# Rainfall and Soil Moisture Effects on Switchgrass Research Study

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## Chapter I

## Introduction

### 1.1 Background

Native warm-season grasses are perennial grasses which evolved and developed in the Middle-south region of the United States. It is between June and August, when temperatures are between 850 and 950 F, that these grasses reach the highest biomass. These NWSGs (native warm-season grasses) have a C4 photosynthetic pathway, which allows them to be more water-efficient than C3 grasses, making them more durable during dry seasons yet maintaining forage production. Examples of native warm-season grasses include big bluestem, little bluestem, switchgrass, eastern Gamagrass and Indian grass. There are also mixed stands of pure grass. Mixed stands of Indian grass, the big bluestem and the little bluestem, can also be established. Each type of grass has its characteristics, but the uses of all of the grasses are common. This paper provides an in-depth analysis of the effects of rainfall and soil moisture on primed and non-primed switchgrass based on the analysis of different plant heights and biomass, discussing the different changes in biomass and plant height as a result of changes in precipitation and the establishment of these grasses and their site conditions such as the dry uplands and the bottomlands.

Adequate rainfall and soil moisture content encourage a high rate of switchgrass seed germination compared to those in drier areas. Adequate soil moisture also helps switchgrass to develop an adventitious root system. This study found that precipitation frequencies of between seven to ten days were very crucial for seedling survival in southwest Mississippi.

In a study carried out at farmer fields in North and South Dakota and Nebraska, yields of 5.2 to 11 tons per hectare of baled switchgrass were attained (Biello, 2012). These differences in yield can be attributed to rainfall. Switchgrass cultivation is suited to forest and Midwestern soils where rainfall is higher than in drought-conditioned areas.

Native warm-season grasses are used to supplement cool-season grasses since they have better growth during summer. Cool-season forages produce most of their biomass during spring and early summer (this is normally before June) and become dormant during summer. Farmers can manage their grazing system all year round by combining the forages produced during spring and early

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summer with the perennial grasses produced during summer. This offers a consistent supply of grasses throughout the whole growing season.

Despite native warm-season grasses being used mainly for livestock feeds, NWSG has several other uses crucial to the economy and the environment. NSWG have the potential to conserve the soil from erosion, manage waste nutrients, provide water quality protection, and provide a habitat for wildlife.

In recent years, interest has developed in the potential uses of native warm-season grasses as Herbaceous Energy Crops; the DOE and USDA have set up U.S. policy goals for biofuels (Perlack et al., 2005). The development of local alternatives to existing fuels used in transport can help overcome several challenges regarding energy while reducing the nation’s dependency on oil that is imported, yet still developing the national agricultural potential to help in the economic growth of rural areas and improvement of the environmental conditions (Brown, 2003). Ethanol, butanol, and biodiesel are alternative sources of fuel to the existing imported petroleum products (Dhugga, 2007). These biofuels are produced from the biomass of the warm-season forages in conversions that are thermochemical and biochemical (Ortiz-Canavate, 1994). Ethanol, of all biofuels, has received increased support from the government as there are suggestions that ethanol production from forages is not at its best and that it may reach its limits very soon.

Native warm-season grasses are also used as wildlife habitats. Native grassland ecosystems are the most endangered systems in the Mid-South U.S. Several species of wildlife depend on grasslands of the Mid-South region and have declined due to this endangerment of the grasslands ecosystem, establishing native warm-season grasses can help enhance the conditions of habitats. These species need for their continued life process. Native warm-season grasses can be used as building materials for bird nests and breeding areas for feeding by various species. Wildlife management comes as a secondary goal, especially for farmers who establish warm-season grasses for livestock feed.

Several species use warm-season grasses as cover, and fields with grasses that produce more cover are attractive harbours for several wildlife species, such as nesting, perching, or brooding places.

