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EXAMINING VEGETATIVE GROWTH OF COOL-SEASON FORAGE GRASSES FOR DAIRY CATTLE GRAZING PREFERENCE

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THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
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By

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ABSTRACT OF THESIS

EXAMINING VEGETATIVE GROWTH OF COOL-SEASON FORAGE GRASSES FOR DAIRY CATTLE GRAZING PREFERENCE

The objective of this study was to determine dairy cattle preference amongst four species of cool-season forage grasses: eight orchardgrasses (*Dactylis glomerata* L.), five tall fescues [*Schedonorus arundinaceus* (Schreb.) Dumort.], five perennial ryegrasses (*Lolium perenne* L.), and six festuloliums [x*Festulolium braunii* (K. Richt.) A. Camus.]; 24 cultivars in total. Each grazing trial utilized four Holstein-Friesian heifers over six hours. Maturity differences were eliminated by having animals graze only vegetative material. After six grazing trials (three each in 2014 and 2015), consistent results in animal preference were not found; three of the six trials did show preference ($P<.01$). However, forage quality analysis shows that the entries, while statistically different ($P<0.1$), did not vary greatly in the measured constituents (NDF, ADF, IVTD, CP), and were high in value. This was due to eliminating the confounding maturity effects, which reduced variation in quality constituents. A second study utilizing 10 orchardgrass cultivars showed no differences in preference. Animals cannot discern between entries with high quality and little variation. Selecting cultivars and species based on agronomic advantages (i.e. drought tolerance, persistence under grazing, winter-hardiness, and yield) would benefit operations over selecting cultivars that vary little in forage quality under optimal management.

KEYWORDS: Forage grasses, Preference, Grazing, Dairy, Cool-season

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November 18, 2015

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To my father, for inspiring my agricultural endeavors

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Palatability and Preference

Grazing animals have long been shown to have a certain degree of selectivity among forages when allowed to graze freely in pasture. This in turn affects their degree of forage utilization and productivity upon grazing of said forages. In describing an animal's tendencies towards selecting one forage over another, two terms are of the utmost importance: palatability and preference. Palatability is the characteristic of a particular feedstuff indicating its acceptability to the animal, and is related to how the animal perceives that feedstuff through visual, olfactory, and gustatory senses (Mertens, 1994). It directly affects the rate of intake of a particular feed, and in the presence of multiple feedstuffs affects the animal's likelihood of selecting one feedstuff over another. In turn, preference is the measure of the acceptability of feeds when multiple options are presented to the animal (Mertens, 1994).

Grazing studies are often focused on detecting and determining differences between forages available to the animals out in the field. As such, these studies are measuring animal preference for available forages rather than directly measuring palatability factors. However, it is important to understand the role palatability plays on animal preferences. Factors that influence forage palatability are maturity, leaf:stem ratio, amount of structural carbohydrates amount of non-structural carbohydrates (NSC), leaf texture, leaf tensile strength, and anti-quality factors (Barnes et al., 2003; Harrison et al., 2003). Maturity and leaf:stem ratio directly influence the ratio of structural carbohydrates in the forage to non-structural carbohydrates (cell solubles like glucose, fructose, and starch). Earlier maturing cultivars will often exhibit higher levels of structural carbohydrates than later maturing cultivars. Leaf tissue contains more NSC, thus is more desirable than stem tissue. Leaf texture is related to the roughness or smoothness of leaves and how the animal perceives these characteristics of the leaf. Rougher leaves are less palatable than smooth. Leaf tensile strength has also been shown to affect palatability (MacAdam and Mayland, 2002). Greater tensile strength equates to requiring the animal to exert more force upon the plant tissue in order to consume that material, either by shearing it from the plant, or effort it takes to chew that plant tissue.

Forage preference has been correlated to a number of factors not associated with palatability. While palatability certainly has an impact on animal preference, it is often superseded by these other factors. There is a hierarchy of grazing on how animals select what forages they gravitate towards first in the field (Bailey et al. 1996). Total forage biomass prior to grazing, i.e. forage availability, is highly correlated to what forage animals consume first. Denser and taller areas of plant material are within easier reach of the animal's mouth and therefore often grazed first. Animals are attempting to maximize intake over energy content of the consumed forage at this level of the hierarchy (Senft 1989). Once an animal has determined its initial grazing area in pasture, it can then become more selective within that smaller grazing area (Heitschmidt and Stuth 1991). Selection between broadleaf plants and grasses is a common observation. It is at this point that the palatability factors mentioned above become involved in animal preference, thus resulting in an animal selecting one forage over another.

Characteristics of Perennial Cool-Season Forage Grasses

In the temperate American Midwest and transition zone perennial cool-season forage grasses comprise a large percentage of total grass species present in pastures. Whereas warm-season forage grasses have Kranz anatomy and utilize the C4 photosynthetic pathway (Anderson 2000), cool-season species use the C3 photosynthetic pathway (Moser and Hoveland, 1996). Biologically this makes cool-season grasses less suited for higher temperatures during the summer months due to increased transpiration and fixing of oxygen rather than carbon by RUBISCO. Thus, perennial cool-season grasses exhibit a bi-modal pattern of growth throughout the growing season. Spring growth comprises the majority of forage growth for the year, lasting from April to June. Growth slows by summer and is greatly reduced until fall, when temperatures return to more ideal levels for growth to resume until first frost occurs (Burns and Bagley, 1996). As a result, forage availability of cool-season grasses varies throughout the growing season and thus management strategies for grazing these grasses must be properly aligned with availability.

In addition, there are aspects of perennial grasses that make management for forage grazing difficult. Each winter perennial grasses undergo vernalization, the process of exposure to short days and long nights with low temperatures which results in the initiation of growth and development of reproductive tillers from the plant (Fiil et al., 2011). These reproductive tillers emerge in the initial flush of spring growth. This is a key aspect to the maturity variation between different species and cultivars of grasses. Once development of these reproductive tillers begins palatability rapidly declines due to a reduced leaf:stem ratio, reallocation of fixed carbon away from vegetative growth and into reproductive growth, and increased amounts of secondary cell-wall components such as hemicellulose, lignin, and pectins that lower digestibility and the amount of available energy to the grazing animal (Nelson and Moser, 1994; Baron et al., 2000). Later maturing species and cultivars of cool-season grasses have a palatability advantage because they have a longer period of vegetative growth prior to the onset of reproductive growth, allowing for increased dry matter accumulation. If grasses are allowed to produce reproductive tillers and are subsequently mowed, reproductive tiller growth will be halted or drastically reduced, returning the plant to a vegetative state of growth.

Grasses also exhibit different morphological growth habits that lend themselves to greater or lesser amounts of regrowth following grazing or cutting for hay, that in turn could affect animal preference. Cespitose, or bunchgrass-type grasses originate from a crown and grow in a radial pattern away from the original point of emergence as more tillers are developed. Common forage species include orchardgrass (*Dacytlis glomerata* L.) and tall fescue (*Schedenorus arundinaceus* (Schreb.) Dumort.). These types of cool-season forage grasses are most commonly used in forage production systems as bunchgrasses often have greater vegetative regrowth, particularly after first cutting, than stoloniferous or rhizomatous type grasses. These sod-type grasses proliferate laterally from their point of origin through the use of prostrate aboveground or belowground stems known as stolons or rhizomes, respectively. Kentucky bluegrass (*Poa pratensis* L.) is a common cool-season sod-type forage grass the spreads through the use of rhizomes (Fustec et al., 2005), but does not exhibit good regrowth following initial grazing or cutting.

Discussion of Relevant Cool-Season Species

Detailed information about agronomic, morphological, and genetic characteristics of perennial cool-season grass species used in this thesis is vital to conveying the importance and results of this research. Species of relevance are orchardgrass, tall fescue, perennial ryegrass (*Lolium perenne* L.) and festulolium (x*Festulolium braunii* (K. Richt.) A. Camus.). Taxonomically they are all found within the Poeae tribe of the Pooideae subfamily within Poaceae, the grass family. As a result these species share many similarities in ancestry and general morphological structures, yet are vastly different when examined with regard to their agricultural use as forages (Harrison et al., 2003). All four species are bunchgrasses rather than sod-type grasses, and as cool-season grasses utilize the C3 photosynthetic pathway. All are widely adopted in the United States and the rest of the world for use as forages for animal consumption. Differences in specific agronomic and genetic characteristics, along with aspects unique to each species will be addressed as follows: orchardgrass, tall fescue, perennial ryegrass, and finally festuloliums.

Orchardgrass

Orchardgrass has been a longstanding grass used in forage productions systems. Agronomically, the grass is highly adapted to shaded areas with slightly acidic to neutral pH, and can also endure significant drought stress. It is not well adapted to persistent and excessive soil moisture and flooding. It has a very high positive response to nitrogen fertilizer application (Mortensen et al. 1964) and has rapid regrowth following grazing or cutting for hay compared with some other forage species. Of the most common cool-season forages used in the U.S., it is one of the earliest to initiate spring growth and this makes it valuable as a forage early on in the growing season. However, this same aspect also means that the grass matures much earlier than other species and this can negatively impact forage quality and palatability to animals grazing it or consuming it for hay (Kunelius, 1990; Van Santen and Sleper, 1996). To rectify this problem, breeders have developed cultivars that mature much slower than other cultivars and will maximize vegetative growth without increasing secondary cell wall components that lower energy usage and intake by animals consuming that forage. Compared with tall fescue, another common forage in the U.S. that is arguably more widely used, it has the distinct advantage of lacking toxic endophytes that can produce harmful alkaloids that poison animals upon consumption (Clay, 1996). This makes it much more suitable for equine pasture and hay. The species also has softer textured and less rigid leaves than most cultivars of tall fescue that make it more palatable to grazing animals. Orchardgrass is fairly susceptible to disease, with brown patch, rusts, and leaf spot diseases commonly resulting in yield losses (Van Santen and Sleper, 1996).

Tall Fescue

Tall fescue is the most widely used forage grass in the United States with roughly 5-6 million hectares (Buckner et al., 1979). The species is most commonly located in the transition zone, the region stretching from Northern Kentucky to Southern Tennessee, and from Arkansas to the Carolinas (Sleper and West, 1996). While still being a cool-season species, it is much more tolerant of high temperatures found farther south than other cool-season grasses (Hoveland, 1993). For this reason, tall fescue has been heavily adopted for forage in states farther south than orchardgrass, perennial ryegrass, and festuloliums have been. In field settings, this species is known for being high yielding, even in adverse environmental conditions. It is deep rooted, providing strong drought tolerance, and extremely persistent under heavy grazing. Tall fescue also has strong disease resistance to pathogens that commonly affect other cool-season grasses.

