1Splot49	7.69	6.991	0.699	0.938	1.301	0.078
11	A1Splot64	9.47	7.938	1.532	1.77	1.111	0.17

12	B1Splot21	6.27	7.008	-0.738	-0.5	1.505	0.09
13	A1Lplot57	6.6	7.064	-0.464	-0.226	1.14	0.043
14	B1Lplot15	8.31	6.409	1.901	2.139	1.713	0.15
15	B1Lplot05	5.74	6.529	-0.789	-0.551	1.658	0.066
16	A1Lplot25	6.82	6.215	0.605	0.844	1.452	0.051

Appendix 3. The full predicted and analyzed cell wall composition data of Chinese field trials.

Year 1															
WinSI Code	Genotype	Field	Plot	Block	Species	Propagation	Fraction	NDF%dm	ADF%dm	Cel%dm	Hem%dm	Lig%dm	Cel%ndf	Hem%ndf	Lig%ndf
A1Lplot13	CN-10	A	13	1	sac	Seed	Leaf	63.80	32.09	27.50	32.20	4.28	42.32	51.45	6.56
A1Lplot46	CN-10	A	46	2	sac	Seed	Leaf	60.06	30.48	26.58	29.29	3.68	43.74	50.54	6.34
A1Lplot58	CN-10	A	58	3	sac	Seed	Leaf	60.26	31.19	26.68	29.80	3.95	43.51	49.73	6.45
A1Lplot25	CN-12	A	25	1	sac	Seed	Leaf	59.07	29.41	25.77	29.67	3.62	42.55	51.12	6.22
A1Lplot47	CN-12	A	47	2	sac	Seed	Leaf	61.57	32.79	28.03	28.89	4.85	44.87	46.97	7.63
A1Lplot71	CN-12	A	71	3	sac	Seed	Leaf	58.44	29.80	25.32	29.06	4.60	42.35	50.37	7.42
A1Lplot14	CN-13	A	14	1	sac	Seed	Leaf	59.48	30.78	26.48	29.16	4.20	43.54	48.89	7.08
A1Lplot28	CN-13	A	28	2	sac	Seed	Leaf	61.22	32.23	27.59	28.89	4.44	44.09	48.16	7.10
A1Lplot70	CN-13	A	70	3	sac	Seed	Leaf	59.04	30.84	27.19	28.65	3.47	44.43	48.51	5.83
A1Lplot11	CN-14	A	11	1	sac	Seed	Leaf	59.00	31.22	26.65	28.26	4.36	43.75	47.99	7.08
A1Lplot43	CN-14	A	43	2	sac	Seed	Leaf	59.42	30.84	26.72	28.79	4.17	43.93	48.82	6.98
A1Lplot54	CN-14	A	54	3	sac	Seed	Leaf	61.54	34.24	29.40	27.45	4.58	46.08	45.14	7.41
A1Lplot07	CN-16	A	7	1	sac	Seed	Leaf	60.30	30.24	26.77	29.59	3.98	42.97	50.07	6.68
A1Lplot45	CN-16	A	45	2	sac	Seed	Leaf	57.53	29.80	25.99	28.13	3.92	44.01	48.50	6.70
A1Lplot59	CN-16	A	59	3	sac	Seed	Leaf	57.69	28.27	25.24	29.13	3.30	42.60	50.69	5.88
A1Lplot17	CN-18	A	17	1	sac	Seed	Leaf	63.56	33.61	28.98	30.49	4.33	44.66	47.86	6.78
A1Lplot36	CN-18	A	36	2	sac	Seed	Leaf	60.59	31.43	26.50	29.66	4.44	42.78	49.59	7.03

A1Lplot61	CN-18	A	61	3	sac	Seed	Leaf	60.58	30.79	27.24	30.29	3.88	43.52	50.29	6.51
A1Lplot05	CN-23	A	5	1	sac	Seed	Leaf	60.21	30.46	27.35	30.15	3.77	43.62	50.45	6.11
A1Lplot35	CN-23	A	35	2	sac	Seed	Leaf	60.36	31.12	27.52	29.94	4.08	44.12	49.51	6.42
A1Lplot68	CN-23	A	68	3	sac	Seed	Leaf	59.34	30.72	26.95	30.31	3.87	44.23	49.11	6.47
A1Lplot10	CN-27	A	10	1	sac	Seed	Leaf	59.97	30.16	26.60	30.18	3.63	43.23	50.76	6.13
A1Lplot49	CN-27	A	49	2	sac	Seed	Leaf	61.35	31.62	27.03	30.47	4.52	43.38	49.58	7.21
A1Lplot66	CN-27	A	66	3	sac	Seed	Leaf	60.11	31.63	26.99	29.20	4.02	43.92	49.21	6.71
A1Lplot09	CN-28	A	9	1	sac	Seed	Leaf	61.69	31.46	27.00	30.39	4.42	43.22	49.99	7.05
A1Lplot33	CN-28	A	33	2	sac	Seed	Leaf	62.81	32.36	28.05	31.05	4.15	43.82	50.17	6.77
A1Lplot55	CN-28	A	55	3	sac	Seed	Leaf	58.92	29.85	26.14	29.14	3.69	43.49	49.96	6.40
A1Lplot21	CN-29	A	21	1	sac	Seed	Leaf	58.43	29.08	25.06	29.26	3.84	42.51	51.07	6.34
A1Lplot41	CN-29	A	41	2	sac	Seed	Leaf	57.48	28.85	25.37	29.96	3.58	42.84	51.11	6.10
A1Lplot62	CN-29	A	62	3	sac	Seed	Leaf	58.80	29.25	26.11	29.52	3.42	43.52	50.05	6.23
A1Lplot02	CN-30	A	2	1	sac	Seed	Leaf	63.12	30.47	26.52	31.93	3.81	41.84	53.33	6.21
A1Lplot31	CN-30	A	31	2	sac	Seed	Leaf	64.17	32.15	28.01	30.43	4.36	43.43	50.36	7.07
A1Lplot72	CN-30	A	72	3	sac	Seed	Leaf	62.27	31.25	27.03	30.68	3.94	43.30	50.54	6.44
A1Lplot01	CN-31	A	1	1	sac	Seed	Leaf	63.96	30.78	26.58	32.08	4.49	41.30	53.03	6.91
A1Lplot34	CN-31	A	34	2	sac	Seed	Leaf	64.15	32.38	27.06	31.94	4.84	42.01	51.34	7.48
A1Lplot74	CN-31	A	74	3	sac	Seed	Leaf	62.80	31.77	26.73	31.26	4.42	42.46	50.58	7.03
A1Lplot20	CN-32	A	20	1	sac	Seed	Leaf	60.33	31.04	27.05	28.73	4.27	43.66	49.18	6.55
A1Lplot38	CN-32	A	38	2	sac	Seed	Leaf	62.47	32.70	27.59	30.76	4.70	43.31	49.83	7.10
A1Lplot75	CN-32	A	75	3	sac	Seed	Leaf	59.31	30.06	25.61	29.56	4.18	42.70	49.49	6.98

A1Lplot12	CN-33	A	12	1	sac	Seed	Leaf	61.47	31.71	26.82	31.04	4.31	42.94	50.16	6.86
A1Lplot40	CN-33	A	40	2	sac	Seed	Leaf	60.92	31.80	26.58	29.65	5.27	43.12	48.59	7.94
A1Lplot65	CN-33	A	65	3	sac	Seed	Leaf	57.65	29.68	24.48	29.45	4.39	42.12	49.82	7.29
A1Lplot18	CN-34	A	18	1	sac	Seed	Leaf	62.57	33.48	27.29	29.85	5.16	42.90	48.29	7.70
A1Lplot32	CN-34	A	32	2	sac	Seed	Leaf	62.80	33.77	28.47	28.78	4.66	44.55	47.26	7.22
A1Lplot51	CN-34	A	51	3	sac	Seed	Leaf	61.68	32.14	26.95	30.11	4.54	42.98	49.21	7.06
A1Lplot08	CN-35	A	8	1	sac	Seed	Leaf	64.75	33.83	28.76	31.47	4.70	43.76	49.34	7.25
A1Lplot29	CN-35	A	29	2	sac	Seed	Leaf	65.55	33.51	29.33	31.82	4.03	44.21	50.24	6.24
A1Lplot73	CN-35	A	73	3	sac	Seed	Leaf	62.01	32.02	26.95	31.08	4.34	43.22	49.58	7.06
A1Lplot15	CN-36	A	15	1	sac	Seed	Leaf	58.64	29.61	24.89	29.95	4.09	42.09	50.22	6.79
A1Lplot26	CN-36	A	26	2	sac	Seed	Leaf	60.06	30.22	26.21	30.61	3.92	42.56	50.43	6.62
A1Lplot63	CN-36	A	63	3	sac	Seed	Leaf	60.18	32.80	27.68	29.32	4.16	45.27	47.06	6.92
A1Lplot06	CN-4	A	6	1	sac	Seed	Leaf	62.59	30.66	27.20	30.98	3.73	42.37	51.54	6.15
A1Lplot27	CN-4	A	27	2	sac	Seed	Leaf	65.52	34.30	30.08	30.56	3.91	45.15	48.09	6.45
A1Lplot60	CN-4	A	60	3	sac	Seed	Leaf	61.89	30.97	27.66	30.67	3.62	43.34	50.89	6.19
A1Lplot16	CN-8	A	16	1	sac	Seed	Leaf	59.60	30.42	25.98	28.63	4.10	42.67	50.17	6.97
A1Lplot30	CN-8	A	30	2	sac	Seed	Leaf	63.00	32.88	28.50	29.14	4.04	44.36	48.47	6.53
A1Lplot53	CN-8	A	53	3	sac	Seed	Leaf	61.40	33.23	28.22	29.68	3.90	44.90	48.21	6.29
A1Lplot03	CN-9	A	3	1	sac	Seed	Leaf	61.46	30.64	27.13	30.93	3.71	43.06	51.73	6.24
A1Lplot42	CN-9	A	42	2	sac	Seed	Leaf	61.07	30.75	26.51	30.58	4.13	43.00	50.97	6.75
A1Lplot52	CN-9	A	52	3	sac	Seed	Leaf	57.87	29.59	25.55	29.29	3.55	43.41	50.67	6.28
A1Lplot04	OPM-1	A	4	1	sac	Rhizomes	Leaf	64.07	31.11	26.51	32.69	4.75	41.04	53.01	7.09

A1Lplot50	OPM-1	A	50	2	sac	Rhizomes	Leaf	62.14	32.09	26.75	30.73	4.67	42.45	50.08	7.11
A1Lplot56	OPM-1	A	56	3	sac	Rhizomes	Leaf	62.77	31.27	26.71	30.98	4.30	42.24	51.32	6.80
A1Lplot24	OPM-3	A	24	1	sac	Rhizomes	Leaf	62.64	33.02	28.15	30.09	4.50	44.21	49.39	7.08
A1Lplot39	OPM-3	A	39	2	sac	Rhizomes	Leaf	62.57	32.42	28.11	30.28	4.27	44.25	48.31	6.83
A1Lplot69	OPM-3	A	69	3	sac	Rhizomes	Leaf	61.80	31.30	27.40	30.90	3.43	43.32	50.88	6.03
A1Lplot23	OPM-6	A	23	1	hybrid	Rhizomes	Leaf	63.27	34.89	30.08	28.82	3.91	46.45	46.23	6.54
A1Lplot44	OPM-6	A	44	2	hybrid	Rhizomes	Leaf	63.59	35.64	30.34	29.26	4.47	46.38	46.49	6.93
A1Lplot57	OPM-6	A	57	3	hybrid	Rhizomes	Leaf	63.64	35.97	30.48	29.04	4.63	45.95	46.62	7.06
A1Lplot22	OPM-8	A	22	1	hybrid	Rhizomes	Leaf	62.39	34.09	30.12	27.86	3.97	46.47	46.24	6.40
A1Lplot48	OPM-8	A	48	2	hybrid	Rhizomes	Leaf	61.66	35.04	30.09	28.24	4.25	46.73	45.45	6.81
A1Lplot67	OPM-8	A	67	3	hybrid	Rhizomes	Leaf	60.90	34.73	29.94	27.87	3.75	46.94	45.22	6.11
A1Lplot19	OPM-9	A	19	1	M. x gig	Rhizomes	Leaf	*	*	*	*	*	*	*	*
A1Lplot37	OPM-9	A	37	2	M. x gig	Rhizomes	Leaf	*	*	*	*	*	*	*	*
A1Lplot64	OPM-9	A	64	3	M. x gig	Rhizomes	Leaf	63.70	33.42	28.99	31.10	4.26	44.89	49.12	6.88
B1Lplot05	CN-10	B	5	1	sac	Seed	Leaf	61.97	33.05	28.76	29.09	4.10	45.16	48.18	6.53
B1Lplot30	CN-10	B	30	2	sac	Seed	Leaf	57.12	27.94	24.53	29.44	3.34	42.22	52.07	5.58
B1Lplot55	CN-10	B	55	3	sac	Seed	Leaf	57.68	28.40	24.81	29.12	3.73	42.57	51.44	6.29
B1Lplot17	CN-12	B	17	1	sac	Seed	Leaf	56.68	28.39	23.98	29.48	4.02	42.07	51.05	6.84
B1Lplot38	CN-12	B	38	2	sac	Seed	Leaf	57.68	28.60	24.30	28.87	4.12	41.55	50.75	6.87
B1Lplot70	CN-12	B	70	3	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B1Lplot09	CN-13	B	9	1	sac	Seed	Leaf	59.70	32.09	27.83	28.18	3.99	44.92	47.18	6.50
B1Lplot43	CN-13	B	43	2	sac	Seed	Leaf	58.70	30.78	26.71	27.56	4.36	43.89	48.25	6.95