Native warm-season grasses are also used as livestock feed. Warm-season grasses produce more forage during summer than cool-season grasses(C3) grasses. This makes the warm-season grasses an attractive source of forage for livestock. Annually, $C_4$ plants outdo $C_3$ plants in terms of production in tonnage by around 1.5 to 2 times. For instance, switchgrass often produces 5 to 6 tons per acre compared to 2.5 to 3 tons per acre for the $C_3$ plant tall fescue. Native warm-season grasses also utilize soil moisture more efficiently compared to cold-season grasses, and hence, they are more tolerant to conditions of drought.

Native warm-season grasses are used for the production of hay. Depending on the type of warm-season grass, soil type, rainfall and other environmental conditions, warm-season grasses can yield around 2 to 6 tons per acre. The Little bluestem is a shorter warm-season species that has been adapted to drier sites. It produces around 1.5 to 2 tons per acre typically. Indian grass and Big Bluestem produce around 2.5 to 4 tons per acre, whereas eastern gamagrass and switchgrass produce around 4 to 5 tons per acre. These figures could increase on soils that are productive with adequate summer rainfall. Switchgrass increased yields with increased summer rainfall. Biomass increased, and plant height increased in switchgrass with an increase in precipitation. Switchgrass reduced biomass, and plant height growth was slow in drought-conditioned soils in South Mississippi.

All the species of forages respond positively to the application of nitrogen fertilizer. Native warm-season grasses have a high nitrogen-utilization efficiency. Warm-season grasses have fewer nitrogen requirements compared to the cool-season grasses. This characteristic benefits the farmer a great deal since he does not have to apply a lot of N fertilizer.

When it comes to nutrient content, native warm-season grasses have a nutrient content of about 16 to 17 per cent crude protein at its maximum and around 8-12 per cent during optimum harvest. Native warm-season grasses decrease their forage quality as they reach maturity compared to cool-season grasses. This is because, after the boot stage in these grasses, lignification is faster. When managing warm-season grasses, timing harvest correctly is more critical than in cool-season grasses.

Hay quality is influenced by two factors. The first factor is the age of the plant. Protein content and energy content deteriorate as a plant matures, whereas the fibre content increases. Practically, grasses should be harvested before the emergence of subheads. Hay from a mature plant is of low quality compared to a young plant that is immature.

Native warm-season grasses have some advantages and some limitations, too. The advantages of warm-season grasses include the high Nitrogen use-efficiency, which helps to require less amount of nitrogen for photosynthesis and plant growth than cool-season grasses. Using warm-season grasses together with cool-season forages gives an all-year-round uniform livestock feeding system. The native perennial grasses' nature helps reduce costs and inputs associated with the early establishment and also reduce risks associated with establishment failure. Warm-season grasses have a higher yield of about 4-5 tons per acre compared to the yield of cool-season grasses, which is around 2.5 to 3 tons per acre (tall fescue).

Native warm-season grasses have several disadvantages. One disadvantage is that the establishment of these grasses is quite difficult since they need shallow seeding with complex weed control before spring planting. Warm-season grasses can take several seasons to establish fully since they focus more on the development of roots than the development of shoots. Warm-season grasses have a protein content of 15% or more, but these levels significantly drop as the plant matures. Management of warm-season grasses is difficult as one has to maintain grass height adequately to help maintain the stand's vigour. Warm-season grasses lodge easily as they mature.

The establishment of the native warm grasses has been unsuccessful many times due to several malpractices that were carried out during the establishment. Reasons for the unsuccessful nature of establishment vary, but the most common reasons include deep seeding or covering of seeds, poor weed control, late planting when the season has already started, poor evaluation of seed bank and others.

# Chapter II

# Review Of The Literature

## 2 .1 What Is Switchgrass?

The biological name of switchgrass is *Panicum virgatum*. Switchgrass is the most productive of the warm-season grasses and the most commonly discussed of all native warm-season grasses. Switchgrass is a native perennial warm-season grass that develops up to 3-7 feet high. Switchgrass spreads using seeds and rhizomes, though it also forms patches or loose lumps. It is a native grass that matures early (late May to early June) as growth starts in April. Rhizomes actively grow from January to April. During the latter part of the warm grass season, growing points are typically 4 to 5 inches above the ground. Leaves of the switchgrass are flat, half an inch wide and sometimes grow up to 30 inches in length. The switchgrass' ligule is normally a dense fringe of short hairs extending to the switchgrass's upper leaf. This characteristic is excellent for identifying the switchgrass before flowering (forming seed heads). The sheath is purplish/red at the switchgrass base and is normally round and split (open). The seed head forms in late May through June. Subheads are usually an open panicle. Switchgrass variety is adapted to a variety of soils and conditions at the site. Switchgrass has an extensive deep root system and thus has an extremely drought-resistant nature, though it also performs well on comparatively wet sites, with some varieties of switchgrass being tolerant to extended flooding.