An important characteristic of tall fescue is its symbiosis with the endophytic fungi *Epichloë coenophiala* (Morgan-Jones & W. Gams) C.W. Bacon & Schardl. This symbiosis is responsible for providing the plant with many of its beneficial agronomic traits, such as improved environmental stress resistance and high yield capability (Schmidt and Osborn, 1993). Unfortunately, presence of the endophyte produces some undesirable compounds, specifically ergot alkaloids such as ergovaline that are toxic to animals when consumed in large amounts. In cattle, ingestion of ergovaline causes several side-effects including rough hair coat retention from winter months, and vasoconstriction which reduces blood flow, resulting in animals being unable to properly regulate body heat and becoming heat stressed. A condition known as "fescue foot" can also arise from ergot alkaloid poisoning in which vasoconstriction limits blood flow to the extremities (Schmidt and Osborn, 1993). If left untreated, this condition can eventually lead to loss of hooves or the switches of animal's tails due to lack of blood flow. These conditions in turn result in lower dry matter intake and lower production by these animals, either in terms of average daily gain in beef cattle or milk production in dairy. Horses are much more sensitive to this toxin, with even low concentrations resulting in pregnant mares aborting fetuses or other birth defects (Brendemuehl et al., 1994). As such, the equine industry is much more cautious about use of tall fescue in pastures and hay. In order to rectify this problem, breeders have developed endophyte free cultivars of tall fescue that are not infected by the common toxic endophytes, thus no alkaloids are produced. However, without the endophyte present, tall fescue loses some of its beneficial agronomic traits, with yields lowered and stress tolerance reduced (Arachevaleta et al., 1989). To correct this problem, plant pathologists and forage grass breeders have worked in tandem to develop novel endophytes that restore some of the agronomic benefits of symbiosis, but do not produce toxic ergot alkaloids. Milk production in dairy cattle was also compared between those fed orchardgrass and those fed endophyte free tall fescue, and no significant difference was observed (Rakes et al. 1988).

Perennial Ryegrass

Perennial ryegrass (*Lolium perenne*) is another cool-season bunchgrass that has seen widespread use as animal forage. This species is native to areas of Northern Europe where it thrives in the cool to mild climates with adequate precipitation found in that region of the world. In Europe it remains the primary forage grass because of this reason (Jung et al., 1996). Its introduction into the United States has seen it spread in some fashion to all 50 states, but it is much more common in areas with cool, wet conditions. As a species, perennial ryegrass has both a diploid and tetraploid form. The diploid form is commonly used in both forage and turf systems, as it tolerates treading and heavy grazing more than the tetraploid forms (Jung, et al., 1996). The tetraploid form is most commonly used in forage production, and exhibits a number of characteristics that make it much more desirable for use as forage: greater tillering, rapid regrowth following cutting or grazing, greater sugar content, and large cells that can hold more cell solubles for improved energy and nutritive content to animals (Jung et al., 1996). The species is known for its high sugar content, especially when compared to other common species such as orchardgrass and tall fescue. This has made it popular among dairy farmers, as it provides highly palatable forage that increases milk production in their herds (Hageman et al., 1993). Its prevalence in New Zealand has also led to preference studies being conducted with sheep, in which the tetraploid accessions were found to be the most palatable (Vipond et al., 1993).

Agronomically, perennial ryegrass is much more sensitive to environmental stresses that other cool-season forages (Jung et al., 1996). This aspect has resulted in lower adoption for use in climates that cannot match the precise needs of the plant. It cannot tolerate extreme temperature fluctuations such as very hot summers or very cold winters. Growth of the grass ceases almost entirely during hot and dry summer months, whereas other species such as orchardgrass and tall fescue continue to produce, albeit at lower than normal rates. Compared to orchardgrass and tall fescue, the species' poor winter hardiness is also problematic for use in areas with low temperatures without snow cover for insulation (Nelson et al. 1997). Perennial ryegrass is also sensitive to water stress, and as a result requires soils with a high water holding capacity and climates with adequate precipitation to persist. In the United States, this limits its practical use to areas around the Great Lakes and Northeast, or the Pacific Northwest, as these areas have mild summers, adequate precipitation, and snow to insulate plants (Great Lakes/Northeast) or mild winters (Pacific Northwest). In the right conditions, perennial ryegrass can produce excellent quality forage, but its specific growth requirements make it less popular than other cool-season grass forages here in the United States.

Festuloliums

Festulolium [x*Festulolium braunii* (K. Richt.) A. Camus.]. is another cool-season forage grass species that is receiving more attention in the agricultural sector in recent years. The distinct feature of this plant is that it is derived from a hybrid cross between two of the aforementioned cool-season forage genera, *Lolium* x *Schedonorus* (formerly *Festuca* spp.). *Lolium* species are desirable for their high forage yield and forage quality, but because of the previously detailed poor response to abiotic stresses, *Schedonorus* species are crossed to them to impart their strong abiotic stress tolerance, in order to create a high yielding, high quality, stress tolerant forage that can be grown in a wide array of environments (Nelson et al, 1997). As such, festuloliums have a much wider area of adaptation than do ryegrasses, and can often be found in drier and hotter climates, yet still yield comparatively to tall fescue. Their winter-hardiness has also been improved, and therefore the species can thrive in climates with harsh winters where temperatures frequently dip below freezing. Perennial ryegrass or Italian ryegrass (*Lolium multiflorum* Lam.) are the most common *Lolium* species used in the cross. Tall fescue and meadow fescue (*Schedonorus pratensis* Huds.) are the most common parents from the *Schedonorus* genus used in crosses to produce festulolium cultivars (Nelson et al., 1997). Phenotypic variation from cross to cross is highly variable, as depending on the parent material, a cultivar may exhibit more fescue or ryegrass-like phenotypes. Current trends suggest the more ryegrass-like cultivars are more desirable to farmers, simply because of their improved forage quality over fescue-like cultivars.

Forage Quality

Forage nutritive value components have long been used to assess the quality of forages and their subsequent value as feedstock to the animals consuming them. The better the forage quality is, the greater the subsequent productivity and/or average daily gain by that animal is. Throughout the last 60 years, a number of nutritive value factors have been consistently associated with, and are widely accepted as ways in which to measure forage quality. These include: neutral detergent fiber (NDF), acid detergent fiber (ADF), crude protein (CP), in-vitro dry matter digestibility (IVDMD), and water soluble carbohydrates (WSC).

NDF (Neutral Detergent Fiber)

NDF is a measure of the total cell wall constituents of the plant (Ball et al., 2007). These include cellulose, hemicellulose, and lignin. Together, these components generally are referred to as fiber content, and greater amounts of them are associated with a reduced level of intake by the animals consuming that forage. These cell wall constituents are extracted via a method developed by Van Soest in the 1960's, wherein forage samples are treated with a neutral detergent solution and cell wall and cell soluble components are separated from one another. The soluble components are dissolved in the solution, leaving behind only the non-degraded cell wall material. Cellulose is the majority of this fiber component, as it makes up the majority of the plant's cell wall. The amount of hemicellulose and lignin is largely dependent on the maturity of the plant, leaf:stem ratio, and individual variation between species and cultivar at time of grazing or harvest (Wilson and Kennedy, 1996). This is because both hemicellulose and lignin make up parts of the secondary cell wall, which increases in total proportion to the cell as a whole as the plant matures. Hemicellulose is a polysaccharide similar to cellulose, but generally is not as strong as cellulose in terms of its ability to resist degradation. Lignin is a much denser polymer which is highly resistant to degradation. As the plant matures, it builds up more lignin in order to support its ever growing structure. This is the key reason why later maturing cultivars of forages are much more palatable to the grazing animal. The total amount of NDF in forage has been negatively correlated to voluntary intake by the animal (Ball et al., 2007). Thus, the greater the NDF of a particular sample, the lower the intake by that animal. As a rule, the lower the NDF value of a forage sample, the better the forage quality.

ADF (Acid Detergent Fiber)

ADF is the measure of the total non-digestible portions of cell wall material present in the forage sample. This component of forage nutritive value differs from NDF as the treatment utilizes a slightly acidic detergent solution, rather than neutral detergent solution that subsequently serves to break down the slowly digestible portions of cell wall material. The result is that the hemicellulose portion of the cell wall is dissolved in solution along with other cell soluble components, and only cellulose and lignin remain. This method is a more accurate measure of the total amount of cellulose and lignin in the plant, while accounting for ruminants being better able to digest hemicellulose than monogastric animals and thus is more valuable for ruminant nutrition (Jung, 1997). ADF has been negatively correlated to digestibility; as ADF increases, forage digestibility decreases (Ball et al., 2007). Therefore, lower ADF values are indicative of better forage quality.

CP (Crude Protein)

Proteins are essential nutrients to all living organisms. In particular, high productivity animals require this nutrient in order to sustain consistent production levels. In animal feed protein in most commonly estimated as crude protein, which is calculated from lab testing to determine the amount of available nitrogen in the sample. Ruminant animals are capable of digesting and utilizing non-protein sources of nitrogen from plant tissue that they digest due to the microflora in the rumen, and thus CP is a much more useful approximation of the amount of available protein for the animal. The standard testing method for determining nitrogen levels in a given sample of forage is known as the Kjeldahl method. Developed in the late 1800's, this procedure utilizes sulfuric acid solutions to convert nitrogen in the plant into ammonia which is then quantified. From these values, total percent N is obtained from the Kjeldahl method. A constant of 6.25 is multiplied by these percent N values in order to obtain the percentage of crude protein in a given sample (Moore, 1980). In terms of forage quality crude protein is highly valued, as the greater the protein content of the forage the more production individual animals will have, producing proteins which are used to form milk or increase their body mass. However, feeding of excess protein to animals beyond their dietary requirements will result in poor nitrogen use efficiency, as there is more protein than what that animal can readily digest and convert into milk production or muscle (Colmenero and Broderick, 2006). Protein that is not utilized will be excreted in manure and urine, and is wasted by the animal. It is important to balance the levels of protein in a feed in order to have optimum utilization by the animal while simultaneously managing costs efficiency.

IVDMD (In Vitro Dry Matter Digestibility)

Dry matter is the form in which all animal feed is commonly referred to when forage quality is reported. Moisture content of forage creates bias in the amount of actual material present in a by-weight basis, thus creating the necessity for drying forage down prior to reporting its quantity and contents. If an animal is fed based on rations calculated without taking percent dry matter of the forge into account, the actual amount of total forage, fiber, protein, and other nutrients available to the animal will be drastically different than calculated values. Therefore, it is vital to know the percent dry matter and percent moisture content of a feed at the time of ration formulation and at feeding.