B1Lplot68	CN-13	B	68	3	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B1Lplot20	CN-14	B	20	1	sac	Seed	Leaf	56.22	29.34	24.87	27.71	4.40	42.73	48.84	6.97
B1Lplot40	CN-14	B	40	2	sac	Seed	Leaf	57.24	30.18	26.72	27.87	3.37	44.90	48.09	5.84
B1Lplot58	CN-14	B	58	3	sac	Seed	Leaf	56.56	28.01	24.25	28.93	3.86	42.26	50.04	6.66
B1Lplot19	CN-16	B	19	1	sac	Seed	Leaf	59.58	30.18	27.83	28.89	3.36	44.65	48.81	5.96
B1Lplot33	CN-16	B	33	2	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B1Lplot53	CN-16	B	53	3	sac	Seed	Leaf	59.94	30.33	26.80	29.40	4.28	43.22	49.22	6.98
B1Lplot06	CN-18	B	6	1	sac	Seed	Leaf	61.73	32.36	28.92	29.12	3.81	45.35	47.36	6.21
B1Lplot47	CN-18	B	47	2	sac	Seed	Leaf	61.96	33.14	29.83	28.23	3.90	46.38	45.99	6.39
B1Lplot75	CN-18	B	75	3	sac	Seed	Leaf	60.95	32.30	29.20	28.52	3.41	46.69	46.13	5.79
B1Lplot07	CN-23	B	7	1	sac	Seed	Leaf	59.18	30.99	28.03	28.44	3.86	45.41	47.25	6.44
B1Lplot49	CN-23	B	49	2	sac	Seed	Leaf	58.67	30.04	27.19	28.47	3.26	44.86	48.07	5.67
B1Lplot61	CN-23	B	61	3	sac	Seed	Leaf	57.52	29.22	26.58	28.29	3.27	44.70	47.83	5.67
B1Lplot11	CN-27	B	11	1	sac	Seed	Leaf	59.65	30.23	26.56	30.07	3.69	43.33	50.22	6.12
B1Lplot31	CN-27	B	31	2	sac	Seed	Leaf	55.74	27.51	24.18	28.50	2.97	42.84	50.75	5.72
B1Lplot71	CN-27	B	71	3	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B1Lplot18	CN-28	B	18	1	sac	Seed	Leaf	60.08	30.04	27.13	29.37	3.88	43.83	50.01	6.53
B1Lplot50	CN-28	B	50	2	sac	Seed	Leaf	57.25	28.82	25.39	27.53	4.01	43.75	48.76	6.88
B1Lplot65	CN-28	B	65	3	sac	Seed	Leaf	57.68	28.98	25.98	29.16	2.71	43.95	50.19	5.00
B1Lplot13	CN-29	B	13	1	sac	Seed	Leaf	59.26	30.61	26.69	29.44	3.83	43.93	49.74	6.29
B1Lplot42	CN-29	B	42	2	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B1Lplot74	CN-29	B	74	3	sac	Seed	Leaf	59.14	31.00	27.23	26.97	3.77	45.58	47.05	6.41

B1Lplot16	CN-30	B	16	1	sac	Seed	Leaf	62.93	31.80	28.18	30.25	3.76	44.37	49.91	6.27
B1Lplot35	CN-30	B	35	2	sac	Seed	Leaf	61.62	30.42	26.84	29.51	3.63	43.26	50.07	6.29
B1Lplot72	CN-30	B	72	3	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B1Lplot04	CN-31	B	4	1	sac	Seed	Leaf	61.64	32.03	27.53	29.38	4.42	44.56	48.64	7.21
B1Lplot48	CN-31	B	48	2	sac	Seed	Leaf	59.58	29.40	23.91	29.93	5.05	40.72	52.01	7.44
B1Lplot59	CN-31	B	59	3	sac	Seed	Leaf	60.53	30.27	25.66	30.35	4.44	42.10	51.56	7.14
B1Lplot10	CN-32	B	10	1	sac	Seed	Leaf	62.43	33.43	29.39	28.78	4.00	45.24	47.24	6.41
B1Lplot28	CN-32	B	28	2	sac	Seed	Leaf	59.62	31.68	26.69	29.24	4.44	43.94	48.18	7.06
B1Lplot64	CN-32	B	64	3	sac	Seed	Leaf	58.14	30.89	26.77	27.78	4.03	44.90	46.60	6.70
B1Lplot03	CN-33	B	3	1	sac	Seed	Leaf	62.14	33.65	28.18	30.11	4.46	44.63	46.84	6.73
B1Lplot39	CN-33	B	39	2	sac	Seed	Leaf	57.88	29.06	25.12	29.18	3.90	42.73	50.22	6.18
B1Lplot62	CN-33	B	62	3	sac	Seed	Leaf	57.35	28.52	25.23	30.12	3.27	43.47	49.49	5.60
B1Lplot24	CN-34	B	24	1	sac	Seed	Leaf	60.25	32.43	27.66	28.61	4.00	44.20	48.52	6.31
B1Lplot45	CN-34	B	45	2	sac	Seed	Leaf	60.49	31.67	27.34	29.23	4.23	43.77	48.52	6.59
B1Lplot52	CN-34	B	52	3	sac	Seed	Leaf	58.50	29.37	25.86	29.25	3.87	43.41	50.18	6.29
B1Lplot14	CN-35	B	14	1	sac	Seed	Leaf	61.03	31.63	27.39	30.38	4.04	44.04	49.43	6.59
B1Lplot44	CN-35	B	44	2	sac	Seed	Leaf	60.72	31.26	27.17	30.00	4.18	43.68	49.15	6.46
B1Lplot66	CN-35	B	66	3	sac	Seed	Leaf	59.47	30.28	27.01	29.08	2.90	44.83	48.51	5.51
B1Lplot21	CN-36	B	21	1	sac	Seed	Leaf	57.40	29.36	24.55	29.66	4.78	42.22	50.17	7.36
B1Lplot29	CN-36	B	29	2	sac	Seed	Leaf	58.90	30.46	25.95	29.03	4.22	43.35	48.77	6.91
B1Lplot69	CN-36	B	69	3	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B1Lplot02	CN-4	B	2	1	sac	Seed	Leaf	64.12	34.02	29.42	30.91	4.09	44.88	48.33	6.40

B1Lplot32	CN-4	B	32	2	sac	Seed	Leaf	59.90	29.13	26.53	29.88	3.62	43.27	50.93	5.99
B1Lplot56	CN-4	B	56	3	sac	Seed	Leaf	60.93	32.04	28.32	29.25	3.08	45.48	47.26	5.75
B1Lplot08	CN-8	B	8	1	sac	Seed	Leaf	60.09	32.55	27.68	28.88	4.13	44.59	47.98	6.59
B1Lplot26	CN-8	B	26	2	sac	Seed	Leaf	61.37	32.22	27.86	29.21	4.27	44.33	48.87	6.74
B1Lplot60	CN-8	B	60	3	sac	Seed	Leaf	59.04	31.02	26.66	28.34	3.70	44.37	48.04	6.50
B1Lplot22	CN-9	B	22	1	sac	Seed	Leaf	57.90	28.73	25.09	29.26	3.55	42.62	50.72	6.08
B1Lplot27	CN-9	B	27	2	sac	Seed	Leaf	59.87	30.77	26.02	30.04	4.07	42.80	50.35	6.52
B1Lplot51	CN-9	B	51	3	sac	Seed	Leaf	58.65	29.41	25.84	29.48	3.30	43.67	50.50	5.94
B1Lplot15	OPM-1	B	15	1	sac	Rhizomes	Leaf	63.60	31.46	27.91	30.78	3.87	43.43	50.48	6.41
B1Lplot34	OPM-1	B	34	2	sac	Rhizomes	Leaf	62.69	30.90	26.98	30.33	4.32	42.84	50.85	6.79
B1Lplot63	OPM-1	B	63	3	sac	Rhizomes	Leaf	*	*	*	*	*	*	*	*
B1Lplot01	OPM-3	B	1	1	sac	Rhizomes	Leaf	62.74	33.52	28.54	30.33	4.27	44.31	49.01	6.59
B1Lplot46	OPM-3	B	46	2	sac	Rhizomes	Leaf	60.64	32.52	27.67	29.19	3.49	44.59	49.09	5.84
B1Lplot54	OPM-3	B	54	3	sac	Rhizomes	Leaf	60.81	33.17	26.97	28.34	4.83	43.24	48.98	7.34
B1Lplot12	OPM-6	B	12	1	hybrid	Rhizomes	Leaf	63.69	35.12	29.77	29.84	4.61	45.27	47.13	7.10
B1Lplot36	OPM-6	B	36	2	hybrid	Rhizomes	Leaf	63.41	36.51	31.00	28.48	4.07	47.14	44.92	6.55
B1Lplot73	OPM-6	B	73	3	hybrid	Rhizomes	Leaf	62.86	35.19	30.67	28.09	3.37	48.06	44.66	6.16
B1Lplot23	OPM-8	B	23	1	hybrid	Rhizomes	Leaf	63.39	33.79	30.55	29.88	3.22	46.30	47.32	5.35
B1Lplot37	OPM-8	B	37	2	hybrid	Rhizomes	Leaf	60.68	33.44	29.47	27.51	3.47	46.45	45.52	5.72
B1Lplot57	OPM-8	B	57	3	hybrid	Rhizomes	Leaf	*	*	*	*	*	*	*	*
B1Lplot25	OPM-9	B	25	1	M. x gig	Rhizomes	Leaf	*	*	*	*	*	*	*	*
B1Lplot41	OPM-9	B	41	2	M. x gig	Rhizomes	Leaf	*	*	*	*	*	*	*	*

B1Lplot67	OPM-9	B	67	3	M. x gig	Rhizomes	Leaf	*	*	*	*	*	*	*	*
A1Splot13	CN-10	A	13	1	sac	Seed	Stem	61.05	33.50	29.95	26.95	4.39	47.87	43.89	7.83
A1Splot46	CN-10	A	46	2	sac	Seed	Stem	60.99	32.95	28.50	29.30	4.83	46.46	46.46	8.26
A1Splot58	CN-10	A	58	3	sac	Seed	Stem	56.53	29.41	25.78	28.10	4.49	45.12	47.80	8.28
A1Splot25	CN-12	A	25	1	sac	Seed	Stem	61.84	33.11	29.11	28.71	4.90	46.25	46.20	8.11
A1Splot47	CN-12	A	47	2	sac	Seed	Stem	66.46	37.85	32.33	28.87	5.62	48.09	43.33	8.70
A1Splot71	CN-12	A	71	3	sac	Seed	Stem	62.97	34.66	29.85	28.66	5.10	46.79	44.67	8.28
A1Splot14	CN-13	A	14	1	sac	Seed	Stem	62.70	35.86	30.64	27.76	5.28	47.75	43.67	8.61
A1Splot28	CN-13	A	28	2	sac	Seed	Stem	64.07	36.59	31.63	27.72	5.30	48.62	43.08	8.58
A1Splot70	CN-13	A	70	3	sac	Seed	Stem	61.62	34.74	29.99	27.94	4.59	47.44	44.89	7.43
A1Splot11	CN-14	A	11	1	sac	Seed	Stem	68.54	40.05	34.96	28.46	5.33	50.11	41.99	7.79
A1Splot43	CN-14	A	43	2	sac	Seed	Stem	62.54	35.14	30.42	28.66	5.04	47.55	45.22	8.01
A1Splot54	CN-14	A	54	3	sac	Seed	Stem	64.51	37.00	31.86	27.76	5.52	48.43	43.23	8.59
A1Splot07	CN-16	A	7	1	sac	Seed	Stem	63.43	35.83	29.75	29.02	6.03	46.54	44.53	9.23
A1Splot45	CN-16	A	45	2	sac	Seed	Stem	63.01	35.69	30.64	28.33	5.45	47.76	44.35	8.58
A1Splot59	CN-16	A	59	3	sac	Seed	Stem	62.65	35.15	29.52	28.70	6.24	46.87	44.36	9.56
A1Splot17	CN-18	A	17	1	sac	Seed	Stem	64.94	36.20	31.81	29.35	4.70	48.24	44.71	7.75
A1Splot36	CN-18	A	36	2	sac	Seed	Stem	62.51	34.02	29.96	28.77	4.77	47.32	45.69	7.93
A1Splot61	CN-18	A	61	3	sac	Seed	Stem	61.74	34.67	29.37	28.25	5.16	46.81	44.96	8.43
A1Splot05	CN-23	A	5	1	sac	Seed	Stem	61.23	33.18	29.18	27.60	5.14	46.38	45.25	8.30
A1Splot35	CN-23	A	35	2	sac	Seed	Stem	62.46	35.15	31.47	27.16	5.22	48.66	43.89	8.39
A1Splot68	CN-23	A	68	3	sac	Seed	Stem	59.12	32.67	28.48	27.27	4.97	46.85	45.35	8.44

A1Splot10	CN-27	A	10	1	sac	Seed	Stem	62.18	34.17	29.92	27.96	4.92	47.57	44.68	8.03
A1Splot49	CN-27	A	49	2	sac	Seed	Stem	63.16	35.51	30.25	28.49	5.19	47.39	44.69	8.17
A1Splot66	CN-27	A	66	3	sac	Seed	Stem	62.70	34.39	29.68	28.49	5.32	47.08	44.99	8.71
A1Splot09	CN-28	A	9	1	sac	Seed	Stem	60.24	33.10	28.74	27.34	4.68	46.96	44.78	7.85
A1Splot33	CN-28	A	33	2	sac	Seed	Stem	64.16	36.02	31.97	27.50	4.24	49.00	43.13	7.47
A1Splot55	CN-28	A	55	3	sac	Seed	Stem	59.13	31.91	28.36	27.70	4.36	47.20	46.23	7.60
A1Splot21	CN-29	A	21	1	sac	Seed	Stem	62.93	35.21	30.46	28.13	5.15	47.44	44.63	8.15
A1Splot41	CN-29	A	41	2	sac	Seed	Stem	59.38	31.73	28.18	28.71	4.62	46.29	47.07	7.80
A1Splot62	CN-29	A	62	3	sac	Seed	Stem	59.17	32.73	27.98	27.72	5.21	46.42	45.53	8.54
A1Splot02	CN-30	A	2	1	sac	Seed	Stem	68.18	42.04	32.98	27.31	8.97	48.54	40.02	11.76
A1Splot31	CN-30	A	31	2	sac	Seed	Stem	68.22	40.62	33.54	28.45	6.82	48.40	41.38	9.50
A1Splot72	CN-30	A	72	3	sac	Seed	Stem	61.45	34.80	29.13	28.33	5.92	46.54	44.64	9.05
A1Splot01	CN-31	A	1	1	sac	Seed	Stem	67.29	40.19	34.14	27.46	6.92	49.87	40.24	10.09
A1Splot34	CN-31	A	34	2	sac	Seed	Stem	58.82	33.09	28.01	27.00	6.29	46.83	43.92	9.98
A1Splot74	CN-31	A	74	3	sac	Seed	Stem	62.44	36.30	29.69	28.36	6.58	47.33	43.10	10.04
A1Splot20	CN-32	A	20	1	sac	Seed	Stem	72.32	44.34	37.20	27.96	7.11	50.80	39.51	9.38
A1Splot38	CN-32	A	38	2	sac	Seed	Stem	70.56	42.28	36.04	28.78	7.02	50.15	41.06	9.41
A1Splot75	CN-32	A	75	3	sac	Seed	Stem	69.43	41.13	35.53	28.42	6.15	49.89	41.25	8.66
A1Splot12	CN-33	A	12	1	sac	Seed	Stem	71.88	42.97	37.18	29.00	6.01	51.00	40.19	8.23
A1Splot40	CN-33	A	40	2	sac	Seed	Stem	70.99	42.09	35.65	29.28	6.75	49.52	41.35	9.09
A1Splot65	CN-33	A	65	3	sac	Seed	Stem	65.87	37.36	32.34	29.10	5.54	48.26	44.15	8.35
A1Splot18	CN-34	A	18	1	sac	Seed	Stem	69.48	40.92	34.83	28.88	6.19	49.63	41.52	8.94