## 2.2 Varieties Of Switchgrass

There are two broad varieties of switchgrass, namely, the Lowland varieties and the Upland varieties. These two varieties have striking differences between them.

## Lowland Varieties

## Characteristics Of Lowland Varieties

Lowland varieties have similar characteristics among them. Varieties in this type of switchgrass usually produce more biomass compared to the upland types. They can grow up to 2.7 meters tall in favourable conditions. They are deeply rooted. Lowland types are fairly coarse and do not have the dense fringe of hairs at the ligule, which is characteristic of switchgrass. The lowland cultivars usually have a longer season of growth compared to the upland types (it takes longer to mature). Grow best under flooded conditions.

## Varieties That Are Lowland Switchgrass Variety

‘Alamo’-TX. It developed in Texas. It matures relatively late, ensuring production is in early fall. Alamo may grow up to 10ft in height and is coarser than other switchgrass types. Adapted to sites with clay and loam soils.

‘Kanlow’ – performs well in the lowland parts of the South. Well-suited for wet or poorly drained marginal areas. Adapted to sites with clay and loam soils.

‘Cimarron’ has a longer growing season than Kanlow. It can be grown in regions with more than 25 inches of rainfall.

## Upland Varieties

## Upland Switchgrass Variety Characteristics

They are less sensitive to drought compared to lowland varieties. Deeply rooted. Rhizomes in the upland variety are more vigorous than those in the lowland cultivars. These varieties are more sod-forming. Upland varieties are shorter than lowland cultivars, about 2.4 meters long. Upland varieties are more cold-resistant than lowland varieties. Upland varieties perform best under more moderate soil water conditions.

## Varieties That Are Upland Switchgrass Varieties

‘Cave-in-Rock’ – this upland variety was collected originally in Southern Illinois. This variety was selected because of its resistance to disease and its palatability. Does well on well-drained fertile soils. Adapted to the high-humidity regions of the eastern U.S.A., seeds of cave-in-rock have a high dormancy rate.

‘Carthage’ –NC- is an upland variety which produces quality forage and the best biomass among the upland varieties.

‘Shelter’- is an upland variety that was collected originally from Western Virginia. It has short rhizomes, lesser leaves than other switchgrass varieties, and thicker stems, which are also stiffer. It is adapted to various soil conditions but does best under well or moderately well-drained silt loam, sandy loam, or silty clay loam soil types. Provides excellent wildlife cover and nesting conditions and is used for biomass energy (biofuels) production.

‘Blackwell’- is an upland switchgrass variety that does well in low fertile wet soils. It is of medium height, leafy, and has fine stems. Blackwell is disease-resistant and produces a good forage yield.

## 2.3 Switchgrass Stand Establishment

Switchgrass stand establishment is not difficult, provided proper management practices are followed. For the switchgrass to be viable economically in the long term, successful stand establishment is vital. When there is timely precipitation and strict following of key management practices, stand establishment will be successful. The first step to successful stand establishment is the purchase of certified seeds with high seed lot quality. The second step is developing a good and firm seedbed. The third step is planting the seeds at the recommended time, at the proper depth and at the proper seed rate. Lastly, make sure that there is advanced weed control during that year of planting.

## How The Plot/Field For Switchgrass Stand Establishment Is Prepared.

It is important to develop a seedbed that promotes good soil-seed contact since the seeds of the switchgrass are naturally small. When preparing a plot that had previously been planted with a crop that leaves behind heavy residue, one should reduce these remains by shredding, baling, removing or grazing. Switchgrass can be established in land that was considered unsuitable for growing row crops, land that is too erosive to produce corn, and gravelly and sandy soils in regions of high humidity, which do not produce good yields for other crops.