Weight of feed is comprised of the amount of total dry matter and water components. Together the mass of these two equate to the total weight of the feed. However, the amount of moisture present varies widely from one feed or forage to another. This is largely based on the time of harvest and the method of harvesting. Fresh pasture will differ greatly in its moisture content from other forms, such as dried hay, baleage, or silage. In addition, environmental factors play a large role, particularly relative humidity and precipitation events. Lower relative humidity greatly increases the rate of transpiration from the plant, thus reducing the amount of moisture present in tissue. Conversely higher relative humidity slows transpiration and causes a greater moisture content to be present in the plant if harvested at this time (Rawson et al., 1977). Windy conditions at harvest can also have a large impact on transpiration, as this movement of dry air across leaf stomata will subsequently increase transpiration and lower plant moisture content.

Calculation of percent dry matter and percent moisture is conducted through a simple process of drying and weighing a representative sample of forage or feed. Representative samples vary, but commonly range from 100-500 grams. Container weight is determined prior to being filled with the representative amount of sample, and then the sample is placed into the container and weighed. Following this, the sample is dried in a forced air drying oven at 60-65°C for a period of 48 hours. Total amount of drying time can vary depending on the type of sample being used (fresh pasture, hay, etc.). Temperature should not exceed the above values, as it can damage forage samples if being analyzed for other quality components. Upon completion of drying, the sample is then weighed again to determine its dry weight. This value is divided by the weight of the sample prior to drying, in order to determine the percent dry matter of the forage sample.

In vitro analyses are lab-based methods of simulating ruminate animal digestive systems and their ability to break down forage components. Rumen fluid containing the beneficial microflora present inside the animal is collected from a cannulated cow. These animals have a cavity cut into their sides which reach inside the rumen. From here, collection of rumen fluid can be done using a syringe which reaches below the mat of solid material floating at the top of the rumen. Fluid is then promptly transferred to the lab in order to make sure rumen microflora survive, where a 48 hour digestion with that rumen fluid and a combination of buffer solutions is conducted on forage samples. Both temperature (39°C) and agitation is simulated in order to recreate conditions similar to the ruminate animal digestive system over this 48 hour period. Following this period of digestion, samples are removed from the solution and then NDF analysis is conducted upon the same samples to determine how much of each sample was successfully digested in vitro.

It is important to note that two forms of this in vitro digestibility analysis exist. The first, developed by Tilley and Terry (1963) is known as in vitro apparent digestibility, also termed in vitro dry matter digestibility (IVDMD). Procedurally, it involves a 48 hour incubation in rumen fluid, followed by a second 48 hour digestion in pepsin and hydrochloric acid solution. This method leaves behind undigested cell wall material, along with bacterial residue and other components not soluble in the pepsin and hydrochloric acid solution used in the second incubation. Its primary disadvantage is that is requires four days (96 hours) to complete the analysis. Values generated from IVDMD analysis are roughly similar to those of NDF analysis. The second form of in vitro digestibility analysis measure what is known as in vitro true digestibility (IVTD). It differs from apparent digestibility by substituting the second 48 hour pepsin/HCl incubation with traditional NDF extraction. The purpose of this NDF extraction is to remove the aforementioned rumen microflora residue left behind with the indigestible cell wall material, which the pepsin/HCl incubation cannot do. Due to substituting this second 48 hour incubation, total analysis time is shortened by 2 days. The end result of true digestibility analysis gives values which are slightly greater in digestibility than IVDMD analysis because of removal of undigested rumen microflora. Repeated testing of these two methods has resulted in calculation of a constant of 11.9% which can be subtracted from IVTD values in order to determine IVDMD (Van Soest, 1994).

Dairy Nutrition and Energy Requirements

Dairy cattle are one of the most highly demanding livestock groups in regards to their need for high energy feed (Ball et al, 2007). While beef cattle and high-activity equine (i.e. racing horses) also require high amounts of energy per day to sustain or gain body mass, dairy cattle must not only sustain body mass, but also produce consistent and high milk yields multiple times a day, each day, over the course of several months until they are dry. Much work has been done to determine the viability of various feeds to meeting the daily dietary needs of dairy cattle in order to meet these productions goals. Forages have seen the most research in this regard (Eastridge, 2006). However, the high production demands of today's dairy herds cannot be sustained or met solely with forages alone. This is because the high fiber content of forages compared to concentrate feed diets results in rapid filling of the animal's rumen. Dairy cows cannot consume more forage at this point, yet are still not meeting their dietary needs to reach or sustain high milk production levels (Mertens, 1994). To counteract this problem, producers have adopted the use of concentrate feeds (those derived from grain). These concentrate diets result in more efficient energy use by the animal, thus increasing their overall production. Forages are important to the dairy cow's digestive system and maintaining rumen health because concentrate based feeds are not part of their natural diet. Acidosis in the stomach can occur when ruminate animals are fed a diet too high in readily digestible carbohydrates, which lower the rumen pH (Krause and Oetzel, 2006). Maintaining forage in their diets prevents this digestive tract disorder. While not as energy demanding as lactating cows, dairy heifers still require high quality forages, particularly when pregnant with their first calf (Ball et al., 2007).

Chapter 2: Comparison Of Dairy Cattle Preference Among And Within Four Cool-Season Forage Grass Species

Introduction

Cool-season forage grasses have been shown to have varying ranges of palatability to the animals that consume them. Palatability is often associated with forage quality factors, such as total available forage, low fiber content, high non-structural carbohydrate levels, high crude protein, and lack of anti-quality factors such as tannins. These palatability factors give rise to animal preference between various plants in the pasture, and hence result in animals selectively grazing plants that they find to be more palatable before consuming other, less palatable, plants if given the opportunity (Mertens, 1994; Provenza, 2003). Identification of what plants are most preferred by grazing animals when given the opportunity to consume them is vital to identifying the key morphological and physiological traits which allow a plant to be more appealing to animals, and thus allow for selection and breeding in cultivar development. Due to the high correlation of forage intake and quality to dairy cattle milk production (Miller et al., 2001), it is a prime area to examine animal preference in order to determine the cool season grass that dairy cattle will most readily consume when grazing to optimize intake and milk production.

Cool-season forage grasses are widely used in dairy systems as a major source of forage biomass. Of particular interest in determining preference are four species that are most commonly found growing in dairy pastures in the central and northern United States: orchardgrass (*Dactylis glomerata* L.), tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort.], perennial ryegrass (*Lolium perenne* L.), and festulolium [x*Festulolium braunii* (K. Richt.) A. Camus.]. Each species has unique morphological traits and chemical compositions that could affect dairy cattle preference, either favorably or adversely. For example, orchardgrass has a rapid rate of regrowth following mowing or grazing, and often has a greater sward height than other species, which has been shown to be correlated to animal preference (Smit et al., 2006). On the other hand, tall fescue can have rigid and coarse leaves that might be undesirable to animals when selecting which plants to graze first. Within species, cultivar differences are less pronounced than among species differences, but do still exist. Previous work has shown that within species variation of chemical composition in perennial ryegrass cultivars led to significant preference of cultivars exhibiting higher water soluble carbohydrates and lower NDF values (Smit et al., 2006), as well as tetraploid perennial ryegrasses being more preferred than diploids due to pregrazing biomass availability (Solomon et al. 2014; Hageman et al., 1993; Vipond et al., 1993). Similar preference studies have been conducted, but are usually done only on a within cultivar basis on a single species (Waldron et al. 2010), or across a wide range of species and plant families, i.e. grasses and legumes (Horadagoda et al., 2009). Limited knowledge exists on preference within the cool-season grasses exclusively across multiple species, and even less on how dairy cattle preferences change across the growing season, based on morphological changes among different cool-season species. It is well established that cool-season grasses undergo a bi-modal pattern of growth across the growing season, with most growth occurring in the spring, a "summer slump" or reduction of growth during summer months, followed by a resurgence of growth in the early fall prior to first frost (Barnes et al., 2003). I suspect that environmental effects over the seasons will play some role in influencing animal preference.

Our primary research question was: do dairy cattle exhibit preferences among cool-season forage grasses, and if so, what are the causes of these preferences? In response to this, there were two major objectives: a) determine dairy cattle preference of cool-season forage grass species and cultivars; b) compare phenotypic traits among entries to determine the causes of these preferences. I hypothesized that: a) there would be a significant preference of at least one cool-season grass species over another, along with cultivars within species will also show preference; b) Morphological and forage quality traits would be significantly related to any observed preferences of species and cultivars.

Materials and Methods

The cool-season forage grass species, orchardgrass, tall fescue, perennial ryegrass, and festulolium, served as the four species entries for this study. Within these, cultivars were randomly selected from available germplasm to serve as individual entries, each nested within a particular species. 24 total cultivars were used, however the number of cultivars per species was unbalanced (See Appendix A for specific information on each cultivar). Eight commercial cultivars of orchardgrass were used: Persist, Potomac, Profit, Harvestar, Benchmark Plus, Prairie, Tekapo, and Prodigy. A total of six cultivars were used to represent festuloliums: Perun, Duo, Barfest, SpringGreen, KYFA1015 and KYFA1016 from the University of Kentucky. A total of five tall fescue cultivars were used: Barianne, Barolex, Jesup EF, Select, and the cultivar KYFA9611 from the

University of Kentucky. Finally, five cultivars of perennial ryegrass were chosen: Linn, Granddaddy, BG34, Power, and Calibra.

Using these 24 entries, a randomized complete block design containing six replications consisting of 144 total plots was planted at the University of Kentucky's Spindletop Research Farm in Lexington, KY in September of 2013. Randomization for each replication was done by cultivar. Each plot was 1x3m long, with border alleys intersecting each range at the ends of the plots. The total dimensions of the study were 24m long by 16m wide. Plots run from north to south in a serpentine pattern so that each replication is 3m wide and 24m long. Plots were planted with a five-row Carter self-propelled, walk-behind planter at a seeding rate of 23 kg/ha in order to create sward plots for each entry. These plots were allowed to overwinter and resume growth at the beginning of the 2014 growing season.

An important goal of this study was to eliminate potential bias of animal preference due to varying maturity rates (timing of reproductive growth) of the different species and within-species cultivars of cool-season grasses used in this study. For example, orchardgrass matures earlier on than other cool-season species, and perennial ryegrass is often one of the latest maturing species. It has been observed that grazing animals are selective against plants that have a low leaf:stem ratio, i.e. they eat plants that have more leaf tissue than stems (Barnes et al., 2003; Harrison et al., 2003). As grasses mature, they develop reproductive tillers which become hard and lignified, and are not readily digestible in the rumen of dairy cattle. Thus if given the choice between a plot in vegetative growth or a plot in reproductive growth, they would first eat the vegetative plot. In our case, if animals were allowed to graze the first flush of reproductive growth, it would bias their preferences away from early maturing cultivars or species. The method for controlling this bias was adapted from a similar study where animals are only grazing on vegetative regrowth, rather than the initial flush of reproductive growth in early spring (Hitchcock et al., 1990). In each year of the study all plots were allowed to reach 50-75% seed-head emergence from the boot stage. At this stage of growth, the entire study was cut at a height of 7cm using a Hege 212 forage harvester to remove all of the reproductive growth and allow for only vegetative regrowth to occur and be grazed the remainder of the growing season. Accommodating this aspect of the study meant waiting until the third week of May in both 2014 (May 19) and 2015 (May 18) in order to cut the crop and return all of the plots to strictly vegetative growth.