A1Splot32	CN-34	A	32	2	sac	Seed	Stem	72.51	43.27	36.87	29.99	6.03	50.17	41.54	8.06
A1Splot51	CN-34	A	51	3	sac	Seed	Stem	72.55	42.99	37.66	29.39	5.67	50.96	41.47	7.92
A1Splot08	CN-35	A	8	1	sac	Seed	Stem	69.71	41.44	35.18	28.97	6.11	49.86	41.19	8.67
A1Splot29	CN-35	A	29	2	sac	Seed	Stem	68.32	40.35	34.54	28.20	5.80	49.96	41.43	8.94
A1Splot73	CN-35	A	73	3	sac	Seed	Stem	67.03	39.16	33.31	28.65	5.94	49.14	41.90	8.95
A1Splot15	CN-36	A	15	1	sac	Seed	Stem	68.60	39.04	33.49	29.70	5.93	48.27	43.17	8.62
A1Splot26	CN-36	A	26	2	sac	Seed	Stem	71.10	41.34	35.46	30.22	6.14	49.27	42.70	8.41
A1Splot63	CN-36	A	63	3	sac	Seed	Stem	69.29	41.25	34.35	29.19	6.87	49.19	41.50	9.45
A1Splot06	CN-4	A	6	1	sac	Seed	Stem	69.82	40.58	35.05	29.23	5.94	49.67	41.82	8.43
A1Splot27	CN-4	A	27	2	sac	Seed	Stem	69.21	40.60	34.54	28.62	5.97	49.55	41.06	8.72
A1Splot60	CN-4	A	60	3	sac	Seed	Stem	67.58	38.87	33.59	29.16	5.95	48.80	42.90	8.55
A1Splot16	CN-8	A	16	1	sac	Seed	Stem	61.80	34.93	29.79	28.58	5.39	47.63	44.60	8.66
A1Splot30	CN-8	A	30	2	sac	Seed	Stem	64.10	36.68	31.71	27.95	4.87	48.45	43.35	8.07
A1Splot53	CN-8	A	53	3	sac	Seed	Stem	59.12	32.75	27.96	27.62	4.71	46.29	45.67	7.98
A1Splot03	CN-9	A	3	1	sac	Seed	Stem	65.48	38.43	31.68	27.70	7.03	48.25	42.20	10.16
A1Splot42	CN-9	A	42	2	sac	Seed	Stem	58.50	30.95	26.95	28.39	5.02	45.68	46.83	8.73
A1Splot52	CN-9	A	52	3	sac	Seed	Stem	56.67	30.04	26.37	27.46	4.31	45.87	46.86	7.71
A1Splot04	OPM-1	A	4	1	sac	Rhizomes	Stem	67.80	38.90	32.48	29.98	7.17	47.72	43.34	9.68
A1Splot50	OPM-1	A	50	2	sac	Rhizomes	Stem	62.82	34.72	29.78	29.10	4.84	46.55	45.31	7.63
A1Splot56	OPM-1	A	56	3	sac	Rhizomes	Stem	62.76	34.51	29.85	28.85	5.03	47.21	44.68	8.06
A1Splot24	OPM-3	A	24	1	sac	Rhizomes	Stem	61.15	32.73	29.38	28.20	4.12	47.50	46.14	7.27
A1Splot39	OPM-3	A	39	2	sac	Rhizomes	Stem	57.06	28.99	26.35	27.97	4.05	45.65	47.91	7.70

A1Splot69	OPM-3	A	69	3	sac	Rhizomes	Stem	57.00	30.72	26.54	27.05	4.32	45.86	46.48	7.82
A1Splot23	OPM-6	A	23	1	hybrid	Rhizomes	Stem	74.44	43.94	37.91	30.96	6.08	50.58	41.93	8.27
A1Splot44	OPM-6	A	44	2	hybrid	Rhizomes	Stem	74.56	43.47	37.56	31.57	5.69	50.44	42.19	8.06
A1Splot57	OPM-6	A	57	3	hybrid	Rhizomes	Stem	74.15	45.23	38.12	29.85	6.34	50.77	40.23	8.68
A1Splot22	OPM-8	A	22	1	hybrid	Rhizomes	Stem	74.17	44.69	37.55	30.72	6.43	50.52	41.47	8.57
A1Splot48	OPM-8	A	48	2	hybrid	Rhizomes	Stem	69.86	41.42	34.82	29.21	5.92	49.60	41.31	8.73
A1Splot67	OPM-8	A	67	3	hybrid	Rhizomes	Stem	72.64	43.71	36.99	29.33	6.51	50.85	39.99	9.20
A1Splot19	OPM-9	A	19	1	M. x gig	Rhizomes	Stem	*	*	*	*	*	*	*	*
A1Splot37	OPM-9	A	37	2	M. x gig	Rhizomes	Stem	*	*	*	*	*	*	*	*
A1Splot64	OPM-9	A	64	3	M. x gig	Rhizomes	Stem	65.56	36.80	31.13	29.27	4.92	47.49	44.85	7.94
B1Splot05	CN-10	B	5	1	sac	Seed	Stem	58.60	30.60	27.24	29.28	4.35	45.40	48.34	7.41
B1Splot30	CN-10	B	30	2	sac	Seed	Stem	60.85	30.88	26.19	32.40	4.05	44.07	50.10	6.49
B1Splot55	CN-10	B	55	3	sac	Seed	Stem	57.77	30.72	25.68	29.71	4.33	44.31	48.89	7.30
B1Splot17	CN-12	B	17	1	sac	Seed	Stem	63.60	34.25	29.40	30.40	4.79	45.87	46.89	7.35
B1Splot38	CN-12	B	38	2	sac	Seed	Stem	59.35	30.39	26.04	30.31	4.29	44.02	49.07	7.14
B1Splot70	CN-12	B	70	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot09	CN-13	B	9	1	sac	Seed	Stem	65.18	36.43	31.24	29.91	5.64	47.14	44.98	8.64
B1Splot43	CN-13	B	43	2	sac	Seed	Stem	61.19	33.07	28.79	29.07	4.10	46.11	46.89	6.94
B1Splot68	CN-13	B	68	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot20	CN-14	B	20	1	sac	Seed	Stem	58.82	30.71	27.05	28.97	4.18	45.08	47.98	7.17
B1Splot40	CN-14	B	40	2	sac	Seed	Stem	58.89	31.27	27.48	29.06	3.81	45.64	47.82	6.47
B1Splot58	CN-14	B	58	3	sac	Seed	Stem	61.10	32.97	28.28	30.86	4.10	45.59	48.77	6.25

B1Splot19	CN-16	B	19	1	sac	Seed	Stem	62.83	34.14	30.04	29.49	4.61	46.81	46.18	7.33
B1Splot33	CN-16	B	33	2	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot53	CN-16	B	53	3	sac	Seed	Stem	62.42	33.31	29.73	29.86	3.76	46.72	47.46	6.50
B1Splot06	CN-18	B	6	1	sac	Seed	Stem	61.70	33.68	28.73	29.33	5.07	45.99	46.02	8.07
B1Splot47	CN-18	B	47	2	sac	Seed	Stem	64.33	35.94	30.57	30.24	4.97	46.80	46.04	7.30
B1Splot75	CN-18	B	75	3	sac	Seed	Stem	63.78	34.75	28.04	31.85	5.16	44.33	48.48	7.01
B1Splot07	CN-23	B	7	1	sac	Seed	Stem	61.92	33.68	29.09	28.63	5.60	45.91	45.73	8.50
B1Splot49	CN-23	B	49	2	sac	Seed	Stem	65.34	35.71	31.78	29.74	4.59	47.71	45.13	6.99
B1Splot61	CN-23	B	61	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot11	CN-27	B	11	1	sac	Seed	Stem	62.53	34.03	29.74	29.19	4.53	46.78	45.99	7.53
B1Splot31	CN-27	B	31	2	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot71	CN-27	B	71	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot18	CN-28	B	18	1	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot50	CN-28	B	50	2	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot65	CN-28	B	65	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot13	CN-29	B	13	1	sac	Seed	Stem	63.02	33.70	30.03	29.78	4.77	46.86	46.50	7.52
B1Splot42	CN-29	B	42	2	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot74	CN-29	B	74	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot16	CN-30	B	16	1	sac	Seed	Stem	65.17	37.15	31.64	29.58	6.14	47.96	44.10	8.79
B1Splot35	CN-30	B	35	2	sac	Seed	Stem	65.16	36.64	30.98	29.24	5.54	46.93	44.39	8.09
B1Splot72	CN-30	B	72	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot04	CN-31	B	4	1	sac	Seed	Stem	55.76	28.45	24.36	28.71	5.33	43.79	48.24	9.00

B1Splot48	CN-31	B	48	2	sac	Seed	Stem	66.44	36.33	30.43	31.66	5.57	46.23	46.84	7.83
B1Splot59	CN-31	B	59	3	sac	Seed	Stem	56.34	28.70	24.73	29.75	4.75	43.83	49.46	7.92
B1Splot10	CN-32	B	10	1	sac	Seed	Stem	70.15	41.68	35.68	29.23	6.56	50.11	41.42	8.97
B1Splot28	CN-32	B	28	2	sac	Seed	Stem	68.55	38.49	32.92	31.08	5.15	47.35	45.40	7.07
B1Splot64	CN-32	B	64	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot03	CN-33	B	3	1	sac	Seed	Stem	69.66	40.15	34.07	30.48	6.41	48.30	43.13	8.88
B1Splot39	CN-33	B	39	2	sac	Seed	Stem	68.49	38.45	34.02	30.44	4.94	48.76	44.37	6.87
B1Splot62	CN-33	B	62	3	sac	Seed	Stem	61.30	32.78	26.86	31.99	5.21	43.97	48.82	7.65
B1Splot24	CN-34	B	24	1	sac	Seed	Stem	67.52	38.57	33.04	29.87	5.74	47.92	44.15	8.11
B1Splot45	CN-34	B	45	2	sac	Seed	Stem	69.88	39.31	34.17	31.12	5.49	48.18	44.46	7.50
B1Splot52	CN-34	B	52	3	sac	Seed	Stem	67.78	37.36	32.89	30.86	4.67	47.75	45.69	6.71
B1Splot14	CN-35	B	14	1	sac	Seed	Stem	62.97	34.16	29.49	29.80	4.89	46.26	46.06	7.66
B1Splot44	CN-35	B	44	2	sac	Seed	Stem	65.37	36.99	31.32	30.14	5.91	47.21	44.79	8.14
B1Splot66	CN-35	B	66	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot21	CN-36	B	21	1	sac	Seed	Stem	64.68	33.62	29.64	31.82	4.56	45.57	48.43	7.01
B1Splot29	CN-36	B	29	2	sac	Seed	Stem	63.72	33.82	29.57	30.93	4.51	45.82	47.51	6.93
B1Splot69	CN-36	B	69	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot02	CN-4	B	2	1	sac	Seed	Stem	71.21	41.97	35.06	30.10	6.62	48.58	42.13	9.00
B1Splot32	CN-4	B	32	2	sac	Seed	Stem	66.32	36.08	31.11	30.67	4.84	46.45	46.18	7.21
B1Splot56	CN-4	B	56	3	sac	Seed	Stem	68.66	40.22	32.84	30.54	6.59	47.32	43.97	8.65
B1Splot08	CN-8	B	8	1	sac	Seed	Stem	61.00	33.08	28.25	29.83	4.72	45.68	47.12	7.53
B1Splot26	CN-8	B	26	2	sac	Seed	Stem	62.89	36.14	29.89	29.38	5.76	46.86	44.86	8.26

B1Splot60	CN-8	B	60	3	sac	Seed	Stem	61.45	32.91	27.53	31.31	4.83	44.49	49.02	7.13
B1Splot22	CN-9	B	22	1	sac	Seed	Stem	58.27	30.32	26.41	29.61	4.69	44.97	48.25	7.90
B1Splot27	CN-9	B	27	2	sac	Seed	Stem	*	*	*	*	*	*	*	*
B1Splot51	CN-9	B	51	3	sac	Seed	Stem	61.28	32.34	28.49	29.67	4.42	45.95	47.79	6.85
B1Splot15	OPM-1	B	15	1	sac	Rhizomes	Stem	*	*	*	*	*	*	*	*
B1Splot34	OPM-1	B	34	2	sac	Rhizomes	Stem	*	*	*	*	*	*	*	*
B1Splot63	OPM-1	B	63	3	sac	Rhizomes	Stem	*	*	*	*	*	*	*	*
B1Splot01	OPM-3	B	1	1	sac	Rhizomes	Stem	57.80	29.30	25.64	29.59	4.23	44.19	49.23	7.59
B1Splot46	OPM-3	B	46	2	sac	Rhizomes	Stem	59.09	29.80	28.01	28.80	3.95	46.48	48.22	6.89
B1Splot54	OPM-3	B	54	3	sac	Rhizomes	Stem	58.56	29.86	26.24	29.65	4.19	44.50	49.91	7.25
B1Splot12	OPM-6	B	12	1	hybrid	Rhizomes	Stem	75.49	44.90	38.43	31.73	5.62	50.36	42.10	7.34
B1Splot36	OPM-6	B	36	2	hybrid	Rhizomes	Stem	75.94	44.81	38.07	32.00	5.30	49.61	42.92	6.80
B1Splot73	OPM-6	B	73	3	hybrid	Rhizomes	Stem	66.00	35.55	30.20	33.17	3.74	46.08	49.45	5.41
B1Splot23	OPM-8	B	23	1	hybrid	Rhizomes	Stem	73.76	42.36	37.38	30.86	5.20	50.14	43.09	7.08
B1Splot37	OPM-8	B	37	2	hybrid	Rhizomes	Stem	71.25	41.20	35.29	31.00	5.08	49.05	43.97	7.17
B1Splot57	OPM-8	B	57	3	hybrid	Rhizomes	Stem	*	*	*	*	*	*	*	*
B1Splot25	OPM-9	B	25	1	M. x gig	Rhizomes	Stem	*	*	*	*	*	*	*	*
B1Splot41	OPM-9	B	41	2	M. x gig	Rhizomes	Stem	*	*	*	*	*	*	*	*
B1Splot67	OPM-9	B	67	3	M. x gig	Rhizomes	Stem	*	*	*	*	*	*	*	*
Year 2															
WinSI Code	Genotype	Field	Plot	Block	Species	Propagation	Fraction	NDF%dm	ADF%dm	Cel%dm	Hem%dm	Lig%dm	Cel%ndf	Hem%ndf	Lig%ndf
A2Lplot13	CN-10	A	13	1	sac	Seed	Leaf	72.62	41.38	36.66	30.27	4.38	50.16	41.92	6.99