Switchgrass can be established by both the conventional tillage and by no-till. Planting regulations for mixtures of native grasses for conservation planting should be adhered to when seeding switchgrass as a part of a mixture of several kinds of grass (Springer, 2001). Some factors promote the likelihood of successful switchgrass establishment. These factors include;

- Switchgrass should be planted after the soil has been well-warmed through spring.
- Seeds that have a high germination rate should be used and planted at a depth of 0.6 to 1.2 cm or about 2 cm depth in sandy soils (Mitchell & Vogel, 2012). Seeds planted deeper than this will have problems emerging. (Hupet and Vancloosterl,2002).
- Seeds should be planted at a rate of 30 PLS (Pure Live Seeds) per square foot (Mitchell & Vogel, 2012).
- Soil should be packed or firmed before and after switchgrass seeding.
- No fertilization when planting to reduce competition.
- Weed control using chemicals or traditional weed control methods.

## How Seed Dormancy And Germination Play A Role In Switchgrass Stand Establishment.

Switchgrass seeds have a very high level of dormancy, and therefore, switchgrass seeds need to have a high rate of germination for them to be successfully established. Choosing seeds with low dormancy and high purity promotes effective germination of the seeds. Switchgrass will germinate at 50F, which will allow the switchgrass stand to develop (Guretzky, 2007). In switchgrass, the seed packet needs to be checked for germination temperature (Kausch et al., 2010).

## Preferred Soil Conditions For Switchgrass Stand Establishment

Switchgrass stands to establish and perform best in warm conditions, with soil temperatures of 600 or warmer for germination. N fertilizer or farmyard manure should not be applied in the year of seeding switchgrass to reduce competition with weeds. Switchgrass tolerates soils that are moderately acidic. Seed germination is at optimum in soils with a pH of between 6 to 8. Soil moisture is also an important aspect of increasing the rate of germination of seedlings. Adequate soil moisture also encourages the formation of adventitious roots that are important for nutrient intake.

## Diseases Or Pests That Affect Switchgrass Stand Establishment

Switchgrass stand establishment can be affected by the presence of a certain microscopic organism. The insect-pathogenic fungus Metarhizium Roberts (Clavicipitaceae) is an endophyte that stimulates switchgrass plant root development, and its presence in the site for switchgrass establishment will lead to a successful stand (Ghimire & Craven, 2009)

## Effect Of Seeding Failure On Switchgrass Stand Establishment

Seeding failure can be a result of planting seeds at a depth that is not recommended or too deep or planting seeds with a high dormancy rate or inadequate soil moisture. This can affect the establishment of the switchgrass stand in various ways. Seeding failure can lead to the establishment of an incomplete stand with patches that do not have plants growing on them. Seedling failure promotes the higher growth of weeds without competition from the switchgrass plants, and this leads to a stand that is poor and that will produce low or no yields in the future.

## 2.4 Switchgrass Agricultural And Environmental Application

## Importance Of Seed Production On The Environmental And Agricultural Application Of Switchgrass.

For switchgrass to become the most cellulosic warm season grass for biofuel production in the U.S., consistent supply and a large amount of seed is required. Production of high-quality seeds will ensure an excellent stand establishment that will promote high yields in the future.

## What Makes Switchgrass Above-Ground Biomass So Valuable As A Biofuel Feedstock For Ethanol Production?

Switchgrass has a huge potential as a bioenergy forage for cellulosic production of ethanol, direct combustion for electrical and heat generation, pyrolysis, and gasification. The U.S. D.O.E selected the switchgrass native as the herbaceous energy crop for biomass energy. The characteristics that make switchgrass an above-ground biomass energy crop include: it is a native grass broadly adapted to North America, it is a species that is very easy to establish from seed, it relatively produces high yields compared to other native species, and it does not require a lot of agricultural inputs.