Following removal of reproductive growth from the plots, I prepared for our grazing sessions to determine dairy cattle preference. Trials took place on the following dates: Trial 1, June 5, 2014; Trial 2, July 17, 2014; Trial 3, Sept. 23, 2014; Trial 4, June 11, 2015; Trial 5, July 30, 2015; and Trial 6, Sept. 1, 2015. Given the relatively small area of the study, roughly 0.04 hectare, only 3-4 animals were able to graze the plots at any one time in order to prevent competition with each other and allow them to select freely between various swards. In both 2014 and 2015 the dairy herd consisted of yearling Holstein-Friesian heifers. Each session lasted for a period of 5-6 hours, depending on how rapidly the animals consumed the available forage. I did not want to leave them on so long that everything would be eaten, but long enough so that clear differences could be observed between plots, with our aim being to achieve approximately 50% consumption of available forage

During each grazing session, a number of morphological traits were measured, henceforth referred to as the "Pre-grazing" and "Post-grazing" traits. Determining these variables allowed us to determine if preference actually was observed and if these factors were involved in affecting animal preference. Of most importance in determining preference were Pre-grazing and Post-grazing dry matter yields of each plot. These were taken before and after each grazing session using Ariens 55 cm deck-width push mowers, and mowing across the 1m width of each plot. Each sample was then bagged and weighed for fresh and dry weight to determine percent dry matter. The difference between the pre and post dry weights was used to determine the percentage of total plot consumption. For our purposes, the greater the percentage consumed, the greater the preference for that plot. Pre and post sward heights were also measured in each plot. Three measurements per plot were taken for each grazing session and averaged to get a mean height for each plot. Following each grazing session, plots were reset by clipping to a height of 7.5cm. This was conducted on June 6, 2014 for Trial 1, July 18, 2014 for Trial 2, Sept. 24, 2014 for Trial 3, June 12, 2015 for Trial 4, July 31, 2015 for Trial 5, and Sept. 2, 2015 for Trial 6. After this, fertilization of 13.6kg of nitrogen using granular urea was applied to initiate regrowth for the next grazing trial.

After weighing of samples for yield data, each was ground to prepare for forage quality analysis. Samples were first run through a Wiley Mill grinder using a 4mm mesh screen, followed by a second grinding using a UDY Cyclone Mill with a 1mm mesh screen. These samples were then placed into cups and analyzed for forage quality components using a FOSS 6500 NIRS (Near Infrared Spectroscopy) machine. Samples were scanned into the FOSS 6500 to obtain spectrum data, which was then used to determine samples to run for wet lab chemistry to develop a calibration for NDF (Neutral Detergent Fiber), ADF (Acid Detergent Fiber), IVTD (In-Vitro True Digestibility), and CP (Crude Protein). ANKOM Fiber digesters and protocol from ANKOM were utilized to conduct NDF, ADF, and IVDMD analysis on these 88 samples. Crude protein analysis was conducted externally at the University of Kentucky by Jim Crutchfield in the Department of Plant and Soil Sciences using the Kjeldahl method. Once these four variables were determined for the 88 samples tested, the calibration equation was developed to predict NDF, ADF, IVDMD, and CP for the remaining samples.

Statistical analysis was performed using SAS 9.3 software and assistance was provided by Dr. Ben Goff of UK's Department of Plant and Soil Science, as well as Edward Roualdes and Sarah Janse, College of Agriculture, Food and Environment consultants from the University of Kentucky Department of Statistics Applied Statistics Lab. Split-plot-in-time analysis using PROC GLM was used to analyze the data set. Our statistical model is: $Y_{ijkl}=\mu+B_i+S_j+BS_{ij}+V_{k(j)}+BV_{ik(j)}+T_l+BT_{il}+ST_{jl}+VT_{kl}+BST_{ijl}+BVT_{ikl(j)}$

In which B=replication, S=species, V=cultivar, and T=trial. In our RCBD, replication, cultivar, and trial were treated as random effects, while species was treated as a fixed effect. Cultivar was also nested within species. Because grazing studies are highly variable, an alpha level of 0.10 was selected to determine significant differences for all variables. Analysis of variance (ANOVA) was conducted on the following response variables: pre and post yield, pre and post sward height, percent consumption, pre and post moisture content, visual ratings, pre and post NDF, pre and post ADF, pre and post IVDMD, and pre and post CP. LSMEANS were determined for species and cultivar. In addition to ANOVA, Pearson's Correlation Coefficients were determined for the above response variables using PROC CORR, and evaluated to determine if any correlation to percent consumption could be derived. Each grazing trial was analyzed separately from each other, due to a highly significant trial effect ($P<.001$) for every trial. Therefore at each trial, the model used is $Y_{ijk}=\mu+B_i+S_j+BS_{ij}+V_{k(j)}+BV_{ik(j)}$.

Results

Species Treatment

The primary trait of interest in this study is percentage of forage consumed, which was measured during each of the six grazing trials conducted across two years. Because of a significant trial*species interaction effect ($P<.0001$), each trial was analyzed separately to determine specific treatment effects related to percent consumption and all other morphological and chemical analysis variables.

Morphological Data Relevant to Species

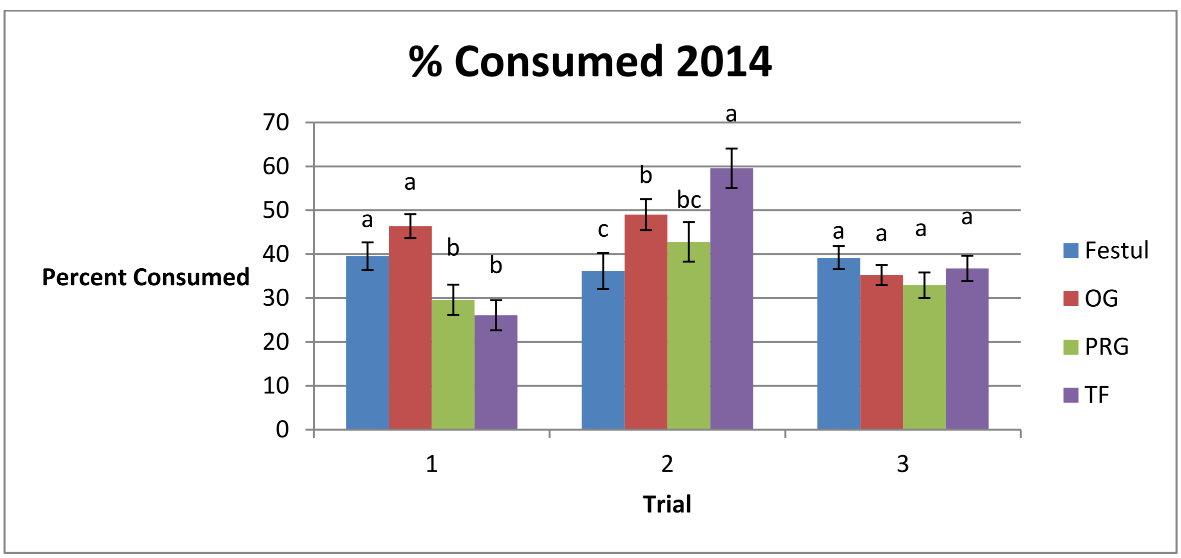

Figure 2.1: Species Consumption 2014, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

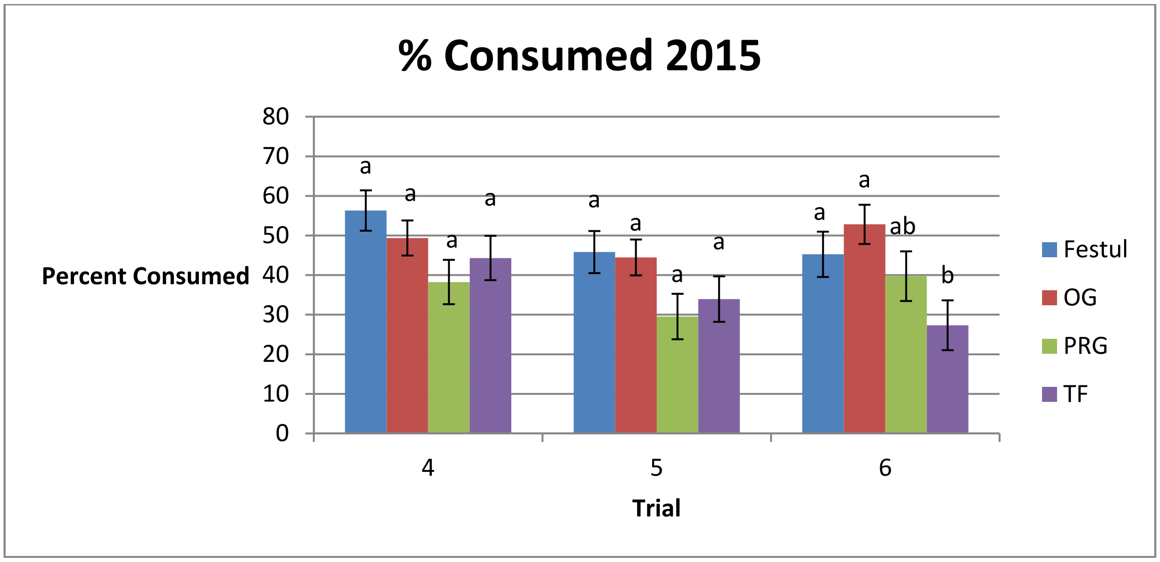

Figure 2.2: Species Consumption 2015, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

Consumption/Preference

Trials 1 and 2 (Figure 2.1) showed a significant difference (P<.10) in the percentage of consumed forage for the species treatment. In Trial 1, orchardgrass (46%) and festulolium (39%) were the most consumed, and by our definition the most preferred, species. Perennial ryegrass (29%) and tall fescue (26%) were significantly lower in their total consumption than both orchardgrass and festulolium. Ranking of consumed species from greatest to lowest were as follows: orchardgrass, festulolium, perennial ryegrass, and tall fescue. In Trial 2, Tall fescue was the most consumed species (59%). Orchardgrass (49%) and perennial ryegrass (43%) follow and were not significantly different from each other. Finally, the least consumed species was festulolium (36%), which is not significantly different from perennial ryegrass. Ranking of species in this trial were: tall fescue, orchardgrass, perennial ryegrass, and festulolium.