A2Lplot46	CN-10	A	46	2	sac	Seed	Leaf	70.69	40.89	35.31	28.74	4.84	49.90	41.43	7.48
A2Lplot58	CN-10	A	58	3	sac	Seed	Leaf	74.89	41.55	37.78	30.95	3.90	50.72	41.63	6.51
A2Lplot25	CN-12	A	25	1	sac	Seed	Leaf	72.05	42.13	36.11	29.58	5.49	49.95	40.80	7.94
A2Lplot47	CN-12	A	47	2	sac	Seed	Leaf	71.80	40.46	36.23	30.68	4.38	50.39	41.66	7.37
A2Lplot71	CN-12	A	71	3	sac	Seed	Leaf	72.25	40.22	36.30	30.51	4.31	49.99	41.76	7.05
A2Lplot14	CN-13	A	14	1	sac	Seed	Leaf	72.44	41.02	36.57	30.36	4.97	50.02	41.90	8.02
A2Lplot28	CN-13	A	28	2	sac	Seed	Leaf	72.06	41.39	36.78	29.83	4.62	50.57	40.77	7.37
A2Lplot70	CN-13	A	70	3	sac	Seed	Leaf	73.99	41.79	38.07	31.11	4.57	50.84	41.53	7.08
A2Lplot11	CN-14	A	11	1	sac	Seed	Leaf	73.06	41.94	37.11	30.90	4.66	50.61	41.24	7.53
A2Lplot43	CN-14	A	43	2	sac	Seed	Leaf	73.63	41.94	37.39	30.75	4.55	50.44	41.27	7.23
A2Lplot54	CN-14	A	54	3	sac	Seed	Leaf	74.90	43.05	38.18	30.85	5.05	50.73	41.30	7.98
A2Lplot07	CN-16	A	7	1	sac	Seed	Leaf	73.68	43.17	37.06	30.61	5.89	50.00	40.87	8.48
A2Lplot45	CN-16	A	45	2	sac	Seed	Leaf	73.69	43.07	37.32	29.76	6.03	50.31	40.39	8.99
A2Lplot59	CN-16	A	59	3	sac	Seed	Leaf	73.80	41.57	37.18	31.61	4.45	49.94	42.32	6.94
A2Lplot17	CN-18	A	17	1	sac	Seed	Leaf	73.46	42.34	37.66	30.16	4.88	50.76	40.32	7.72
A2Lplot36	CN-18	A	36	2	sac	Seed	Leaf	74.16	41.82	37.45	30.92	4.90	50.48	41.40	7.45
A2Lplot61	CN-18	A	61	3	sac	Seed	Leaf	75.96	43.77	39.18	30.97	4.65	51.31	40.33	7.22
A2Lplot05	CN-23	A	5	1	sac	Seed	Leaf	72.94	42.11	37.04	30.61	5.11	50.53	40.56	7.64
A2Lplot35	CN-23	A	35	2	sac	Seed	Leaf	72.55	41.73	36.70	30.25	4.75	49.98	41.30	7.21
A2Lplot68	CN-23	A	68	3	sac	Seed	Leaf	73.05	41.63	36.53	30.63	5.39	49.85	41.04	8.22
A2Lplot10	CN-27	A	10	1	sac	Seed	Leaf	73.82	42.72	37.59	30.65	5.24	50.59	41.75	7.83
A2Lplot49	CN-27	A	49	2	sac	Seed	Leaf	72.56	40.48	36.37	30.62	4.35	49.76	42.45	6.98

A2Lplot66	CN-27	A	66	3	sac	Seed	Leaf	73.76	43.17	37.25	29.57	5.31	50.55	40.10	8.00
A2Lplot09	CN-28	A	9	1	sac	Seed	Leaf	72.43	41.49	36.66	29.84	4.85	50.26	42.34	7.50
A2Lplot33	CN-28	A	33	2	sac	Seed	Leaf	75.57	42.86	38.43	31.11	5.14	50.98	41.87	7.59
A2Lplot55	CN-28	A	55	3	sac	Seed	Leaf	73.03	41.64	35.99	30.05	5.59	49.80	41.64	8.55
A2Lplot21	CN-29	A	21	1	sac	Seed	Leaf	72.21	40.90	36.92	29.76	4.11	50.94	41.55	6.83
A2Lplot41	CN-29	A	41	2	sac	Seed	Leaf	74.36	41.95	37.72	31.04	4.67	50.47	41.78	7.15
A2Lplot62	CN-29	A	62	3	sac	Seed	Leaf	75.25	43.63	38.50	30.77	5.24	51.08	40.52	7.91
A2Lplot02	CN-30	A	2	1	sac	Seed	Leaf	71.42	39.58	35.71	29.27	3.80	50.05	42.79	6.36
A2Lplot31	CN-30	A	31	2	sac	Seed	Leaf	72.02	39.59	35.94	29.65	3.81	50.08	43.48	6.40
A2Lplot72	CN-30	A	72	3	sac	Seed	Leaf	73.43	41.40	36.70	30.33	4.68	50.02	42.84	7.30
A2Lplot01	CN-31	A	1	1	sac	Seed	Leaf	70.02	38.88	34.07	29.92	4.52	48.56	44.05	7.22
A2Lplot34	CN-31	A	34	2	sac	Seed	Leaf	71.87	41.01	35.47	30.49	5.00	49.38	42.49	7.73
A2Lplot74	CN-31	A	74	3	sac	Seed	Leaf	72.24	40.82	35.27	30.57	5.04	48.97	42.67	7.81
A2Lplot20	CN-32	A	20	1	sac	Seed	Leaf	74.96	43.89	39.34	30.25	5.12	51.72	39.63	7.20
A2Lplot38	CN-32	A	38	2	sac	Seed	Leaf	74.55	43.05	37.99	31.41	5.12	50.57	41.05	7.23
A2Lplot75	CN-32	A	75	3	sac	Seed	Leaf	75.59	43.17	38.97	31.06	4.99	51.32	40.71	7.07
A2Lplot12	CN-33	A	12	1	sac	Seed	Leaf	74.94	42.42	38.13	30.92	4.98	50.85	41.37	7.43
A2Lplot40	CN-33	A	40	2	sac	Seed	Leaf	74.00	41.55	37.23	31.42	4.65	49.99	42.67	6.94
A2Lplot65	CN-33	A	65	3	sac	Seed	Leaf	78.00	45.93	39.95	31.18	5.98	51.45	40.78	8.56
A2Lplot18	CN-34	A	18	1	sac	Seed	Leaf	76.16	43.85	39.29	30.94	4.86	51.07	42.02	6.96
A2Lplot32	CN-34	A	32	2	sac	Seed	Leaf	78.90	46.31	41.01	31.20	5.61	52.01	40.26	7.65
A2Lplot51	CN-34	A	51	3	sac	Seed	Leaf	78.79	47.22	41.94	30.47	5.79	52.78	39.08	7.80

A2Lplot08	CN-35	A	8	1	sac	Seed	Leaf	75.62	43.03	37.86	32.10	5.40	50.41	42.23	7.86
A2Lplot29	CN-35	A	29	2	sac	Seed	Leaf	74.86	42.44	38.26	30.70	4.57	50.97	41.83	7.13
A2Lplot73	CN-35	A	73	3	sac	Seed	Leaf	76.75	43.05	38.57	32.07	4.94	50.61	42.50	7.57
A2Lplot15	CN-36	A	15	1	sac	Seed	Leaf	74.64	42.43	38.18	30.67	4.79	50.99	41.45	7.06
A2Lplot26	CN-36	A	26	2	sac	Seed	Leaf	77.43	45.43	39.89	31.18	5.69	51.59	40.07	8.02
A2Lplot63	CN-36	A	63	3	sac	Seed	Leaf	77.98	45.72	40.44	31.43	5.74	51.76	40.22	8.17
A2Lplot06	CN-4	A	6	1	sac	Seed	Leaf	75.61	42.43	38.29	31.42	4.85	50.87	41.09	7.28
A2Lplot27	CN-4	A	27	2	sac	Seed	Leaf	75.93	43.45	38.06	31.62	5.12	50.40	40.76	7.47
A2Lplot60	CN-4	A	60	3	sac	Seed	Leaf	74.70	43.55	38.28	29.65	5.66	51.12	39.30	8.44
A2Lplot16	CN-8	A	16	1	sac	Seed	Leaf	73.24	41.91	37.80	29.40	4.52	51.31	41.35	6.76
A2Lplot30	CN-8	A	30	2	sac	Seed	Leaf	72.72	41.39	37.61	29.36	4.18	51.48	41.72	6.45
A2Lplot53	CN-8	A	53	3	sac	Seed	Leaf	75.06	44.14	38.64	30.79	5.47	51.36	40.58	7.94
A2Lplot03	CN-9	A	3	1	sac	Seed	Leaf	73.10	41.29	37.15	29.92	5.02	50.53	41.79	7.67
A2Lplot42	CN-9	A	42	2	sac	Seed	Leaf	73.29	41.24	37.07	31.08	4.28	50.29	42.45	6.61
A2Lplot52	CN-9	A	52	3	sac	Seed	Leaf	73.85	41.26	37.82	30.57	3.75	51.05	41.98	6.31
A2Lplot04	OPM-1	A	4	1	sac	Rhizomes	Leaf	73.17	40.99	36.09	31.11	5.13	49.45	43.56	7.91
A2Lplot50	OPM-1	A	50	2	sac	Rhizomes	Leaf	75.10	41.64	37.23	31.41	5.32	49.86	42.14	8.19
A2Lplot56	OPM-1	A	56	3	sac	Rhizomes	Leaf	72.72	40.20	35.79	30.40	4.86	49.98	43.08	7.49
A2Lplot24	OPM-3	A	24	1	sac	Rhizomes	Leaf	73.70	42.21	36.26	30.91	5.34	49.76	41.55	8.31
A2Lplot39	OPM-3	A	39	2	sac	Rhizomes	Leaf	74.18	43.68	37.55	29.87	5.76	50.58	41.06	8.50
A2Lplot69	OPM-3	A	69	3	sac	Rhizomes	Leaf	75.55	44.72	38.07	30.70	6.23	50.54	40.48	8.95
A2Lplot23	OPM-6	A	23	1	hybrid	Rhizomes	Leaf	75.37	44.62	38.50	31.09	5.30	51.00	40.77	7.83

A2Lplot44	OPM-6	A	44	2	hybrid	Rhizomes	Leaf	77.64	45.45	40.61	32.14	5.75	51.98	41.07	7.88
A2Lplot57	OPM-6	A	57	3	hybrid	Rhizomes	Leaf	76.23	45.66	40.27	30.98	5.17	51.96	40.22	7.39
A2Lplot22	OPM-8	A	22	1	hybrid	Rhizomes	Leaf	73.58	42.75	37.90	30.33	4.98	50.54	41.58	7.42
A2Lplot48	OPM-8	A	48	2	hybrid	Rhizomes	Leaf	77.37	46.36	40.83	31.18	5.38	52.35	39.51	7.36
A2Lplot67	OPM-8	A	67	3	hybrid	Rhizomes	Leaf	77.79	46.34	40.83	31.05	5.80	52.02	39.89	8.13
A2Lplot19	OPM-9	A	19	1	M. x gig	Rhizomes	Leaf	*	*	*	*	*	*	*	*
A2Lplot37	OPM-9	A	37	2	M. x gig	Rhizomes	Leaf	*	*	*	*	*	*	*	*
A2Lplot64	OPM-9	A	64	3	M. x gig	Rhizomes	Leaf	70.82	42.96	34.30	28.73	6.38	49.15	38.88	9.14
B2Lplot05	CN-10	B	5	1	sac	Seed	Leaf	70.99	40.11	35.40	30.05	4.34	49.32	43.60	6.44
B2Lplot30	CN-10	B	30	2	sac	Seed	Leaf	70.84	40.14	35.36	29.58	4.45	49.71	42.76	6.82
B2Lplot55	CN-10	B	55	3	sac	Seed	Leaf	71.38	40.68	35.76	29.35	4.77	50.11	41.90	7.42
B2Lplot17	CN-12	B	17	1	sac	Seed	Leaf	71.86	40.91	36.28	30.44	4.36	50.21	42.59	7.03
B2Lplot38	CN-12	B	38	2	sac	Seed	Leaf	71.33	40.78	35.84	30.09	4.30	50.46	41.83	7.30
B2Lplot70	CN-12	B	70	3	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B2Lplot09	CN-13	B	9	1	sac	Seed	Leaf	71.67	40.43	36.12	30.72	4.00	49.70	42.01	6.16
B2Lplot43	CN-13	B	43	2	sac	Seed	Leaf	69.41	38.12	34.77	30.04	3.93	49.53	43.57	6.54
B2Lplot68	CN-13	B	68	3	sac	Seed	Leaf	66.11	36.49	31.97	29.67	4.35	47.83	44.52	7.29
B2Lplot20	CN-14	B	20	1	sac	Seed	Leaf	70.56	38.80	35.03	31.74	3.48	49.40	43.80	6.13
B2Lplot40	CN-14	B	40	2	sac	Seed	Leaf	69.30	38.95	34.63	29.85	4.54	49.42	42.90	7.32
B2Lplot58	CN-14	B	58	3	sac	Seed	Leaf	69.44	38.88	34.54	30.38	3.97	49.03	43.89	6.83
B2Lplot19	CN-16	B	19	1	sac	Seed	Leaf	70.20	39.76	34.72	30.21	5.28	48.92	42.04	8.22
B2Lplot33	CN-16	B	33	2	sac	Seed	Leaf	70.19	39.41	35.11	30.55	4.25	49.43	43.91	6.89

B2Lplot53	CN-16	B	53	3	sac	Seed	Leaf	72.29	41.91	36.66	30.56	4.57	50.22	41.78	7.09
B2Lplot06	CN-18	B	6	1	sac	Seed	Leaf	72.64	41.64	36.60	30.48	4.56	49.85	41.12	6.99
B2Lplot47	CN-18	B	47	2	sac	Seed	Leaf	72.27	40.90	36.46	30.61	4.39	50.12	41.94	7.15
B2Lplot75	CN-18	B	75	3	sac	Seed	Leaf	67.73	37.87	32.90	29.61	4.43	48.60	43.78	7.11
B2Lplot07	CN-23	B	7	1	sac	Seed	Leaf	70.40	38.84	35.47	30.25	4.10	49.80	42.69	6.60
B2Lplot49	CN-23	B	49	2	sac	Seed	Leaf	69.60	39.68	34.81	29.66	4.77	49.69	42.05	7.58
B2Lplot61	CN-23	B	61	3	sac	Seed	Leaf	70.97	39.47	34.46	31.10	5.33	48.22	43.47	8.00
B2Lplot11	CN-27	B	11	1	sac	Seed	Leaf	70.54	40.18	35.77	28.90	4.67	49.56	42.38	7.18
B2Lplot31	CN-27	B	31	2	sac	Seed	Leaf	68.42	37.39	33.86	28.97	4.14	49.26	43.28	6.64
B2Lplot71	CN-27	B	71	3	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B2Lplot18	CN-28	B	18	1	sac	Seed	Leaf	71.80	40.43	36.42	29.87	4.38	50.10	43.10	6.59
B2Lplot50	CN-28	B	50	2	sac	Seed	Leaf	70.41	38.74	34.40	30.60	4.42	48.44	44.30	6.77
B2Lplot65	CN-28	B	65	3	sac	Seed	Leaf	68.67	37.40	33.01	30.47	4.39	48.34	45.08	6.76
B2Lplot13	CN-29	B	13	1	sac	Seed	Leaf	71.90	40.47	35.79	30.25	4.66	49.62	42.38	7.23
B2Lplot42	CN-29	B	42	2	sac	Seed	Leaf	66.29	36.07	31.67	29.53	3.94	47.64	45.49	6.31
B2Lplot74	CN-29	B	74	3	sac	Seed	Leaf	67.93	36.91	32.40	30.46	4.15	48.26	44.78	6.84
B2Lplot16	CN-30	B	16	1	sac	Seed	Leaf	71.76	38.79	36.14	30.12	3.63	50.12	44.12	5.91
B2Lplot35	CN-30	B	35	2	sac	Seed	Leaf	72.17	39.47	36.10	30.06	3.68	49.86	43.67	5.87
B2Lplot72	CN-30	B	72	3	sac	Seed	Leaf	*	*	*	*	*	*	*	*
B2Lplot04	CN-31	B	4	1	sac	Seed	Leaf	72.19	40.33	35.78	29.99	4.33	49.73	43.31	6.84
B2Lplot48	CN-31	B	48	2	sac	Seed	Leaf	68.63	36.76	31.36	30.53	4.90	46.83	45.92	7.61
B2Lplot59	CN-31	B	59	3	sac	Seed	Leaf	69.33	38.04	33.49	29.46	4.27	48.21	44.55	7.00