## How Does Switchgrass Reduce Soil Erosion?

Soil erosion can come from both wind and water. The height of switchgrass can create an effective wind barrier, preventing soil erosion by wind. Switchgrass also has a deep root system that holds the soil firmly in place, preventing erosion of soil by flooding and runoffs.

## Switchgrass Being Drought And Flooding Tolerant

Switchgrass is tolerant to both drought and flooding conditions. The lowland cultivars are adapted to high-moisture soils, whereas the upland varieties equally perform well in drought conditions.

## Role Of Switchgrass In Storing Carbon In The Soil

Switchgrass has the potential to sequester (store) carbon in soils as a bioenergy crop. In the process of carbon sequestration, switchgrass acts as a sink by storing carbon in the soil because it uses a large amount of carbon dioxide during photosynthesis.

## 2.5 Arkansas Grand Prairie Switchgrass

Arkansas Grand Prairie was collected out of the Grand Prairie in the lower Mississippi Delta region. In 2014, Alcorn State University partnered with Audubon to determine if Arkansas could be established in southwest Mississippi. The field plot was established in July 2012. The plot was established by non-primed and primed Arkansas switchgrass seedlings. Alcorn has conducted production research on this stand establishment since 2012. Alcorn has presented numerous research presentations at local, regional and national conferences.

Chapter III

# Methodology

This chapter describes the research methods used in the study of the effects of precipitation and soil moisture content of the switchgrass native. This chapter tries to give insight as to why Alcorn State University conducted a study on switchgrass and also the implications of the resulting data.

## 3.1 Research Sample

This research paper draws data from research carried out by Alcorn State University. In 2014, Alcorn State University partnered with Audubon to determine if Arkansas could be established in southwest Mississippi. The field plot was established in July 2012. The plot was established by non-primed and primed Arkansas Grand Prairie switchgrass seedlings. The research would also get information based on the plant heights of the Primed Arkansas Grand Prairie, including the amount of rainfall and soil moisture. Results of this research were reached through an online survey of some landowners and farmers in southwest Mississippi.

### 3.2 Instrumentation

Field experiments were carried out by Alcorn State University between 2014 and the end of 2016. These experiments helped gather a lot of data concerning the switchgrass variety. They answered several questions about the field of study, Switchgrass, including its characteristics, its applications, and why it is the best among all other native warm-season grasses.

The survey was administered to the farmers of switchgrass in this region of South Mississippi, especially those who established Arkansas Grand Prime Switchgrass. This survey aimed to answer questions about the Switchgrass species in the form of questionnaires.

### 3.3 Data Collection Procedures

Data collection was done through surveys carried out on Switchgrass farmers in South-West Mississippi and through an online survey. Questionnaires were the main method used to get a response from the farmers.

Rainfall patterns and frequencies in southwest Mississippi were also studied, as well as their effects on the primed and non-primed switchgrass cultivated in this region.

Data collected was recorded as it involved a lot of numerals, mainly based on the Arkansas Grand

Prime Switchgrass plant heights and rainfall frequencies. Data were analyzed and recorded in tables or represented in charts.

The confidentiality of the farmers who participated in the survey was maintained as per the IRB (Institution Review Board) guidelines) to ensure privacy and also non-infringement of rights.

## 3.4 Data Analysis

The data recorded were analyzed quantitatively using statistical methods. Data was recorded in tables, analyzed and later recorded in charts and histograms.

Data were analyzed to help determine the more complex characteristics of Switchgrass species, especially the Arkansas Grand Prime Switchgrass. Data were compared for plant height between May 31, 2016, with that of different plant heights towards the end of the study on August 1, 2016. Plant heights increased greatly between 1 June 2016 and 1 August 2016, when rainfall was adequate.

# Chapter IV

# Results And Discussion

## 4.1 Primed Arkansas Grand Prairie Switchgrass Plant Height Results

This study was carried out on the plant heights of the primed and non-primed Arkansas Grand Prairie switchgrass in different periods when the amount of rainfall and soil moisture content were different between May and August. Switchgrass plant height increased with the increase in rainfall amount, which increased soil moisture.