In trials 3, 4, and 5 there were no differences observed (P>.10) among the species treatment for percentage of forage consumed.

Finally, trial 6 (Figure 2.2) showed different consumption (P<.10) for the species treatment. Orchardgrass was the most consumed species (56%). festulolium was the next most consumed (45%), and was not statistically different from orchardgrass and perennial ryegrass, which was the third most consumed (39%). Perennial ryegrass was statistically different from orchardgrass, but not from tall fescue, the least consumed species (27%).

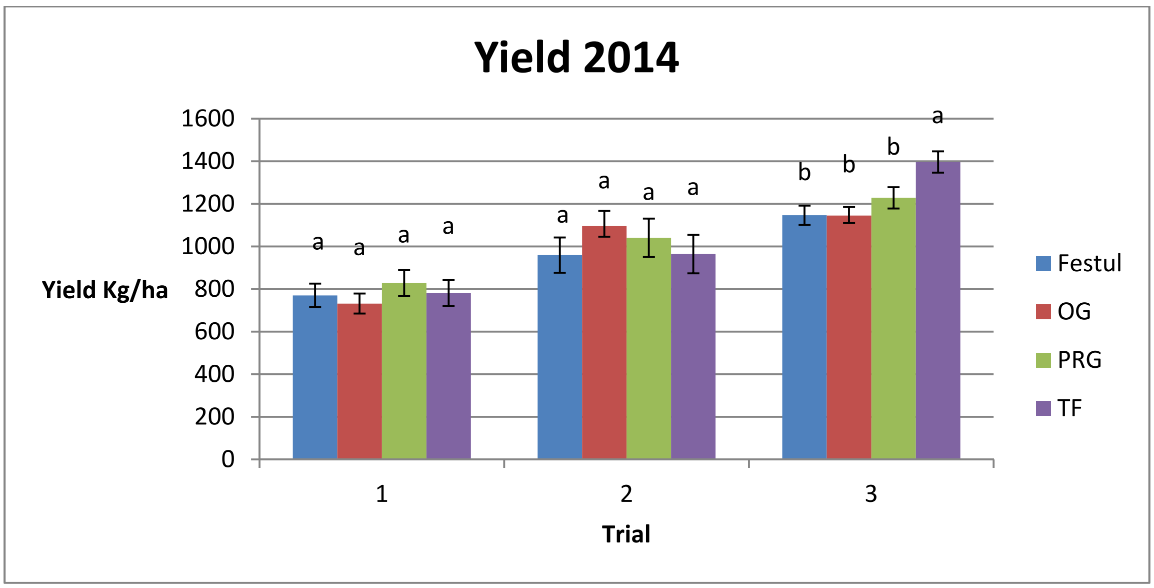

Figure 2.3: Species Yield 2014, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

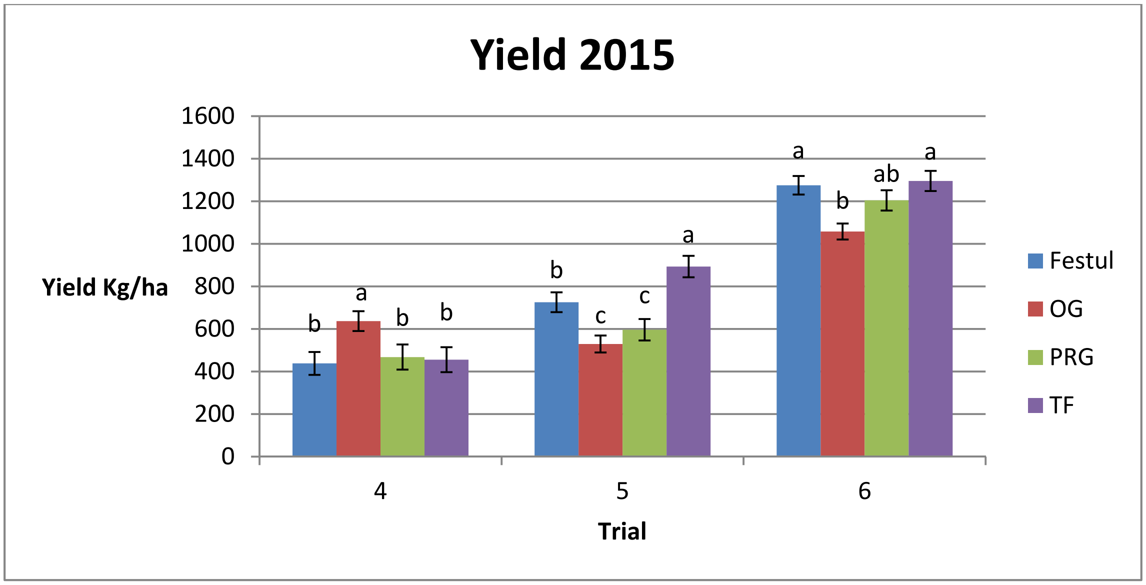

Figure 2.4: Species Yield 2015, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

Yield

Pre-grazing yield (available forage) was not different among species treatments in trials 1 and 2 (Figure 2.3). However, a significant differences among the species was present in trials 3 (P=.0036), 4 (P=.0337), 5 (P=.0001) and 6 (P=.002). In trial 3, tall fescue had significantly greater yield (1397 kg/ha) than orchardgrass (1229 kg/ha), perennial ryegrass (1146 kg/ha), and festulolium (1147 kg/ha). Trial 4 (Figure 2.4) showed that orchardgrass had a significantly greater yield (637 kg/ha) than perennial ryegrass (468 kg/ha), tall fescue (456 kg/ha), and festuloliums (438 kg/ha). Trial 5 showed that tall fescue was the greatest yielding species (894 kg/ha), greater than festulolium, which was the second highest yielding (726 kg/ha). Festulolium was significantly greater in yield than perennial ryegrass (596 kg/ha) and orchardgrass (530 kg/ha), which were the lowest yielding species. Lastly, trial 6 results show that tall fescue had the greatest yield (1295 kg/ha), followed closely by festulolium (1275 kg/ha); the two were not different from each other. Perennial ryegrass was the third highest yielding species (1204 kg/ha), but was not different from any species. Orchardgrass was the lowest yielding species (1057 kg/ha) and was lower yielding than tall fescue and festulolium.

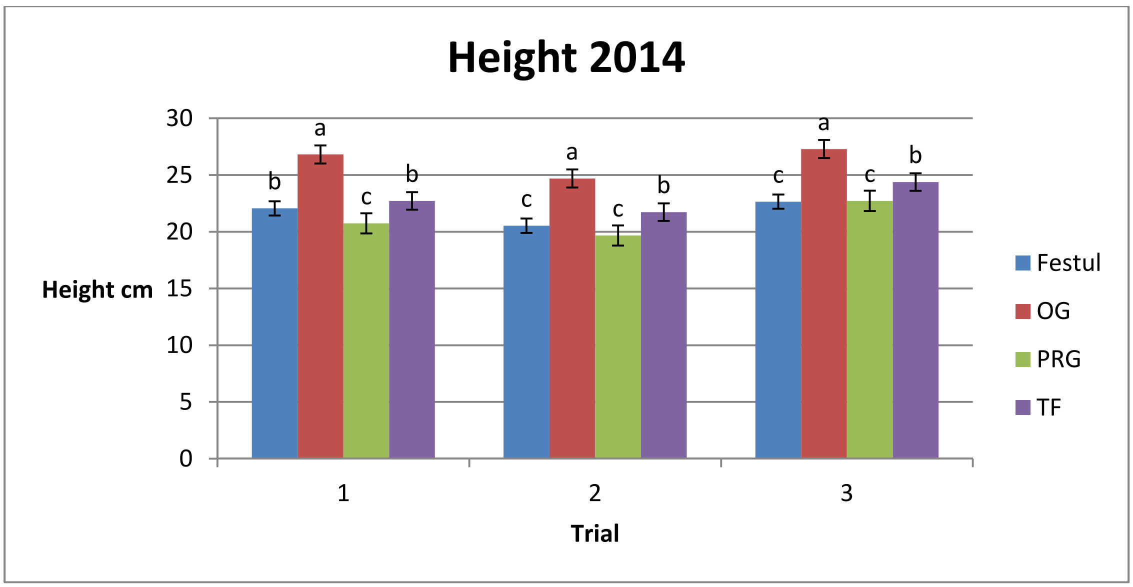

Figure 2.5: Species Height 2014, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

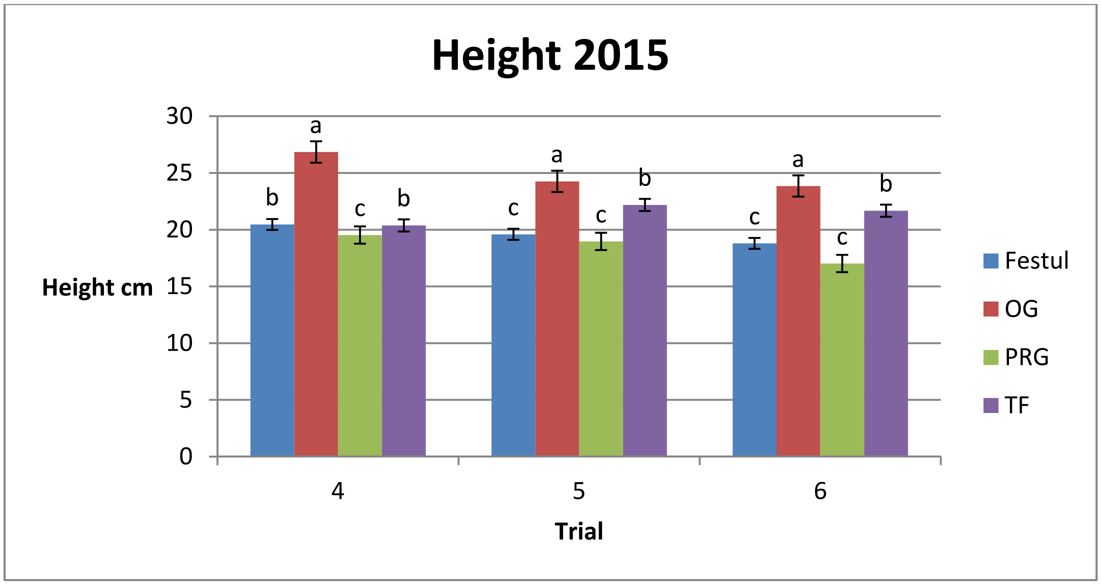

Figure 2.6: Species Height 2015, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

Sward Height

Height differences were present among the species in all six trials, and were fairly consistent (Figures 2.5 and 2.6). Trial 1 results showed orchardgrass had the greatest height (27 cm). Tall fescue (23 cm) and festulolium (22 cm) follow, and were lower in height than orchardgrass, but not different from each other. Perennial ryegrass was the shortest species (21 cm) and was lower than all other species. Trial 2 results again show orchardgrass to be the tallest species (25 cm) and greater than all other species. Tall fescue (22 cm) and festulolium (21 cm) were not different from each other, but were different from perennial ryegrass (20 cm). Trial 3 showed that orchardgrass was the tallest species (27 cm), and was greater than all other species. Tall fescue (24 cm) was shorter than orchardgrass, but taller than festuloliums (23 cm) and perennial ryegrass (23 cm). Trial 4 results show orchardgrass at a greater height (27 cm) than the other three species; tall fescue (20 cm), festulolium (20 cm), and perennial ryegrass (19 cm). Trial 5 showed orchardgrass to be the tallest species (24 cm), followed by tall fescue (22 cm). Tall fescue was in turn taller than both perennial ryegrass (19 cm) and festulolium (19 cm). Finally, trial 6 results once again showed orchardgrass (24 cm) to be the tallest species. Tall fescue (22 cm) was the second tallest species, and was shorter than orchardgrass, but taller than festuloliums (19 cm) and perennial ryegrass (17 cm). Festulolium was also taller than perennial ryegrass.