B2Lplot10	CN-32	B	10	1	sac	Seed	Leaf	75.83	45.02	39.51	29.97	5.07	51.73	39.40	7.40
B2Lplot28	CN-32	B	28	2	sac	Seed	Leaf	71.88	41.67	36.62	29.88	5.17	50.89	40.03	7.86
B2Lplot64	CN-32	B	64	3	sac	Seed	Leaf	68.71	37.88	33.70	31.19	4.06	48.82	44.18	6.40
B2Lplot03	CN-33	B	3	1	sac	Seed	Leaf	74.82	42.98	38.28	31.45	5.51	50.62	41.52	7.22
B2Lplot39	CN-33	B	39	2	sac	Seed	Leaf	70.14	38.76	34.43	29.87	4.41	48.86	43.38	6.91
B2Lplot62	CN-33	B	62	3	sac	Seed	Leaf	72.14	40.68	35.87	30.78	4.83	49.47	42.18	7.32
B2Lplot24	CN-34	B	24	1	sac	Seed	Leaf	73.75	42.10	38.10	30.83	3.99	51.31	41.73	6.14
B2Lplot45	CN-34	B	45	2	sac	Seed	Leaf	72.88	41.54	36.92	30.64	4.52	50.32	41.85	6.73
B2Lplot52	CN-34	B	52	3	sac	Seed	Leaf	72.85	41.66	36.87	30.00	4.88	50.55	41.85	7.44
B2Lplot14	CN-35	B	14	1	sac	Seed	Leaf	73.11	40.77	36.80	30.99	4.73	50.28	42.05	7.08
B2Lplot44	CN-35	B	44	2	sac	Seed	Leaf	71.46	40.48	35.78	29.66	4.72	49.70	42.37	7.41
B2Lplot66	CN-35	B	66	3	sac	Seed	Leaf	66.34	36.34	31.27	29.64	4.71	47.41	44.65	7.76
B2Lplot21	CN-36	B	21	1	sac	Seed	Leaf	73.54	41.87	36.95	31.01	5.56	50.35	41.81	8.12
B2Lplot29	CN-36	B	29	2	sac	Seed	Leaf	73.46	42.20	38.00	30.38	4.81	51.42	41.42	7.11
B2Lplot69	CN-36	B	69	3	sac	Seed	Leaf	68.21	37.81	33.11	30.60	4.22	48.42	43.68	6.82
B2Lplot02	CN-4	B	2	1	sac	Seed	Leaf	72.98	41.28	36.13	30.73	5.40	49.55	40.86	7.86
B2Lplot32	CN-4	B	32	2	sac	Seed	Leaf	71.91	39.96	35.52	31.74	4.47	49.42	42.99	6.70
B2Lplot56	CN-4	B	56	3	sac	Seed	Leaf	73.09	40.95	36.47	31.43	4.27	49.93	42.91	6.65
B2Lplot08	CN-8	B	8	1	sac	Seed	Leaf	72.04	40.60	36.98	30.03	4.19	50.79	42.74	6.75
B2Lplot26	CN-8	B	26	2	sac	Seed	Leaf	69.79	38.80	35.25	29.94	3.69	49.55	44.82	5.85
B2Lplot60	CN-8	B	60	3	sac	Seed	Leaf	69.96	39.12	34.44	29.82	4.66	49.35	43.00	7.47
B2Lplot22	CN-9	B	22	1	sac	Seed	Leaf	72.65	40.50	36.68	31.20	4.05	50.33	43.22	6.34

B2Lplot27	CN-9	B	27	2	sac	Seed	Leaf	71.19	40.17	35.54	30.38	3.98	49.44	43.52	6.10
B2Lplot51	CN-9	B	51	3	sac	Seed	Leaf	69.18	38.29	33.77	30.67	3.82	48.86	44.97	6.37
B2Lplot15	OPM-1	B	15	1	sac	Rhizomes	Leaf	73.14	39.76	36.17	30.92	4.55	49.53	43.75	7.25
B2Lplot34	OPM-1	B	34	2	sac	Rhizomes	Leaf	71.11	38.54	35.38	29.21	4.11	49.64	43.36	6.66
B2Lplot63	OPM-1	B	63	3	sac	Rhizomes	Leaf	68.62	36.66	32.34	30.11	4.32	47.46	45.58	6.92
B2Lplot01	OPM-3	B	1	1	sac	Rhizomes	Leaf	71.77	42.02	36.06	28.86	5.39	49.91	41.54	8.16
B2Lplot46	OPM-3	B	46	2	sac	Rhizomes	Leaf	70.65	39.67	35.46	28.91	4.11	49.90	43.43	6.93
B2Lplot54	OPM-3	B	54	3	sac	Rhizomes	Leaf	71.82	40.68	35.67	29.12	5.03	50.08	42.04	8.00
B2Lplot12	OPM-6	B	12	1	hybrid	Rhizomes	Leaf	75.41	43.31	39.19	31.73	4.06	51.45	42.17	6.36
B2Lplot36	OPM-6	B	36	2	hybrid	Rhizomes	Leaf	74.64	42.72	38.02	31.46	5.10	50.72	41.62	7.48
B2Lplot73	OPM-6	B	73	3	hybrid	Rhizomes	Leaf	*	*	*	*	*	*	*	*
B2Lplot23	OPM-8	B	23	1	hybrid	Rhizomes	Leaf	75.51	42.80	39.14	31.26	4.06	51.15	42.17	6.21
B2Lplot37	OPM-8	B	37	2	hybrid	Rhizomes	Leaf	72.59	42.67	37.19	29.77	4.51	50.53	40.82	6.89
B2Lplot57	OPM-8	B	57	3	hybrid	Rhizomes	Leaf	71.48	40.79	37.22	28.92	3.90	51.18	41.93	6.23
B2Lplot25	OPM-9	B	25	1	M. x gig	Rhizomes	Leaf	71.84	40.93	35.78	29.63	4.61	50.47	41.16	7.32
B2Lplot41	OPM-9	B	41	2	M. x gig	Rhizomes	Leaf	73.49	41.53	36.48	30.90	4.57	50.19	42.21	6.86
B2Lplot67	OPM-9	B	67	3	M. x gig	Rhizomes	Leaf	*	*	*	*	*	*	*	*
A2Splot13	CN-10	A	13	1	sac	Seed	Stem	77.15	52.85	42.62	24.05	9.17	54.42	31.38	11.61
A2Splot46	CN-10	A	46	2	sac	Seed	Stem	78.82	52.35	43.88	25.00	8.55	55.17	32.81	10.90
A2Splot58	CN-10	A	58	3	sac	Seed	Stem	78.64	53.46	43.25	24.96	8.56	54.54	32.17	10.69
A2Splot25	CN-12	A	25	1	sac	Seed	Stem	77.66	52.17	42.48	24.73	9.60	53.85	32.67	12.07
A2Splot47	CN-12	A	47	2	sac	Seed	Stem	77.17	50.50	42.10	25.29	8.17	53.65	34.33	10.49

A2Splot71	CN-12	A	71	3	sac	Seed	Stem	73.47	48.01	39.54	24.35	9.28	52.32	34.67	12.04
A2Splot14	CN-13	A	14	1	sac	Seed	Stem	80.74	54.40	44.53	26.60	8.59	54.72	32.79	10.44
A2Splot28	CN-13	A	28	2	sac	Seed	Stem	78.55	52.89	43.77	25.15	8.24	54.86	33.25	10.27
A2Splot70	CN-13	A	70	3	sac	Seed	Stem	83.35	56.92	46.88	25.02	9.21	55.74	31.07	10.97
A2Splot11	CN-14	A	11	1	sac	Seed	Stem	78.76	52.98	43.77	24.98	8.61	54.75	32.73	10.76
A2Splot43	CN-14	A	43	2	sac	Seed	Stem	79.59	53.38	44.04	25.41	9.35	54.45	32.55	11.46
A2Splot54	CN-14	A	54	3	sac	Seed	Stem	82.46	55.09	45.20	26.87	8.46	54.61	32.83	9.93
A2Splot07	CN-16	A	7	1	sac	Seed	Stem	79.14	54.30	43.53	25.32	10.39	54.17	32.48	12.46
A2Splot45	CN-16	A	45	2	sac	Seed	Stem	78.59	53.97	44.17	24.19	9.11	55.48	31.04	11.51
A2Splot59	CN-16	A	59	3	sac	Seed	Stem	77.59	52.98	42.34	24.25	10.46	53.58	31.84	12.65
A2Splot17	CN-18	A	17	1	sac	Seed	Stem	79.66	54.92	44.40	24.19	9.54	54.94	30.63	11.70
A2Splot36	CN-18	A	36	2	sac	Seed	Stem	80.52	56.79	46.04	23.16	10.44	56.54	29.43	12.70
A2Splot61	CN-18	A	61	3	sac	Seed	Stem	83.00	57.25	46.41	24.59	9.78	55.63	30.12	11.50
A2Splot05	CN-23	A	5	1	sac	Seed	Stem	78.83	53.14	43.59	25.07	9.63	54.51	32.62	11.79
A2Splot35	CN-23	A	35	2	sac	Seed	Stem	81.44	55.54	45.24	24.99	9.91	54.97	31.11	11.93
A2Splot68	CN-23	A	68	3	sac	Seed	Stem	81.25	55.41	44.39	25.44	9.68	54.17	31.23	11.48
A2Splot10	CN-27	A	10	1	sac	Seed	Stem	77.65	51.46	42.50	24.87	8.91	54.28	33.07	11.30
A2Splot49	CN-27	A	49	2	sac	Seed	Stem	82.22	55.57	45.38	26.22	8.52	55.16	31.93	10.03
A2Splot66	CN-27	A	66	3	sac	Seed	Stem	82.81	56.19	46.04	25.80	9.16	55.69	30.61	10.98
A2Splot09	CN-28	A	9	1	sac	Seed	Stem	80.12	53.19	44.25	25.88	8.30	55.13	32.82	10.33
A2Splot33	CN-28	A	33	2	sac	Seed	Stem	86.16	60.10	49.63	25.55	9.49	57.88	29.58	10.95
A2Splot55	CN-28	A	55	3	sac	Seed	Stem	79.53	52.86	44.57	25.70	7.61	56.06	32.30	9.89

A2Splot21	CN-29	A	21	1	sac	Seed	Stem	79.21	52.50	42.93	26.23	8.49	54.05	33.70	10.39
A2Splot41	CN-29	A	41	2	sac	Seed	Stem	79.39	52.91	43.37	25.83	8.87	54.25	33.03	10.79
A2Splot62	CN-29	A	62	3	sac	Seed	Stem	82.74	56.81	46.17	25.89	9.67	55.27	31.44	11.19
A2Splot02	CN-30	A	2	1	sac	Seed	Stem	85.60	55.55	44.91	29.37	10.13	52.59	34.88	11.26
A2Splot31	CN-30	A	31	2	sac	Seed	Stem	85.25	54.79	44.79	29.10	9.87	52.71	35.17	11.02
A2Splot72	CN-30	A	72	3	sac	Seed	Stem	82.21	55.96	44.49	26.06	10.95	53.38	31.91	12.56
A2Splot01	CN-31	A	1	1	sac	Seed	Stem	81.55	56.05	44.14	24.62	11.40	53.92	31.10	13.25
A2Splot34	CN-31	A	34	2	sac	Seed	Stem	82.88	55.46	44.32	27.14	10.54	53.13	33.26	12.02
A2Splot74	CN-31	A	74	3	sac	Seed	Stem	80.11	53.96	44.40	26.02	9.04	54.57	33.18	10.64
A2Splot20	CN-32	A	20	1	sac	Seed	Stem	86.44	58.52	48.18	26.63	9.65	56.04	31.44	10.96
A2Splot38	CN-32	A	38	2	sac	Seed	Stem	83.90	58.65	46.93	24.75	11.00	55.80	29.81	12.65
A2Splot75	CN-32	A	75	3	sac	Seed	Stem	84.69	58.81	47.98	24.68	10.44	56.30	29.91	12.05
A2Splot12	CN-33	A	12	1	sac	Seed	Stem	85.12	59.37	47.59	24.66	10.90	55.92	29.67	12.41
A2Splot40	CN-33	A	40	2	sac	Seed	Stem	87.24	60.25	48.72	25.83	11.41	56.03	30.59	12.78
A2Splot65	CN-33	A	65	3	sac	Seed	Stem	83.09	56.07	46.04	25.51	9.86	55.27	30.89	11.61
A2Splot18	CN-34	A	18	1	sac	Seed	Stem	85.36	60.14	47.92	24.82	11.24	56.11	29.39	12.57
A2Splot32	CN-34	A	32	2	sac	Seed	Stem	82.35	56.25	45.36	25.39	10.10	54.70	31.83	11.73
A2Splot51	CN-34	A	51	3	sac	Seed	Stem	85.74	59.23	48.24	25.44	10.79	56.10	31.19	12.23
A2Splot08	CN-35	A	8	1	sac	Seed	Stem	86.15	61.14	49.84	24.75	10.43	57.69	29.10	11.62
A2Splot29	CN-35	A	29	2	sac	Seed	Stem	83.79	57.92	46.89	24.89	9.92	55.88	30.82	11.34
A2Splot73	CN-35	A	73	3	sac	Seed	Stem	85.36	58.47	47.53	25.89	10.86	55.42	30.74	12.15
A2Splot15	CN-36	A	15	1	sac	Seed	Stem	83.83	57.43	46.82	25.24	10.22	55.74	31.24	11.84