Primed Arkansas, Grand Prairie switchgrass displayed a plant height range of 2.036m to 2.864 from May to August 2016 (Table 1). The mean plant height for primed switchgrass plants on May 31, 2016, was 2.036m. The mean plant height for primed switchgrass plants on June 2, 2016, was 2.083m. The mean plant height for primed switchgrass plants on June 7, 2016, was 2.098m. The mean plant height for primed switchgrass plants on June 9, 2016, was 2.136m. The mean plant height for primed switchgrass plants on June 14, 2016, was 2.176m. The mean plant height for primed switchgrass plants on June 16, 2016, was 2.212m. The mean plant height for primed switchgrass on June 21, 2016, was 2.251m. The mean plant height for primed switchgrass on June 30, 2016, was 2.333m. The mean plant height for primed switchgrass on July 5, 2016, and July 7, 2016, were 2.518m and 2.562m, respectively. The mean plant height for primed switchgrass on August 1, 2016, was 2.864.

## Table 1: Primed Switchgrass Plant Height Descriptive Data

| Treatment | Size | Missing | Mean (M) | Std Dev | Std. Error | C.I. Of Mean |
|---|---|---|---|---|---|---|
| P 5-31-16 | 28 | 0 | 2.036 | 0.241 | 0.0456 | 0.0936 |
| P 6-2-2016 | 28 | 0 | 2.083 | 0.223 | 0.0422 | 0.0865 |
| P 6-7-2016 | 28 | 0 | 2.098 | 0.307 | 0.0581 | 0.119 |
| P 6-9-2016 | 28 | 0 | 2.136 | 0.218 | 0.0413 | 0.0847 |
| P 06-14-16 | 28 | 0 | 2.176 | 0.206 | 0.0389 | 0.0797 |
| P 6-16-16 | 28 | 0 | 2.212 | 0.216 | 0.0409 | 0.0839 |
| P 6-21-16 | 28 | 0 | 2.251 | 0.191 | 0.0361 | 0.0740 |
| P 6-23-16 | 28 | 0 | 2.294 | 0.201 | 0.0380 | 0.0780 |
| P 6-28-16 | 28 | 0 | 2.326 | 0.152 | 0.0288 | 0.0591 |
| P 6-30-16 | 28 | 0 | 2.333 | 0.136 | 0.0257 | 0.0528 |
| P 7-5-16 | 28 | 0 | 2.518 | 0.0755 | 0.0143 | 0.0293 |
| P 7-7-16 | 28 | 0 | 2.562 | 0.0829 | 0.0157 | 0.0321 |
| P 8-1-16 | 28 | 0 | 2.864 | 0.0660 | 0.0125 | 0.0256 |

Primed Arkansas Grand Prairie switchgrass did display a significant difference between plant heights through the sampling dates of the study (Table 2). However, there was not a significant difference in switchgrass plant heights on July 5, 2016, and August 1, 2016. There was a significant difference in switchgrass plant heights from the beginning of the study (May 31, 2016) to the end of the study (August 1, 2016). August 1, 2016, primed switchgrass plant heights displayed a significant difference from all June 2016 plant heights.