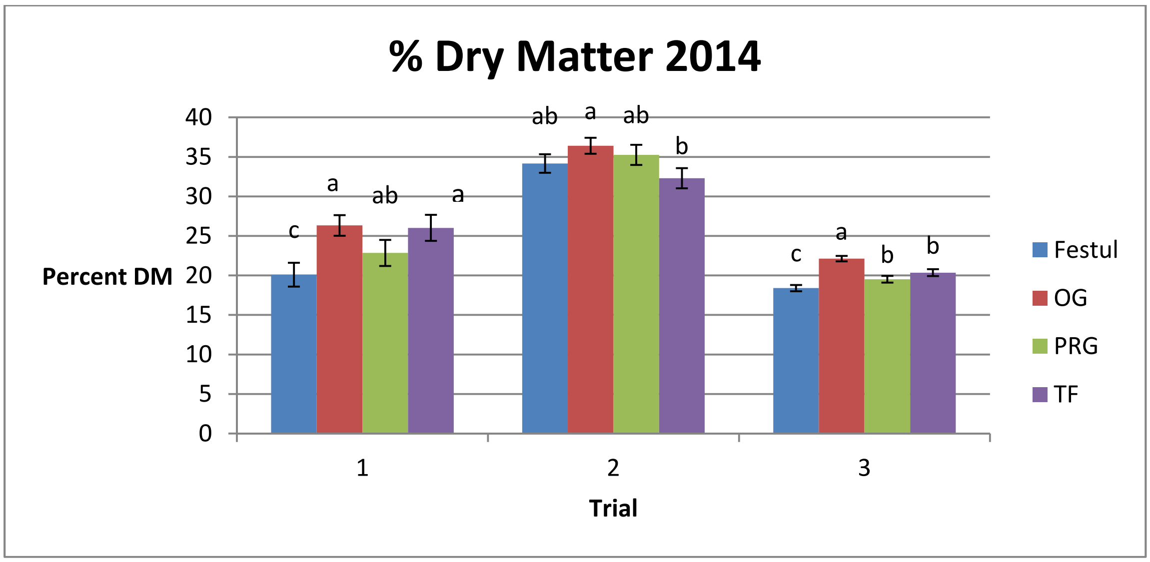

Figure 2.7: Species Dry Matter 2014, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

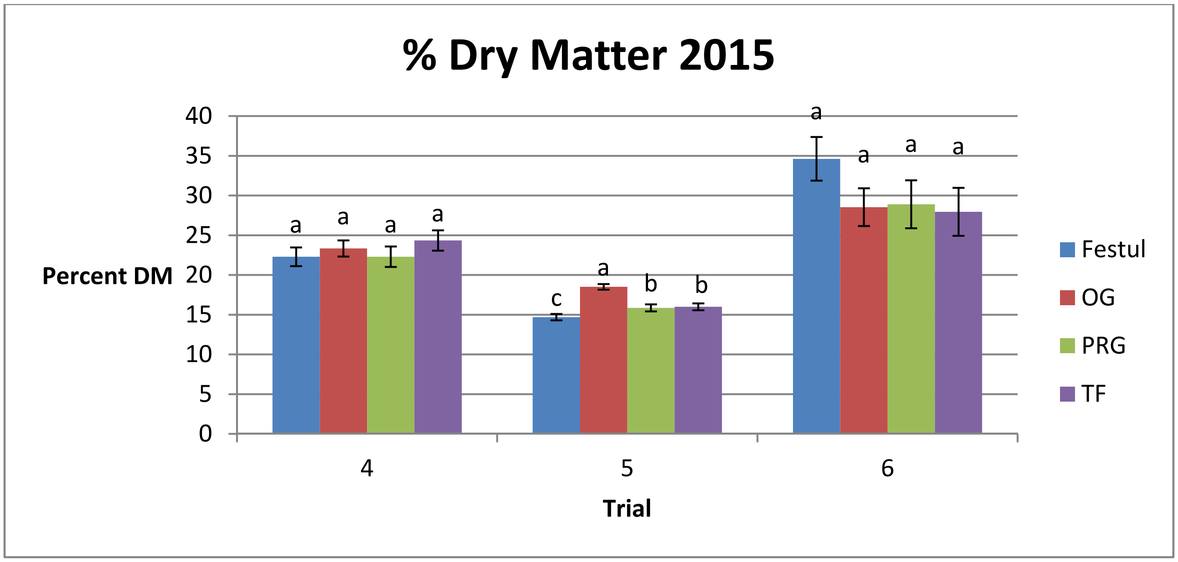

Figure 2.8: Species Dry Matter 2015, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

Dry Matter Content

The final morphological characteristic measured for each species was percent dry matter (Figures 2.7 and 2.8). Trial 1 showed orchardgrass and tall fescue to have the greatest mean percent dry matter (26%) which was greater than the lowest rank, festulolium (20%). Perennial ryegrass (23%) was not different from any of the species. In trial 2 the only differences were between orchardgrass (36%) and tall fescue (32%). Festulolium (34%) and perennial ryegrass (35%) were not different from any other species. Trial 3 results showed that orchardgrass again had the greatest amount of dry matter (22%), and was different from all other entries. Tall fescue and perennial ryegrass (20%) were not different from each other, but greater than festulolium (18%). Trial 4 was not significant for dry matter variation among species. Trial 5 results mirror those of trial 3, as orchardgrass had the greatest dry matter (18%), tall fescue and perennial ryegrass grouped together (16%), and festulolium had the lowest value (14%). Finally, trial 6 did not show any differences in dry matter content.

Chemical Analysis Data Relevant to Species

Chemical analysis results of forage quality constituents were fairly consistent from one trial to the next. Those species that have greater values for detergent fiber categories, NDF and ADF, tend to have inherently lower values for IVTD and CP, but there were exceptions.

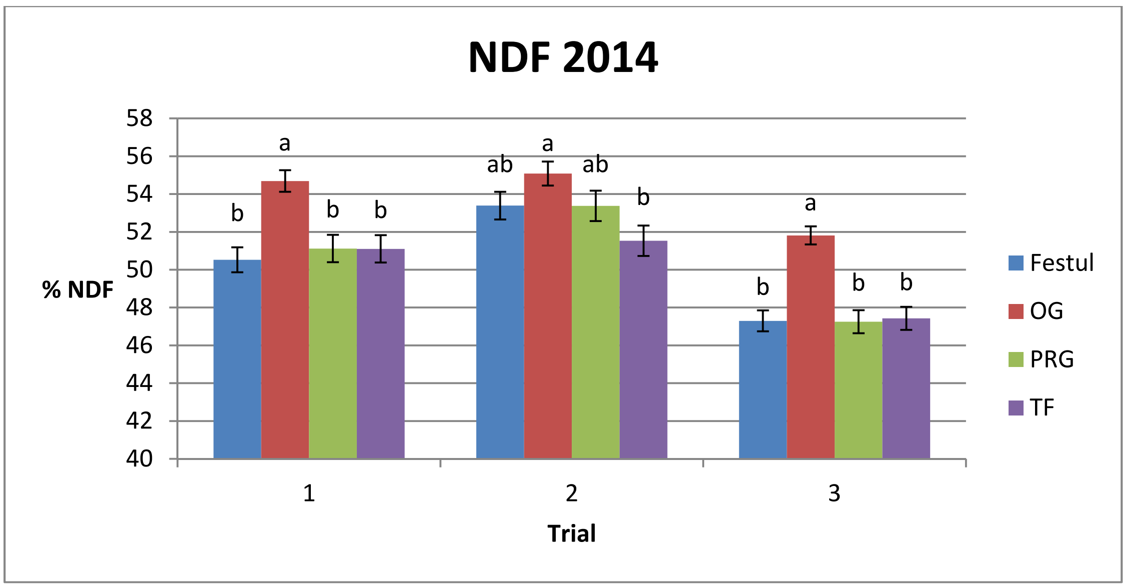

Figure 2.9: Species NDF 2014, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

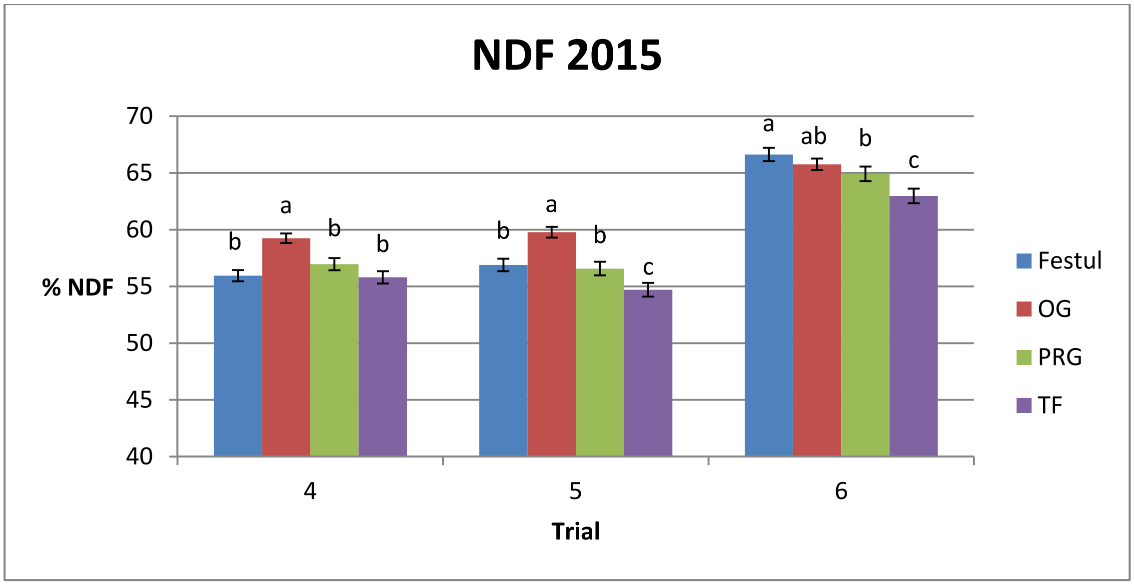

Figure 2.10: Species NDF 2015, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

NDF

NDF analysis (Figures 2.9 and 2.10) across the six trials tended to show orchardgrass as a species having the highest NDF values. All trials showed orchardgrass ranking greatest in NDF value except trial 6, and trials 1, 3, 4, and 5 showed it to be different from all other species. Every trial also ranked tall fescue as the species with the lowest NDF value. The greatest range of differences for NDF was 5%, found in trials 3 and 5. All other trials had a range of NDF mean values between species between 3% and 4%. NDF values in trials 5 and 6 were greater than those of previous trials, likely because of encroachment of crabgrass (See Appendix B) in the mid to late summer. This also explains why festulolium had a greater NDF than orchardgrass in trial six.