A2Splot26	CN-36	A	26	2	sac	Seed	Stem	85.18	57.75	47.88	25.56	10.31	56.02	31.10	11.75
A2Splot63	CN-36	A	63	3	sac	Seed	Stem	85.10	57.22	47.38	26.13	9.89	55.48	31.72	11.57
A2Splot06	CN-4	A	6	1	sac	Seed	Stem	83.58	56.02	46.06	26.45	9.51	54.91	32.90	10.98
A2Splot27	CN-4	A	27	2	sac	Seed	Stem	83.48	56.47	45.24	26.00	10.45	54.27	32.02	12.05
A2Splot60	CN-4	A	60	3	sac	Seed	Stem	83.30	55.99	45.75	25.57	9.95	54.71	31.86	11.73
A2Splot16	CN-8	A	16	1	sac	Seed	Stem	78.10	53.20	43.40	23.46	9.78	55.24	31.21	12.18
A2Splot30	CN-8	A	30	2	sac	Seed	Stem	80.38	53.06	44.12	25.38	8.89	54.73	33.49	10.90
A2Splot53	CN-8	A	53	3	sac	Seed	Stem	77.52	52.33	42.76	24.40	9.10	54.45	32.35	11.34
A2Splot03	CN-9	A	3	1	sac	Seed	Stem	81.02	54.90	45.48	24.89	8.89	55.80	31.63	10.79
A2Splot42	CN-9	A	42	2	sac	Seed	Stem	75.51	49.71	41.28	24.44	8.49	53.69	34.04	11.17
A2Splot52	CN-9	A	52	3	sac	Seed	Stem	77.46	51.00	42.66	25.27	8.41	54.66	33.39	10.68
A2Splot04	OPM-1	A	4	1	sac	Rhizomes	Stem	84.61	57.94	46.34	26.58	10.60	54.70	31.75	11.81
A2Splot50	OPM-1	A	50	2	sac	Rhizomes	Stem	83.70	55.73	44.77	26.90	10.86	53.27	33.06	12.24
A2Splot56	OPM-1	A	56	3	sac	Rhizomes	Stem	86.28	57.21	47.01	27.53	10.56	54.70	32.37	11.72
A2Splot24	OPM-3	A	24	1	sac	Rhizomes	Stem	78.53	53.03	42.42	24.94	9.96	53.67	32.68	12.26
A2Splot39	OPM-3	A	39	2	sac	Rhizomes	Stem	78.34	52.87	43.43	23.95	9.57	54.79	31.90	12.07
A2Splot69	OPM-3	A	69	3	sac	Rhizomes	Stem	76.26	50.58	41.68	24.36	8.83	53.54	33.78	11.29
A2Splot23	OPM-6	A	23	1	hybrid	Rhizomes	Stem	88.17	55.19	46.87	32.10	7.96	53.94	37.38	8.74
A2Splot44	OPM-6	A	44	2	hybrid	Rhizomes	Stem	88.18	57.23	48.83	30.27	8.34	56.04	34.71	9.17
A2Splot57	OPM-6	A	57	3	hybrid	Rhizomes	Stem	87.46	57.69	48.40	29.21	8.79	56.09	33.59	9.87
A2Splot22	OPM-8	A	22	1	hybrid	Rhizomes	Stem	87.98	55.44	47.28	30.94	8.11	54.99	36.45	9.14
A2Splot48	OPM-8	A	48	2	hybrid	Rhizomes	Stem	89.70	56.54	47.90	31.64	8.67	54.57	35.78	9.59

A2Splot67	OPM-8	A	67	3	hybrid	Rhizomes	Stem	88.71	59.72	49.63	28.07	9.67	56.78	31.97	10.88
A2Splot19	OPM-9	A	19	1	M. x gig	Rhizomes	Stem	*	*	*	*	*	*	*	*
A2Splot37	OPM-9	A	37	2	M. x gig	Rhizomes	Stem	*	*	*	*	*	*	*	*
A2Splot64	OPM-9	A	64	3	M. x gig	Rhizomes	Stem	80.29	53.61	42.20	26.91	10.28	53.23	32.96	12.24
B2Splot05	CN-10	B	5	1	sac	Seed	Stem	75.76	47.37	40.72	26.74	6.90	53.14	36.60	9.09
B2Splot30	CN-10	B	30	2	sac	Seed	Stem	75.14	45.75	39.53	27.38	6.12	52.36	38.00	8.26
B2Splot55	CN-10	B	55	3	sac	Seed	Stem	77.01	46.34	39.64	29.19	5.61	51.63	39.54	7.27
B2Splot17	CN-12	B	17	1	sac	Seed	Stem	76.58	47.97	40.30	26.82	7.84	52.37	36.28	10.02
B2Splot38	CN-12	B	38	2	sac	Seed	Stem	78.06	48.95	40.62	28.51	7.23	52.47	36.96	9.18
B2Splot70	CN-12	B	70	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B2Splot09	CN-13	B	9	1	sac	Seed	Stem	80.56	56.59	46.10	23.23	9.55	56.51	29.91	11.73
B2Splot43	CN-13	B	43	2	sac	Seed	Stem	76.32	47.33	40.52	27.61	6.04	52.86	37.28	7.96
B2Splot68	CN-13	B	68	3	sac	Seed	Stem	68.90	38.69	32.16	31.46	4.84	47.22	44.69	6.93
B2Splot20	CN-14	B	20	1	sac	Seed	Stem	76.59	49.75	41.43	26.07	7.51	53.60	34.68	9.71
B2Splot40	CN-14	B	40	2	sac	Seed	Stem	76.99	49.24	40.48	27.48	7.58	52.61	35.77	9.42
B2Splot58	CN-14	B	58	3	sac	Seed	Stem	73.77	45.32	38.63	27.92	6.15	51.93	38.91	8.19
B2Splot19	CN-16	B	19	1	sac	Seed	Stem	77.57	50.82	42.65	25.61	8.62	54.25	34.18	10.87
B2Splot33	CN-16	B	33	2	sac	Seed	Stem	75.80	48.83	40.58	25.84	8.01	53.01	34.68	10.32
B2Splot53	CN-16	B	53	3	sac	Seed	Stem	78.69	50.91	41.84	27.00	8.79	52.78	35.49	10.81
B2Splot06	CN-18	B	6	1	sac	Seed	Stem	78.66	50.73	42.81	26.71	7.61	53.63	35.44	9.43
B2Splot47	CN-18	B	47	2	sac	Seed	Stem	76.64	47.51	39.59	27.54	7.52	51.71	36.89	9.73
B2Splot75	CN-18	B	75	3	sac	Seed	Stem	*	*	*	*	*	*	*	*

B2Splot07	CN-23	B	7	1	sac	Seed	Stem	76.19	47.48	40.21	26.64	7.87	52.04	36.84	10.36
B2Splot49	CN-23	B	49	2	sac	Seed	Stem	77.57	47.08	38.93	29.48	7.15	50.45	38.65	9.18
B2Splot61	CN-23	B	61	3	sac	Seed	Stem	75.92	46.83	37.46	28.28	8.01	49.49	37.76	10.09
B2Splot11	CN-27	B	11	1	sac	Seed	Stem	80.65	52.80	44.66	26.54	7.54	55.23	34.08	9.29
B2Splot31	CN-27	B	31	2	sac	Seed	Stem	78.70	47.96	41.22	28.84	6.05	52.76	39.00	7.43
B2Splot71	CN-27	B	71	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B2Splot18	CN-28	B	18	1	sac	Seed	Stem	76.78	45.44	39.70	29.02	5.82	51.90	39.00	7.61
B2Splot50	CN-28	B	50	2	sac	Seed	Stem	78.65	47.71	39.76	29.58	7.31	51.33	38.07	9.23
B2Splot65	CN-28	B	65	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B2Splot13	CN-29	B	13	1	sac	Seed	Stem	79.22	52.10	43.63	26.26	7.02	55.00	34.01	8.91
B2Splot42	CN-29	B	42	2	sac	Seed	Stem	*	*	*	*	*	*	*	*
B2Splot74	CN-29	B	74	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B2Splot16	CN-30	B	16	1	sac	Seed	Stem	83.80	53.00	43.13	29.69	9.39	51.53	36.18	10.41
B2Splot35	CN-30	B	35	2	sac	Seed	Stem	83.81	52.34	43.00	28.99	9.50	51.46	35.76	10.77
B2Splot72	CN-30	B	72	3	sac	Seed	Stem	*	*	*	*	*	*	*	*
B2Splot04	CN-31	B	4	1	sac	Seed	Stem	82.62	54.18	43.25	26.75	10.32	52.41	32.88	11.94
B2Splot48	CN-31	B	48	2	sac	Seed	Stem	80.68	47.67	40.76	30.05	7.46	51.06	38.86	9.24
B2Splot59	CN-31	B	59	3	sac	Seed	Stem	78.01	48.31	38.97	29.08	8.50	50.00	38.44	10.31
B2Splot10	CN-32	B	10	1	sac	Seed	Stem	85.30	58.68	47.83	25.03	10.48	56.09	29.98	12.18
B2Splot28	CN-32	B	28	2	sac	Seed	Stem	82.84	55.88	45.70	25.72	9.68	54.99	32.39	11.36
B2Splot64	CN-32	B	64	3	sac	Seed	Stem	77.86	46.78	37.86	31.14	7.13	49.06	40.51	8.31
B2Splot03	CN-33	B	3	1	sac	Seed	Stem	84.84	56.47	47.55	26.77	8.95	55.76	33.05	10.31

B2Splot39	CN-33	B	39	2	sac	Seed	Stem	81.49	49.43	41.75	30.15	7.69	51.73	38.65	9.02
B2Splot62	CN-33	B	62	3	sac	Seed	Stem	81.69	51.52	42.79	28.35	8.38	52.51	36.16	9.72
B2Splot24	CN-34	B	24	1	sac	Seed	Stem	81.19	52.55	43.54	27.38	8.79	53.39	35.30	10.31
B2Splot45	CN-34	B	45	2	sac	Seed	Stem	82.96	52.48	44.01	28.38	8.60	53.10	36.08	10.17
B2Splot52	CN-34	B	52	3	sac	Seed	Stem	80.31	50.32	42.25	28.95	7.96	52.77	37.17	9.44
B2Splot14	CN-35	B	14	1	sac	Seed	Stem	81.48	52.13	44.37	26.75	7.93	54.54	34.39	9.72
B2Splot44	CN-35	B	44	2	sac	Seed	Stem	*	*	*	*	*	*	*	*
B2Splot66	CN-35	B	66	3	sac	Seed	Stem	71.10	40.51	33.01	31.78	6.30	47.62	43.59	8.38
B2Splot21	CN-36	B	21	1	sac	Seed	Stem	79.68	51.82	42.46	27.06	8.88	52.97	35.37	10.57
B2Splot29	CN-36	B	29	2	sac	Seed	Stem	82.35	52.88	44.73	27.37	8.61	54.34	35.16	10.07
B2Splot69	CN-36	B	69	3	sac	Seed	Stem	75.01	46.59	38.46	28.17	6.77	50.95	38.77	8.48
B2Splot02	CN-4	B	2	1	sac	Seed	Stem	84.25	56.31	46.47	26.18	9.58	55.10	32.43	11.11
B2Splot32	CN-4	B	32	2	sac	Seed	Stem	78.86	50.28	41.17	27.15	7.93	52.12	36.02	9.76
B2Splot56	CN-4	B	56	3	sac	Seed	Stem	81.03	49.21	41.00	30.30	7.39	51.18	38.81	8.53
B2Splot08	CN-8	B	8	1	sac	Seed	Stem	75.76	48.85	41.02	25.55	8.37	53.21	35.60	10.60
B2Splot26	CN-8	B	26	2	sac	Seed	Stem	74.37	45.60	37.53	28.33	6.78	50.48	38.57	8.77
B2Splot60	CN-8	B	60	3	sac	Seed	Stem	71.49	42.12	35.90	28.62	5.67	50.57	40.46	7.73
B2Splot22	CN-9	B	22	1	sac	Seed	Stem	76.98	48.91	41.70	26.27	6.98	53.61	35.67	8.90
B2Splot27	CN-9	B	27	2	sac	Seed	Stem	73.31	44.95	38.39	25.65	6.94	51.69	36.96	9.44
B2Splot51	CN-9	B	51	3	sac	Seed	Stem	73.93	42.81	36.80	29.94	5.26	50.00	42.28	6.93
B2Splot15	OPM-1	B	15	1	sac	Rhizomes	Stem	81.95	51.75	43.09	28.55	8.70	52.25	36.31	9.76
B2Splot34	OPM-1	B	34	2	sac	Rhizomes	Stem	84.65	51.74	43.94	30.87	8.23	52.14	38.73	9.00

B2Splot63	OPM-1	B	63	3	sac	Rhizomes	Stem	77.13	45.63	38.72	30.36	6.56	50.37	40.90	7.84
B2Splot01	OPM-3	B	1	1	sac	Rhizomes	Stem	77.29	51.63	42.58	24.15	9.57	54.69	31.80	12.49
B2Splot46	OPM-3	B	46	2	sac	Rhizomes	Stem	72.83	44.77	37.81	27.45	6.43	51.57	38.68	8.89
B2Splot54	OPM-3	B	54	3	sac	Rhizomes	Stem	74.12	45.60	37.05	28.12	7.79	50.45	38.06	10.32
B2Splot12	OPM-6	B	12	1	hybrid	Rhizomes	Stem	87.43	55.79	47.52	30.11	8.15	54.94	35.17	9.08
B2Splot36	OPM-6	B	36	2	hybrid	Rhizomes	Stem	86.39	54.12	46.83	30.71	7.29	54.81	37.20	7.93
B2Splot73	OPM-6	B	73	3	hybrid	Rhizomes	Stem	*	*	*	*	*	*	*	*
B2Splot23	OPM-8	B	23	1	hybrid	Rhizomes	Stem	89.55	55.91	48.37	31.14	8.29	55.40	36.09	9.31
B2Splot37	OPM-8	B	37	2	hybrid	Rhizomes	Stem	88.37	54.51	46.62	32.04	7.82	54.00	38.19	8.61
B2Splot57	OPM-8	B	57	3	hybrid	Rhizomes	Stem	85.19	51.46	44.84	32.40	6.22	54.01	40.28	7.04
B2Splot25	OPM-9	B	25	1	M. x gig	Rhizomes	Stem	76.06	46.79	38.82	28.04	7.40	51.44	37.92	9.41
B2Splot41	OPM-9	B	41	2	M. x gig	Rhizomes	Stem	80.25	49.37	40.40	29.46	8.55	51.48	37.33	10.38
B2Splot67	OPM-9	B	67	3	M. x gig	Rhizomes	Stem	*	*	*	*	*	*	*	*

Appendix 4. The cell wall composition comparison and salt tolerance data of control and stress of Chinese field trials.