## Table 2: Primed Switchgrass Plant Height All Pairwise Statistical Comparisons

## Treatment Comparisons Ranking Diff Q P <0.05

## (S. Range) (Significance)

P 8-1-16 Vs P 5-31-16 412.000 13.836 Yes

P 8-1-16 Vs P 6-2-2016 391.500 13.148 Yes

P 8-1-16 Vs P 6-7-2016 387.000 12.997 Yes

P 8-1-16 Vs P 6-7-2016 387.000 12.997 Yes

P 8-1-16 Vs P 6-9-2016 342.500 11.502 Yes

P 8-1-16 Vs P 6-9-2016 342.500 11.502 Yes

P 8-1-16 Vs P 6-9-2016 342.500 11.502 Yes

P 8-1-16 Vs P 06-14-16 300.500 10.092 Yes

P 8-1-16 Vs P 6-16-16 288.000 9.672 Yes

P 8-1-16 Vs P 6-21-16 246.500 8.278 Yes

P 8-1-16 Vs P 6-23-16 228.000 7.657 Yes

P 8-1-16 Vs P 6-28-16 217.500 7.304 Yes

P 8-1-16 Vs P 6-30-16 208.000 6.985 Yes

P 8-1-16 Vs P 7-5-16 135.500 4.550 No

P 8-1-16 Vs P 7-7-16 85.000 2.855 No

Yes = Indicated Significant Difference

No = No Significant Difference

## 4.2 Non-Primed Arkansas Grand Prairie Switchgrass Plant Height Results

Non-primed Arkansas Grand Prairie Switchgrass displayed a mean plant height range of 1.922m (May 31, 2016) to 2.913m (August 1, 2016) (Table 3). Non-primed switchgrass on May 31, 2016, had a mean plant height of 1.922m. Non-primed switchgrass, June 9, 2016, had a mean average plant height of 2.084m. Non-primed switchgrass, June 14, 2016, had a mean average plant height of 2.184m. Non-primed switchgrass, on June 16, 2016, had an average plant height mean of 2.186m.

Non-primed switchgrass, on June 21, 2016, had an average plant height mean of 2.259m. Non-primed switchgrass, on June 23, 2016, had an average plant height mean of 2.226m. Non-primed switchgrass, June 28, 2016, had an average plant height mean of 2.335m. Non-primed switchgrass, on June 30, 2016, had an average plant height mean of 2.354m. Non-primed switchgrass, on July 7, 2016, had an average plant height mean of 2.565m. Non-primed switchgrass, August 1, 2016, had an average plant height mean of 2.913m.

## Table 3: Non-Primed Switchgrass Plant Height Descriptive Data

## Column Size Missing Mean Std Dev Std. Error C.I. Of Mean

NP 6-2-2016 28 0 2.034 0.156 0.0296 0.0607

NP 6-7-2016 28 0 2.041 0.148 0.0281 0.0576

NP 5-31-16 28 0 1.922 0.224 0.0423 0.0869

NP 6-9-16 28 0 2.084 0.166 0.0314 0.0644

NP 6-14-16 28 0 2.184 0.148 0.0279 0.0573

NP 6-16-16 28 0 2.186 0.153 0.0289 0.0593

NP 6-21-16 28 0 2.259 0.172 0.0325 0.0667

NP 6-23-16 28 0 2.226 0.149 0.0281 0.0577

NP 6-28-16 28 0 2.335 0.121 0.0229 0.0470

NP 6-30-16 28 0 2.354 0.0930 0.0176 0.0361

NP 7-5-16 28 0 2.565 0.0772 0.0146 0.0300

NP 7-7-16 28 0 2.612 0.0847 0.0160 0.0328

NP 7-7-16 28 0 2.612 0.0847 0.0160 0.0328

NP 8-1-16 28 0 2.913 0.0652 0.0123 0.0253

Yes = Indicated Significant Difference

No = No Significant Difference.

There were statistical differences in the plant height of non-primed Arkansas Grand Prairie

Switchgrass through the sampling dates of the study (Table 4). Primed switchgrass August 1, 2016, plant height mean was significantly different from all other sampling dates plant height, except July 5, 2016, plant height and July 7, 2015, plant height respectively. Primed Switchgrass, on July 7, 2016, plant height was significantly different from all other sampling dates, except for plant height on June 30, 2016.