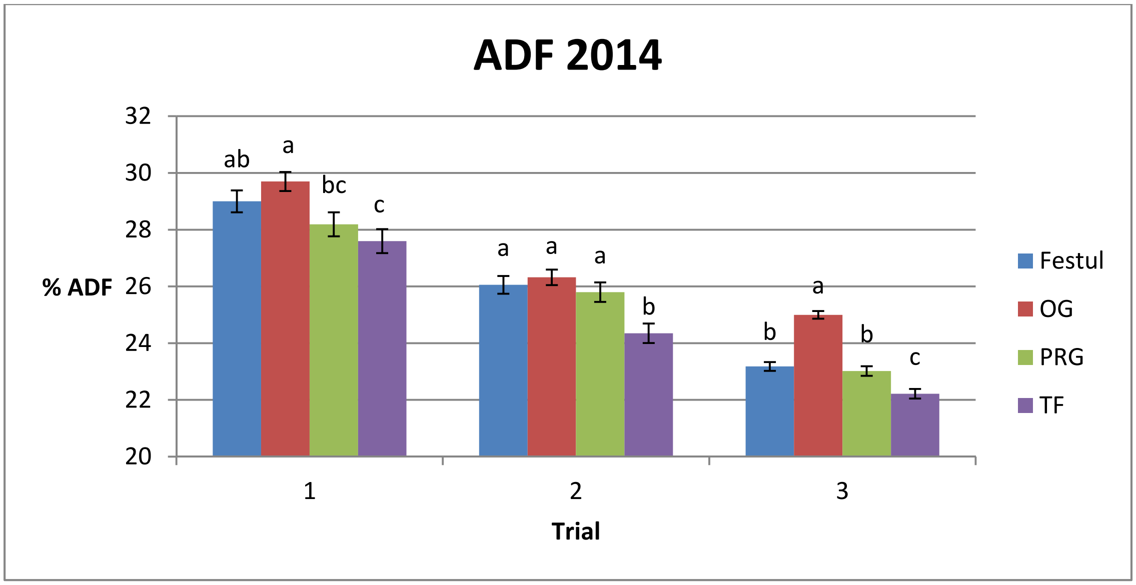

Figure 2.11: Species ADF 2014, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

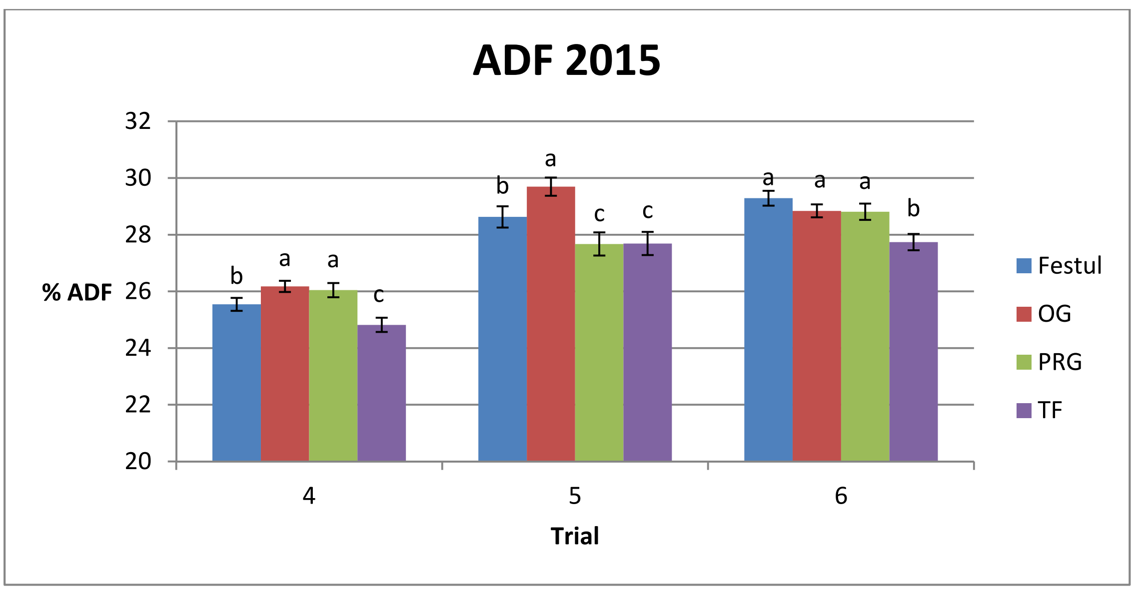

Figure 2.12: Species ADF 2015, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

ADF

Similar to NDF results, ADF analysis (Figures 2.11 and 2.12) across the six trials showed that orchardgrass had the largest ADF mean, and that tall fescue had the lowest ADF mean at every trial. In trials 1 and 5, perennial ryegrass shared the lowest ranking with tall fescue. As with the NDF variable, the range of differences in ADF values between species was relatively small, ranging from 1% to 3% across all six trials, despite differences being present between species at every trial.

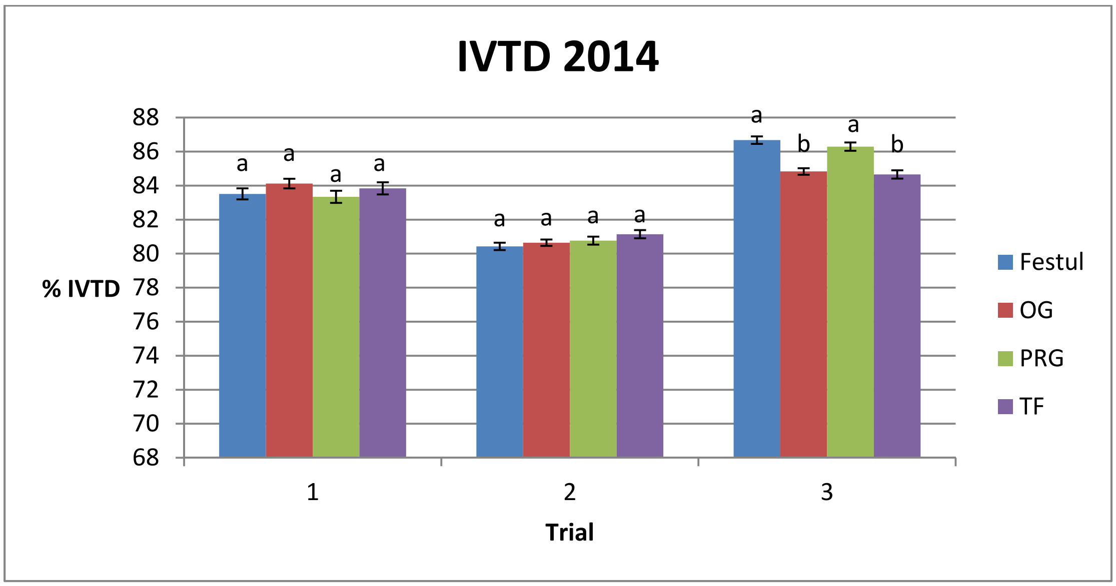

Figure 2.13: Species IVTD 2014, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

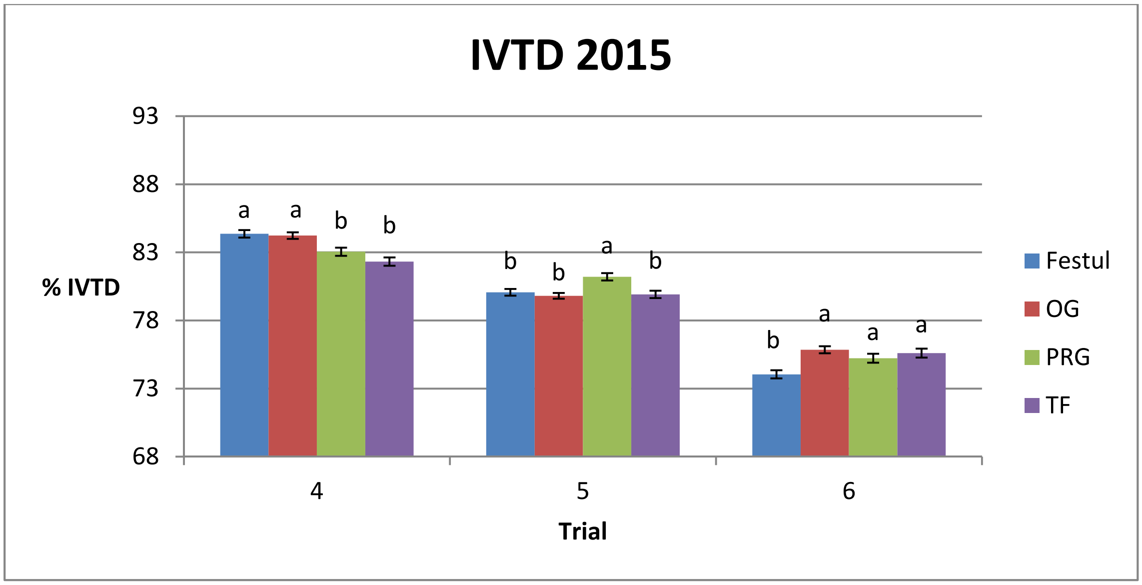

Figure 2.14: Species IVTD 2015, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

IVTD

Conversely to NDF and ADF, IVTD (Figures 2.13 and 2.14) was not different at every trial. Only trials 3-6 showed different IVTD means for the species tested. However, the range of differences was never greater than 1%, showing that total digestibility for each species on average did not vary greatly within each trial. Trials 3 and 5 show that orchardgrass, which had greater NDF and ADF values, averaged a lower IVTD value than at least one other species, but it was never tall fescue, which consistently had the lowest NDF and ADF values. IVTD values in trial 6 were noticeably lower than all other trials, likely because of crabgrass becoming prevalent in between trials 5 and 6.