				year 1					year 2				
Genotype	Species	Salt Tolerance%	Fraction	Treatment	NDF%dm	Cel%ndf	Hem%ndf	Lig%ndf	Treatment	Cel%ndf	Hem%ndf	Lig%ndf	Cel%ndf
CN-10	sac	22.24	Leaf	Control	61.38	43.19	50.57	6.45	Control	72.73	50.26	41.66	7
				Salinity	58.92	43.32	50.56	6.13	Salinity	71.07	49.71	42.75	6.9
			Stem	Control	59.52	46.48	46.05	8.12	Control	78.2	54.71	32.12	11.07
				Salinity	59.07	44.59	49.11	7.07	Salinity	75.97	52.37	38.05	8.21
CN-12	sac	23.93	Leaf	Control	59.69	43.25	49.48	7.09	Control	72.03	50.11	41.41	7.45
				Salinity	57.18	41.81	50.9	6.85	Salinity	71.59	50.34	42.21	7.16
			Stem	Control	63.76	47.04	44.73	8.36	Control	76.1	53.27	33.89	11.53
				Salinity	61.47	44.94	47.98	7.24	Salinity	77.32	52.42	36.62	9.6
CN-13	sac	50.13	Leaf	Control	59.92	44.02	48.52	6.67	Control	72.83	50.48	41.4	7.49
				Salinity	59.2	44.41	47.72	6.72	Salinity	69.06	49.02	43.37	6.66
			Stem	Control	62.8	47.93	43.88	8.21	Control	80.88	55.11	32.37	10.56
				Salinity	63.18	46.63	45.93	7.79	Salinity	75.26	52.2	37.29	8.87
CN-14	sac	27.84	Leaf	Control	59.99	44.59	47.32	7.15	Control	73.86	50.6	41.27	7.58
				Salinity	56.67	43.3	48.99	6.49	Salinity	69.77	49.28	43.53	6.76
			Stem	Control	65.19	48.7	43.48	8.13	Control	80.27	54.6	32.7	10.72
				Salinity	59.6	45.43	48.19	6.63	Salinity	75.79	52.71	36.45	9.11
CN-16	sac	33.36	Leaf	Control	58.51	43.19	49.75	6.42	Control	73.72	50.09	41.19	8.13
				Salinity	59.76	59.76	49.02	6.47	Salinity	70.89	49.53	42.58	7.4

			Stem	Control	63.03	47.06	44.41	9.12	Control	78.44	54.41	31.79	12.21
				Salinity	62.62	46.77	46.82	62.62	Salinity	77.35	53.35	34.78	10.66
CN-18	sac	18.74	Leaf	Control	61.58	43.65	49.25	6.77	Control	74.53	50.85	40.69	7.46
				Salinity	61.55	46.14	46.49	6.13	Salinity	70.88	49.52	42.28	7.08
			Stem	Control	63.07	47.45	45.12	8.04	Control	81.06	55.7	30.06	11.97
				Salinity	63.27	45.71	46.85	7.46	Salinity	77.65	52.67	36.16	9.58
CN-23	sac	15.87	Leaf	Control	59.97	43.99	49.69	6.33	Control	72.85	50.12	40.97	7.69
				Salinity	58.46	44.99	47.72	5.93	Salinity	70.32	49.24	42.73	7.39
			Stem	Control	60.94	47.3	44.83	8.38	Control	80.51	54.55	31.65	11.73
				Salinity	63.63	46.81	45.43	7.75	Salinity	76.56	50.66	37.75	9.88
CN-27	sac	33.84	Leaf	Control	60.48	43.51	49.85	6.68	Control	73.38	50.3	41.43	7.6
				Salinity	57.7	43.08	50.49	5.92	Salinity	69.48	49.41	42.83	6.91
			Stem	Control	62.68	47.35	44.78	8.3	Control	80.89	55.04	31.87	10.77
				Salinity	31.27	23.39	45.99	7.53	Salinity	79.67	53.99	36.54	8.36
CN-28	sac	15.93	Leaf	Control	61.14	43.51	50.04	6.74	Control	73.67	50.35	41.95	7.88
				Salinity	58.34	43.84	49.65	6.13	Salinity	70.29	48.96	44.16	6.71
			Stem	Control	61.17	47.72	44.71	7.64	Control	81.94	56.36	31.57	10.39
				Salinity	0	0	0	0	Salinity	77.71	51.62	38.54	8.42
CN-29	sac	24.44	Leaf	Control	58.23	42.95	50.74	6.22	Control	73.94	50.83	41.28	7.3
				Salinity	59.2	44.75	48.39	6.35	Salinity	68.71	48.51	44.22	6.79
			Stem	Control	60.49	46.71	45.74	8.16	Control	80.45	54.53	32.72	10.79
				Salinity	46.86	63.02	46.5	7.52	Salinity	79.22	55	34.01	8.91

CN-30	sac	17.02	Leaf	Control	63.19	42.86	51.41	6.57	Control	72.29	50.05	43.03	6.69
				Salinity	62.28	43.82	49.99	6.28	Salinity	71.97	49.99	43.9	5.89
			Stem	Control	65.95	47.83	42.01	10.1	Control	84.35	52.89	33.99	11.61
				Salinity	65.16	47.45	44.25	8.44	Salinity	83.81	51.49	35.97	10.59
CN-31	sac	12.83	Leaf	Control	63.63	41.92	51.65	7.14	Control	71.38	48.97	43.07	7.58
				Salinity	60.58	42.46	50.74	7.26	Salinity	70.05	48.26	44.59	7.15
			Stem	Control	62.85	48.01	42.42	10.04	Control	81.51	53.87	32.51	11.97
				Salinity	59.52	44.62	48.18	8.25	Salinity	80.44	51.15	36.73	10.5
CN-32	sac	38.13	Leaf	Control	60.7	43.22	49.5	6.88	Control	75.03	51.21	40.46	7.17
				Salinity	60.06	44.69	47.34	6.72	Salinity	72.14	50.48	41.2	7.22
			Stem	Control	70.77	50.28	40.61	9.15	Control	85.01	56.05	30.39	11.89
				Salinity	69.35	48.73	43.41	8.02	Salinity	82	53.38	34.29	10.61
CN-33	sac	18.20	Leaf	Control	60.01	42.73	49.52	7.36	Control	75.65	50.76	41.61	7.64
				Salinity	59.12	43.61	48.85	6.17	Salinity	72.37	49.65	42.36	7.15
			Stem	Control	69.58	49.6	41.9	8.56	Control	85.15	55.74	30.38	12.27
				Salinity	66.48	47.01	45.44	7.8	Salinity	82.67	53.34	35.96	9.68
CN-34	sac	24.37	Leaf	Control	62.35	43.48	48.25	7.33	Control	77.95	51.95	40.46	7.47
				Salinity	59.75	43.79	49.07	6.4	Salinity	73.16	50.73	41.81	6.77
			Stem	Control	71.51	50.25	41.51	8.31	Control	84.48	55.64	30.8	12.18
				Salinity	68.39	47.95	44.77	7.44	Salinity	81.49	53.09	36.19	9.97
CN-35	sac	17.38	Leaf	Control	64.1	43.73	49.72	6.85	Control	75.74	50.66	42.18	7.52
				Salinity	60.41	44.19	49.03	6.19	Salinity	70.3	49.13	43.03	7.42

			Stem	Control	68.36	49.65	41.51	8.85	Control	85.1	56.33	30.22	11.7
				Salinity	64.17	46.73	45.42	7.9	Salinity	76.29	51.08	38.99	9.05
CN-36	sac	24.60	Leaf	Control	59.63	43.3	49.24	6.78	Control	76.68	51.45	40.58	7.75
				Salinity	58.15	42.78	49.47	7.14	Salinity	71.74	50.06	42.3	7.35
			Stem	Control	69.66	48.91	42.46	8.83	Control	84.7	55.75	31.36	11.72
				Salinity	64.2	45.69	47.97	6.97	Salinity	79.01	52.75	36.43	9.71
CN-4	sac	33.67	Leaf	Control	63.33	43.62	50.17	6.26	Control	75.41	50.8	40.38	7.73
				Salinity	61.65	44.54	48.84	6.05	Salinity	72.66	49.63	42.25	7.07
			Stem	Control	68.87	49.34	41.93	8.56	Control	83.45	54.63	32.26	11.59
				Salinity	68.73	47.45	44.09	8.28	Salinity	81.38	52.8	35.75	9.8
CN-8	sac	38.47	Leaf	Control	61.33	43.97	48.95	6.59	Control	73.67	51.38	41.22	7.05
				Salinity	60.17	44.43	48.29	6.61	Salinity	70.6	49.9	43.52	6.69
			Stem	Control	61.67	47.46	44.54	8.24	Control	78.66	54.81	32.35	11.47
				Salinity	61.78	45.68	47	7.64	Salinity	73.87	51.42	38.21	9.03
CN-9	sac	14.84	Leaf	Control	60.13	43.16	51.12	6.42	Control	73.41	50.62	42.07	6.86
				Salinity	58.81	43.03	50.52	6.18	Salinity	71	49.54	43.9	6.27
			Stem	Control	60.22	46.6	45.3	8.86	Control	78	54.72	33.02	10.88
				Salinity	59.77	45.46	48.02	7.38	Salinity	74.74	51.77	38.3	8.43
OPM-1	sac	27.86	Leaf	Control	62.99	41.91	51.47	7	Control	73.66	49.76	42.93	7.86
				Salinity	63.15	43.13	50.66	6.6	Salinity	70.96	48.88	44.23	6.94
			Stem	Control	64.46	47.16	44.44	8.45	Control	84.86	54.22	32.39	11.92
				Salinity	0	0	0	0	Salinity	81.24	51.59	38.65	8.87

OPM-3	sac	57.49	Leaf	Control	62.34	43.93	49.53	6.65	Control	74.48	50.29	41.03	8.58
				Salinity	61.4	44.05	49.02	6.59	Salinity	71.41	49.96	42.33	7.7
			Stem	Control	58.4	46.33	46.84	7.6	Control	77.71	54	32.79	11.87
				Salinity	58.48	45.06	49.12	7.24	Salinity	74.75	52.24	36.18	10.56
OPM-6	hybrid	68.48	Leaf	Control	63.5	46.26	46.45	6.85	Control	76.41	51.65	40.69	7.7
				Salinity	63.32	46.82	45.57	6.61	Salinity	75.03	51.09	41.9	6.92
			Stem	Control	74.39	50.6	41.45	8.34	Control	87.94	55.36	35.22	9.26
				Salinity	72.48	48.69	44.82	6.52	Salinity	86.91	54.88	36.18	8.5
OPM-8	hybrid	26.49	Leaf	Control	61.65	46.71	45.64	6.44	Control	76.25	51.64	40.33	7.63
				Salinity	62.04	46.38	46.42	5.53	Salinity	73.19	50.95	41.64	6.44
			Stem	Control	72.22	50.32	40.92	8.83	Control	88.8	55.45	34.73	9.87
				Salinity	72.51	49.59	43.53	7.13	Salinity	87.7	54.47	38.19	8.32
OPM-9	M. x gig	0	Leaf	Control	63.7	44.89	49.12	6.88	Control	70.82	49.15	38.88	9.14
				Salinity	0	0	0	0	Salinity	72.67	50.33	41.69	7.09
			Stem	Control	0	0	0	0	Control	80.29	53.23	32.96	12.24
				Salinity	0	0	0	0	Salinity	78.16	51.46	37.62	9.9

Appendix 5. The full analyzed cell wall composition data of Pot trials.

WinISI Code	Genotype	Treatment	Pool	Species	Propagation	Fraction	NDF%dm	ADF%dm	Cel%dm	Hem%dm	Lig%dm	Cel%ndf	Hem%ndf	Lig%ndf
OPM07T1LP1	OPM07	Control	1	hybrid	Tissue Culture	Leaf	63.46	31.94	28.98	31.53	2.96	45.66	49.68	4.67
OPM07T1LP2	OPM07	Control	2	hybrid	Tissue Culture	Leaf	63.83	31.66	28.73	32.16	2.94	45.01	50.39	4.60
OPM09T1LP1	OPM09	Control	1	M x gig.	Tissue Culture	Leaf	59.39	31.60	27.68	27.78	3.93	46.60	46.78	6.61
OPM09T1LP2	OPM09	Control	2	M x gig.	Tissue Culture	Leaf	61.00	32.11	27.51	28.88	4.61	45.10	47.35	7.55
OPM31T1LP1	OPM31	Control	1	sin	Tissue Culture	Leaf	69.36	34.01	31.75	35.36	2.26	45.77	50.97	3.26
OPM31T1LP2	OPM31	Control	2	sin	Tissue Culture	Leaf	65.12	31.53	28.44	33.59	3.09	43.67	51.59	4.74
OPM37T1LP1	OPM37	Control	1	sin	Tissue Culture	Leaf	65.61	34.37	31.59	31.25	2.78	48.14	47.62	4.23
OPM37T1LP2	OPM37	Control	2	sin	Tissue Culture	Leaf	60.22	29.65	26.87	30.58	2.77	44.62	50.77	4.61
OPM42T1LP1	OPM42	Control	1	sin	Tissue Culture	Leaf	69.59	37.67	34.44	31.92	3.22	49.50	45.87	4.63
OPM42T1LP2	OPM42	Control	2	sin	Tissue Culture	Leaf	65.39	34.18	30.72	31.21	3.46	46.98	47.73	5.29
OPM48T1LP1	OPM48	Control	1	sin	Tissue Culture	Leaf	62.87	30.65	27.21	32.21	3.44	43.29	51.24	5.47
OPM48T1LP2	OPM48	Control	2	sin	Tissue Culture	Leaf	65.89	33.98	30.44	31.91	3.54	46.20	48.43	5.37
OPM49T1LP1	OPM49	Control	1	sin	Tissue Culture	Leaf	71.97	37.18	32.89	34.79	4.29	45.69	48.34	5.97
OPM49T1LP2	OPM49	Control	2	sin	Tissue Culture	Leaf	72.17	37.40	33.31	34.77	4.09	46.15	48.18	5.67
OPM56T1LP1	OPM56	Control	1	sin	Tissue Culture	Leaf	59.48	27.06	24.06	32.42	2.99	40.45	54.51	5.03
OPM56T1LP2	OPM56	Control	2	sin	Tissue Culture	Leaf	58.56	24.91	21.65	33.65	3.26	36.97	57.46	5.57
OPM67T1LP1	OPM67	Control	1	sin	Tissue Culture	Leaf	71.38	36.93	33.34	34.46	3.59	46.70	48.27	5.03
OPM67T1LP2	OPM67	Control	2	sin	Tissue Culture	Leaf	69.87	36.21	32.27	33.66	3.94	46.19	48.17	5.64
OPM71T1LP1	OPM71	Control	1	sin	Tissue Culture	Leaf	62.59	30.20	27.13	32.39	3.07	43.35	51.75	4.90