## Table 4: Non-Primed Switchgrass Plant Height All Pairwise Statistical Comparisons

## Comparison Diff Of Ranks Q P<0.05

P 8-1-16 vs P 5-31-16 283.500 13.757 Yes

P 8-1-16 vs P 6-2-2016 267.500 12.981 Yes

P 8-1-16 vs P 6-7-2016 266.000 12.908 Yes

P 8-1-16 vs P 6-9-2016 241.000 11.695 Yes

P 8-1-16 vs P 06-14-16 218.000 10.579 Yes

P 8-1-16 vs P 6-16-16 206.000 9.996 Yes

P 8-1-16 vs P 6-21-16 167.000 8.104 Yes

P 8-1-16 vs P 6-23-16 149.000 7.230 Yes

P 8-1-16 vs P 6-28-16 137.500 6.672 Yes

P 8-1-16 vs P 6-30-16 128.000 6.211 Yes

P 8-1-16 vs P 7-5-16 67.500 3.276 No

P 8-1-16 vs P 7-7-16 40.000 1.941 No

P 7-7-16 vs P 5-31-16 243.500 11.816 Yes

P 7-7-16 vs P 6-2-2016 227.500 11.040 Yes

P 7-7-16 vs P 6-7-2016 226.000 10.967 Yes

P 7-7-16 vs P 6-9-2016 201.000 9.754 Yes

P 7-7-16 vs P 06-14-16 178.000 8.638 Yes

P 7-7-16 vs P 6-16-16 166.000 8.055 Yes

P 7-7-16 vs P 6-21-16 127.000 6.163 Yes

P 7-7-16 vs P 6-23-16 109.000 5.289 Yes

P 7-7-16 vs P 6-28-16 97.500 4.731 Yes

P 7-7-16 vs P 6-30-16 88.000 4.270 No

### 4.3 Prediction Of Arkansas Grand Prairie Switchgrass Plant Height Based On Soil Moisture And Rainfall Linear Regression

Arkansas Grand Prairie Switchgrass is primed, and non-primed plant height can be predicted based on soil moisture concentrations, rainfall concentrations, and sampling dates (Table 5). Sampling dates were the most reliable prediction of non-primed and primed switchgrass plant height. The R-value for the prediction of switchgrass plant height based on soil moisture, rainfall, and sampling dates is 0.986. Switchgrass plant height increases as the sampling date increases (Figure 1). Soil moisture concentrations and rainfall concentrations display a linear relationship. Therefore, soil moisture concentrations can be predicted from rainfall concentrations.

# Chapter V

# Conclusions, Implications, And Recommendations

## Conclusions

The study indicates that primed and non-primed prairie switchgrass plant height is affected by soil moisture, rainfall, and sampling date. Plant height increases during the period of the study (May 30, 2016, to August 1, 2016). These results agree with the previous findings that switchgrass produced 80% of its above biomass from June –August (George, Blanchet, & Gittle, 2000). The ability of switchgrass and other native warm-season grasses to perform well on marginal land is a very strong attribute, allowing one fallow ground to develop into a productive field capable of producing multiple tons of dry biomass per acre (Yongqing Ma, Shui & Zhong, 2015). Warm-season grasses are slow to germinate and often have less seedling vigour than weedy species. Switchgrass has a high pest resistance and is tolerant to flood and drought. Switchgrass has low fertilizer and water requirements. Moisture is essential for initial germination and establishment. The soil should remain moist for at least one month during this period.

## Implications

The main aim of this study was to analyze the effects of rainfall and soil moisture on switchgrass based on the analysis of plant heights of the primed and non-primed switchgrass. This study will help switchgrass farmers, together with aspiring farmers, understand how important adequate rainfall and soil moisture is to switchgrass cultivation. This study has broadened our understanding of warm-season grasses, their site conditions, their establishment, their uses, and their application. This study has helped us to understand what variety does best and the site in which it performs best.

This study will help farmers understand more about Switchgrass stand establishment, which was perceived as very difficult and unsuccessful earlier. This paper proves that Switchgrass can be successful and produce high yields.

## Recommendations

This study has discussed the various effects of precipitation and soil moisture on switchgrass. These uses include increased germination rate and increased growth of switchgrass plants, as evidenced by the increased biomass and plant height and the total yields per hectare as a result of adequate rainfall and soil moisture. The following are the recommendations as a result of this study:

- Since switchgrass requires enough soil moisture to germinate fully, farmers should time their planting time and stand establishment period. Planting too early or too late may result in a lower percentage of germination of switchgrass. In case of rainfall failure, it is recommended that farmers use irrigation to prevent the establishment failure of the switchgrass stand.
- Farmers are also encouraged to involve agricultural officers to help determine soil moisture content in their switchgrass fields.
- Farmers are advised to maintain soil moisture content even through irrigation to ensure maximum biomass and plant height.

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