OPM71T1LP2	OPM71	Control	2	sin	Tissue Culture	Leaf	58.25	29.18	26.74	29.07	2.44	45.91	49.90	4.19
OPM76T1LP1	OPM76	Control	1	sin	Tissue Culture	Leaf	61.89	28.78	25.80	33.11	2.98	41.68	53.50	4.82
OPM76T1LP2	OPM76	Control	2	sin	Tissue Culture	Leaf	61.63	30.81	28.10	30.82	2.71	45.59	50.01	4.40
OPM86T1LP1	OPM86	Control	1	sin	Tissue Culture	Leaf	66.15	32.98	29.44	33.16	3.54	44.51	50.13	5.36
OPM86T1LP2	OPM86	Control	2	sin	Tissue Culture	Leaf	69.07	33.70	30.20	35.36	3.50	43.72	51.20	5.07
OPM07T2LP1	OPM07	Salt	1	hybrid	Tissue Culture	Leaf	63.63	30.22	27.95	33.42	2.26	43.93	52.51	3.56
OPM07T2LP2	OPM07	Salt	2	hybrid	Tissue Culture	Leaf	62.73	30.50	28.18	32.22	2.32	44.92	51.37	3.71
OPM09T2LP1	OPM09	Salt	1	M x gig.	Tissue Culture	Leaf	59.52	28.81	25.03	30.71	3.78	42.05	51.60	6.35
OPM09T2LP2	OPM09	Salt	2	M x gig.	Tissue Culture	Leaf	58.59	27.90	23.72	30.69	4.17	40.50	52.38	7.12
OPM31T2LP1	OPM31	Salt	1	sin	Tissue Culture	Leaf	68.00	32.95	29.64	35.05	3.31	43.60	51.54	4.86
OPM31T2LP2	OPM31	Salt	2	sin	Tissue Culture	Leaf	66.31	31.25	28.51	35.06	2.74	43.00	52.87	4.13
OPM37T2LP1	OPM37	Salt	1	sin	Tissue Culture	Leaf	66.47	32.17	29.50	34.30	2.67	44.38	51.60	4.02
OPM37T2LP2	OPM37	Salt	2	sin	Tissue Culture	Leaf	63.25	30.45	28.22	32.79	2.23	44.62	51.85	3.53
OPM42T2LP1	OPM42	Salt	1	sin	Tissue Culture	Leaf	69.42	35.12	31.20	34.29	3.92	44.95	49.40	5.65
OPM42T2LP2	OPM42	Salt	2	sin	Tissue Culture	Leaf	68.17	34.94	31.35	33.23	3.59	46.00	48.74	5.26
OPM48T2LP1	OPM48	Salt	1	sin	Tissue Culture	Leaf	69.21	33.91	30.74	35.30	3.17	44.42	51.00	4.58
OPM48T2LP2	OPM48	Salt	2	sin	Tissue Culture	Leaf	67.67	33.31	30.47	34.35	2.84	45.03	50.77	4.20
OPM49T2LP1	OPM49	Salt	1	sin	Tissue Culture	Leaf	68.37	35.83	32.24	32.54	3.59	47.15	47.59	5.26
OPM49T2LP2	OPM49	Salt	2	sin	Tissue Culture	Leaf	68.35	34.59	31.26	33.75	3.33	45.74	49.38	4.88
OPM56T2LP1	OPM56	Salt	1	sin	Tissue Culture	Leaf	62.42	31.49	27.05	30.93	4.44	43.33	49.55	7.12
OPM56T2LP2	OPM56	Salt	2	sin	Tissue Culture	Leaf	62.26	30.32	26.67	31.93	3.66	42.83	51.29	5.88
OPM67T2LP1	OPM67	Salt	1	sin	Tissue Culture	Leaf	71.43	38.93	33.62	32.50	5.30	47.08	45.50	7.42

OPM67T2LP2	OPM67	Salt	2	sin	Tissue Culture	Leaf	69.54	35.66	31.82	33.88	3.84	45.75	48.72	5.53
OPM71T2LP1	OPM71	Salt	1	sin	Tissue Culture	Leaf	63.36	31.42	28.80	31.94	2.62	45.46	50.41	4.14
OPM71T2LP2	OPM71	Salt	2	sin	Tissue Culture	Leaf	65.32	31.63	28.49	33.69	3.14	43.62	51.58	4.80
OPM76T2LP1	OPM76	Salt	1	sin	Tissue Culture	Leaf	61.90	31.06	27.85	30.84	3.21	44.99	49.82	5.19
OPM76T2LP2	OPM76	Salt	2	sin	Tissue Culture	Leaf	65.67	32.79	29.37	32.88	3.42	44.72	50.07	5.21
OPM86T2LP1	OPM86	Salt	1	sin	Tissue Culture	Leaf	68.04	33.89	30.17	34.16	3.72	44.33	50.20	5.47
OPM86T2LP2	OPM86	Salt	2	sin	Tissue Culture	Leaf	66.56	33.04	29.90	33.52	3.14	44.92	50.36	4.72
OPM07T1SP1	OPM07	Control	1	hybrid	Tissue Culture	Stem	74.78	45.37	39.99	29.42	5.38	53.47	39.34	7.19
OPM07T1SP2	OPM07	Control	2	hybrid	Tissue Culture	Stem	74.03	45.28	40.21	28.74	5.08	54.32	38.83	6.86
OPM09T1SP1	OPM09	Control	1	M x gig.	Tissue Culture	Stem	62.06	36.23	31.98	25.84	4.25	51.52	41.63	6.85
OPM09T1SP2	OPM09	Control	2	M x gig.	Tissue Culture	Stem	66.25	38.76	34.69	27.49	4.06	52.37	41.50	6.13
OPM31T1SP1	OPM31	Control	1	sin	Tissue Culture	Stem	72.31	40.68	37.26	31.63	3.42	51.53	43.74	4.73
OPM31T1SP2	OPM31	Control	2	sin	Tissue Culture	Stem	73.82	43.14	39.41	30.68	3.74	53.38	41.56	5.06
OPM37T1SP1	OPM37	Control	1	sin	Tissue Culture	Stem	68.93	34.37	30.56	34.56	3.80	44.34	50.14	5.52
OPM37T1SP2	OPM37	Control	2	sin	Tissue Culture	Stem	62.53	34.34	30.60	28.19	3.74	48.93	45.09	5.98
OPM42T1SP1	OPM42	Control	1	sin	Tissue Culture	Stem	78.26	44.88	40.80	33.38	4.09	52.13	42.65	5.22
OPM42T1SP2	OPM42	Control	2	sin	Tissue Culture	Stem	77.97	47.03	41.83	30.94	5.20	53.65	39.69	6.67
OPM48T1SP1	OPM48	Control	1	sin	Tissue Culture	Stem	73.40	42.16	38.61	31.23	3.55	52.61	42.55	4.84
OPM48T1SP2	OPM48	Control	2	sin	Tissue Culture	Stem	75.44	46.11	42.95	29.33	3.17	56.93	38.88	4.20
OPM49T1SP1	OPM49	Control	1	sin	Tissue Culture	Stem	72.23	40.23	37.25	31.99	2.98	51.58	44.29	4.13
OPM49T1SP2	OPM49	Control	2	sin	Tissue Culture	Stem	74.25	43.90	39.63	30.35	4.27	53.37	40.88	5.75
OPM56T1SP1	OPM56	Control	1	sin	Tissue Culture	Stem	72.46	43.19	39.34	29.27	3.85	54.29	40.39	5.31

OPM56T1SP2	OPM56	Control	2	sin	Tissue Culture	Stem	65.01	35.36	31.72	29.65	3.64	48.79	45.61	5.60
OPM67T1SP1	OPM67	Control	1	sin	Tissue Culture	Stem	71.83	39.44	36.34	32.40	3.09	50.60	45.10	4.30
OPM67T1SP2	OPM67	Control	2	sin	Tissue Culture	Stem	72.41	40.11	37.09	32.30	3.02	51.22	44.60	4.17
OPM71T1SP1	OPM71	Control	1	sin	Tissue Culture	Stem	66.92	37.17	33.41	29.75	3.75	49.93	44.46	5.61
OPM71T1SP2	OPM71	Control	2	sin	Tissue Culture	Stem	62.05	34.33	31.24	27.72	3.09	50.34	44.68	4.97
OPM76T1SP1	OPM76	Control	1	sin	Tissue Culture	Stem	62.62	34.98	31.72	27.64	3.26	50.65	44.14	5.21
OPM76T1SP2	OPM76	Control	2	sin	Tissue Culture	Stem	69.41	39.38	35.34	30.02	4.04	50.92	43.26	5.83
OPM86T1SP1	OPM86	Control	1	sin	Tissue Culture	Stem	75.25	44.09	39.76	31.16	4.33	52.84	41.41	5.75
OPM86T1SP2	OPM86	Control	2	sin	Tissue Culture	Stem	73.79	39.82	36.50	33.97	3.32	49.46	46.04	4.50
OPM07T2SP1	OPM07	Salt	1	hybrid	Tissue Culture	Stem	74.39	44.04	38.85	30.36	5.19	52.22	40.80	6.98
OPM07T2SP2	OPM07	Salt	2	hybrid	Tissue Culture	Stem	74.03	43.45	38.84	30.58	4.61	52.46	41.31	6.23
OPM09T2SP1	OPM09	Salt	1	M x gig.	Tissue Culture	Stem	61.83	36.16	31.00	25.67	5.16	50.15	41.51	8.34
OPM09T2SP2	OPM09	Salt	2	M x gig.	Tissue Culture	Stem	65.02	39.63	33.82	25.40	5.81	52.01	39.06	8.93
OPM31T2SP1	OPM31	Salt	1	sin	Tissue Culture	Stem	70.94	36.11	32.54	34.83	3.58	45.86	49.10	5.04
OPM31T2SP2	OPM31	Salt	2	sin	Tissue Culture	Stem	68.42	35.92	32.58	32.50	3.34	47.61	47.50	4.88
OPM37T2SP1	OPM37	Salt	1	sin	Tissue Culture	Stem	68.11	36.32	33.02	31.79	3.30	48.48	46.68	4.84
OPM37T2SP2	OPM37	Salt	2	sin	Tissue Culture	Stem	68.98	35.71	32.29	33.27	3.42	46.81	48.23	4.96
OPM42T2SP1	OPM42	Salt	1	sin	Tissue Culture	Stem	76.48	40.87	36.95	35.62	3.91	48.32	46.57	5.12
OPM42T2SP2	OPM42	Salt	2	sin	Tissue Culture	Stem	75.76	42.81	39.05	32.95	3.76	51.54	43.49	4.97
OPM48T2SP1	OPM48	Salt	1	sin	Tissue Culture	Stem	70.77	35.48	32.71	35.29	2.77	46.22	49.86	3.92
OPM48T2SP2	OPM48	Salt	2	sin	Tissue Culture	Stem	70.96	36.76	33.47	34.20	3.29	47.17	48.20	4.63
OPM49T2SP1	OPM49	Salt	1	sin	Tissue Culture	Stem	73.81	40.40	37.69	33.40	2.71	51.07	45.26	3.67

OPM49T2SP2	OPM49	Salt	2	sin	Tissue Culture	Stem	74.60	45.37	39.99	29.42	5.38	53.47	39.34	7.19
OPM56T2SP1	OPM56	Salt	1	sin	Tissue Culture	Stem	69.28	37.43	34.46	31.85	2.97	49.74	45.97	4.28
OPM56T2SP2	OPM56	Salt	2	sin	Tissue Culture	Stem	68.24	37.69	34.15	30.55	3.54	50.04	44.77	5.19
OPM67T2SP1	OPM67	Salt	1	sin	Tissue Culture	Stem	72.85	38.43	35.05	34.42	3.38	48.11	47.24	4.64
OPM67T2SP2	OPM67	Salt	2	sin	Tissue Culture	Stem	74.37	38.55	34.92	35.82	3.63	46.96	48.16	4.88
OPM71T2SP1	OPM71	Salt	1	sin	Tissue Culture	Stem	61.31	37.34	34.03	23.97	3.30	55.51	39.10	5.39
OPM71T2SP2	OPM71	Salt	2	sin	Tissue Culture	Stem	68.96	36.49	33.46	32.47	3.03	48.52	47.08	4.40
OPM76T2SP1	OPM76	Salt	1	sin	Tissue Culture	Stem	68.93	37.91	34.03	31.01	3.88	49.37	45.00	5.64
OPM76T2SP2	OPM76	Salt	2	sin	Tissue Culture	Stem	68.27	37.50	35.01	30.77	2.49	51.28	45.07	3.65
OPM86T2SP1	OPM86	Salt	1	sin	Tissue Culture	Stem	74.90	40.10	36.72	34.80	3.38	49.03	46.47	4.51
OPM86T2SP2	OPM86	Salt	2	sin	Tissue Culture	Stem	73.14	39.21	35.58	33.93	3.62	48.65	46.39	4.96

Appendix 6. The cell wall composition comparison and salt tolerance data of control and stress of Pot trials.

Genotype	Species	Salt Tolerance%	Fraction	Treatment	NDF%dm	Cel%ndf	Hem%ndf	Lig%ndf
OPM86	sin	58.47	Leaf	Control	67.61	44.12	50.67	5.22
				Salinity	67.30	44.63	50.28	5.10
			Stem	Control	63.65	45.34	50.04	4.64
				Salinity	63.18	44.43	51.94	3.64
OPM07	hybrid	67.16	Leaf	Control	70.63	46.45	48.22	5.34
				Salinity	70.49	46.42	47.11	6.48
			Stem	Control	67.49	48.24	46.80	4.96
				Salinity	68.80	45.48	49.07	5.46
OPM67	sin	67.76	Leaf	Control	60.42	44.63	50.83	4.55
				Salinity	64.34	44.54	51.00	4.47
			Stem	Control	61.76	43.64	51.76	4.61
				Salinity	63.79	44.86	49.95	5.20
OPM42	sin	74.21	Leaf	Control	67.24	44.72	51.28	4.00
				Salinity	67.16	43.30	52.21	4.50
			Stem	Control	62.92	46.38	49.20	4.42
				Salinity	64.86	44.50	51.73	3.78
OPM71	sin	75.68	Leaf	Control	72.07	45.92	48.26	5.82
				Salinity	68.36	46.45	48.49	5.07

			Stem	Control	59.02	38.71	55.99	5.30
				Salinity	62.34	43.08	50.42	6.50
OPM76	sin	77.71	Leaf	Control	60.20	45.85	47.07	7.08
				Salinity	59.06	41.28	51.99	6.74
			Stem	Control	64.38	44.75	49.84	5.42
				Salinity	68.44	44.73	50.89	4.39
OPM31	sin	78.52	Leaf	Control	72.16	48.28	46.31	5.41
				Salinity	71.99	46.38	48.84	4.79
			Stem	Control	69.31	49.24	44.87	5.90
				Salinity	69.11	48.62	45.60	5.79
OPM37	sin	86.74	Leaf	Control	70.85	48.40	46.64	4.97
				Salinity	71.36	47.15	47.71	5.14
			Stem	Control	71.83	49.56	45.19	5.26
				Salinity	70.94	47.65	47.15	5.21
OPM49	sin	89.63	Leaf	Control	62.59	47.92	47.18	4.90
				Salinity	59.78	50.71	44.50	4.79
			Stem	Control	62.13	48.12	47.08	4.81
				Salinity	65.28	47.48	47.51	5.02
OPM56	sin	92.71	Leaf	Control	68.72	47.60	47.67	4.74
				Salinity	68.03	44.77	50.35	4.89
			Stem	Control	64.58	44.48	50.46	5.07
				Salinity	64.17	46.55	48.73	4.73

OPM09	hybrid (giganteus)	140.23	Leaf	Control	72.20	48.87	46.24	4.90
				Salinity	72.99	48.61	46.72	4.67
			Stem	Control	65.51	45.63	48.93	5.44
				Salinity	63.92	43.36	51.72	4.93
OPM48	sin	147.25	Leaf	Control	61.53	48.31	44.49	7.20
				Salinity	61.42	47.63	44.43	7.95
			Stem	Control	69.65	49.41	45.49	5.11
				Salinity	68.33	46.21	49.15	4.65