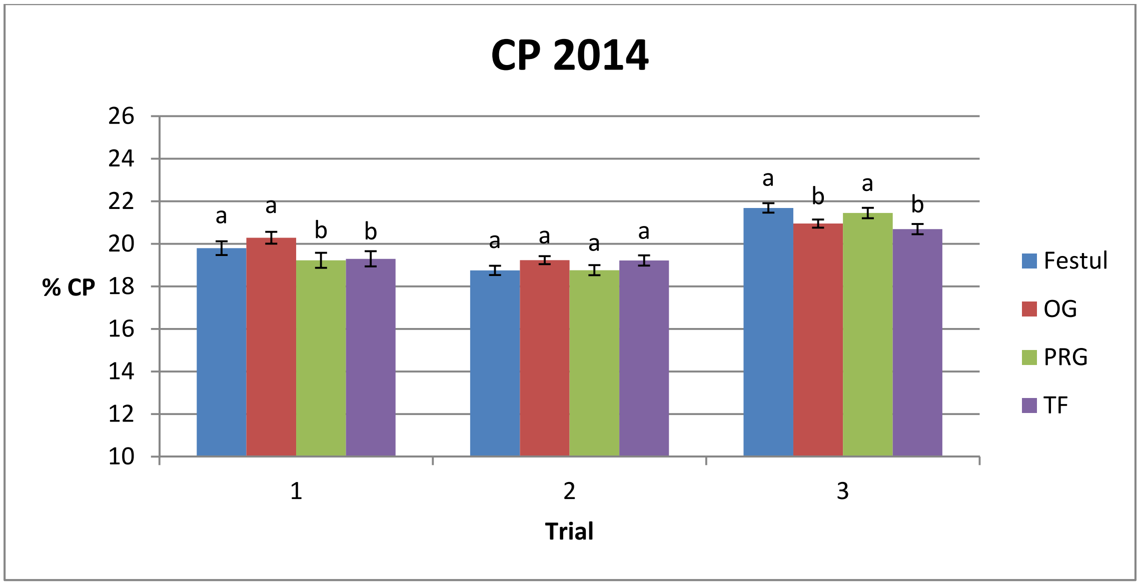

Figure 2.15: Species CP 2014, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

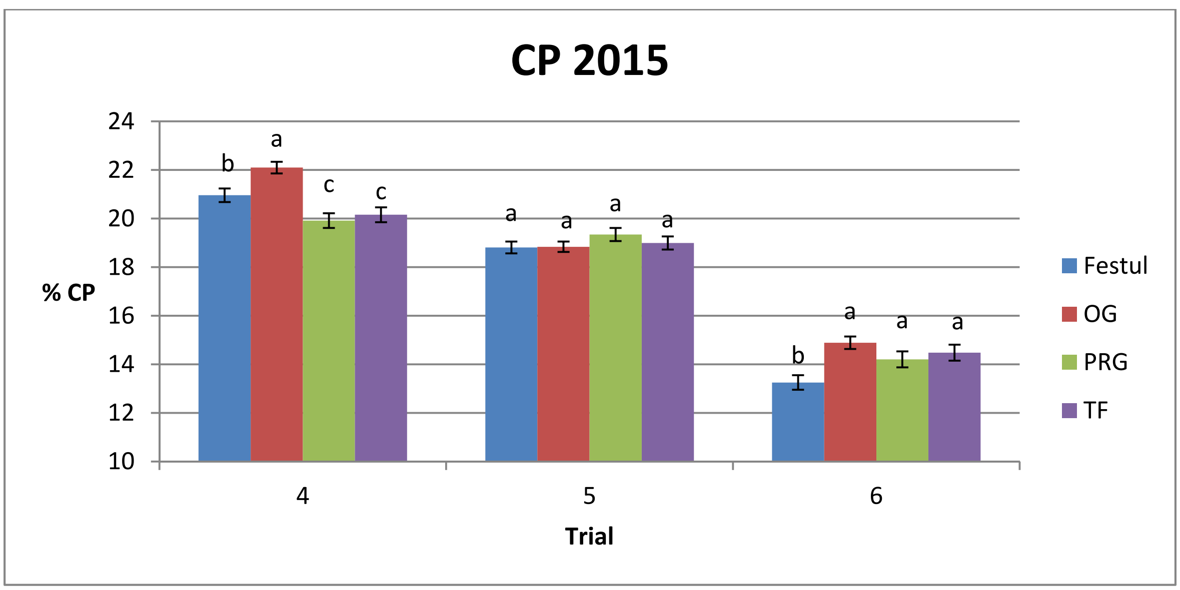

Figure 2.16: Species CP 2015, Festul= festulolium (blue), OG= orchardgrass (red), PRG= perennial ryegrass (green), TF= tall fescue (purple)

CP

Crude protein (CP) values (Figures 2.15 and 2.16) were different in trials 1, 3, 4, and 6. Similar to IVTD, however, the CP values had a small range, and never exceeded 2%. This narrow range and lack of clear patterns make it difficult to assess which species has consistently high or low CP values. As with IVTD and NDF, CP was negatively affected by crabgrass encroachment during trial 6, the final grazing session in 2015. The relatively high CP values in trials 1-5 likely were a result of our uniform fertilization of the plots after every grazing session with 13.6kg of nitrogen fertilizer.

Cultivars within Species Treatment

In addition to analyzing the effect of species on percent consumption/preference and our other traits, I also wished to analyze the effect of cultivar. Because I have 24 cultivar entries across multiple species, analyzing cultivar effects across all four species, while possible, makes drawing of clear conclusions difficult, due to the fact of its nesting within species. Therefore, at each trial species, were also separated from cultivar, and one can see the means of individual cultivars within each of our four species separately from another.

Morphological Data Relevant to Cultivars within Species

Table 2.1: Festulolium Cultivar Morphological Characteristics: %Consumed= Percentage of forage consumed, Pre-Yield=Yield prior to grazing, Pre-height=Sward height prior to grazing, Pre-%DM=Percentage of dry matter content prior to grazing

		Festulolium Cultivars							
Trial	**Variable**	**Barfest**	**Duo**	**KYFA1015**	**KYFA1016**	**Perun**	**SpringGreen**	**$LSD_{\alpha=0.10}$**	**P-Value**
1	**% Consumed**	32	36	41	42	52	34	-	0.2503
	Pre-yield	798	729	743	713	905	730	-	0.1943
	Pre-height	22	21	21	22	24	23	-	0.215
	Pre-%DM	20b	22a	20b	21ab	18c	19bc	1.7	*0.0122
2	**% Consumed**	40	42	22	36	48	28	-	0.1194
	Pre-yield	1173	967	853	892	993	876	-	0.1138
	Pre-height	21ab	19c	19c	20bc	22a	21ab	1.5	*0.0078
	Pre-%DM	31	39	37	34	31	34	-	0.1691
3	**% Consumed**	33	42	40	38	38	44	-	0.9002
	Pre-yield	1026	1124	1156	1222	1166	1182	-	0.496
	Pre-height	23	22	22	22	24	23	-	0.3787
	Pre-%DM	18	19	18	19	17	18	-	0.1617
4	**% Consumed**	46	72	56	49	62	51	-	0.1749
	Pre-yield	322	553	397	384	593	378	-	0.2411
	Pre-height	19c	19c	20bc	20bc	23a	21b	1.3	*0.001
	Pre-%DM	20	33	21	20	19	21	-	0.4766
5	**% Consumed**	53	53	36	41	41	43	-	0.8421
	Pre-yield	543	641	785	782	824	791	-	0.6776
	Pre-height	19	19	19	19	21	19	-	0.49
	Pre-%DM	12	15	15	16	14	14	-	0.1265
6	**% Consumed**	72a	52ab	26c	40bc	34bc	45bc	25.4	*0.0704
	Pre-yield	1283	1280	1192	1303	1264	1326	-	0.9778
	Pre-height	18bc	17c	18bc	18bc	21a	19b	1.7	*0.0052
	Pre-%DM	29	29	30	29	29	28	-	0.3928

Festulolium

Consumption/Preference

Cultivars within festulolium were not significantly different (P>.10) in consumption in trials 1-5. Trial six did show significant difference in consumption between festulolium cultivars, with Barfest (76%) and Duo (52%) exhibiting the greatest means. Experimental population KYFA1015 was consumed the least (26%). This striking difference is likely a factor of crabgrass weeds during the sixth trial. Consistently high consumption across both years for cultivars was not observed. Only in trials 1 and 2 was the cultivar Perun consumed the most at both time points.

Yield

Festulolium cultivars did not differ from each other at any trial. Perun, Barfest, and Duo appear to have the greatest yields out of the six cultivars tested, and the greatest between the three varies from trial to trial.

Height

Differences in height were observed in trials 2, 4, and 6. However, in all trials regardless of significance, Perun was found to be the consistently tallest cultivar of festulolium tested. Duo ranked consistently as one of the shortest cultivars.

Dry Matter Content

Percentage of dry matter only differed between cultivars in trial 1. Duo was the cultivar that exhibited the greatest amount of dry matter (22%), and it also was consistently one of the highest ranking cultivars in terms of dry matter at other trials. Perun possessed the lowest dry matter content in trial 1 (18%) and at all other trials except trials 5 and 6.

Table 2.2: Orchardgrass Cultivar Morphological Characteristics: %Consumed= Percentage of forage consumed, Pre-Yield=Yield prior to grazing, Pre-height=Sward height prior to grazing, Pre-%DM=Percentage of dry matter content prior to grazing

		Orchardgrass Cultivars									
Trial	**Variable**	**Benchmark**	**Harvestar**	**Persist**	**Potomac**	**Prairie**	**Prodigy**	**Profit**	**Tekapo**	**$LSD_{\alpha=0.10}$**	**P-Value**
1	**% Consumed**	53	30	57	50	46	35	48	52	-	0.4198
	Pre-yield	870ab	645c	886a	788abc	681bc	945a	668c	368d	202	*0.0008
	Pre-height	29a	25c	27bc	27bc	28ab	29a	27bc	23d	1.6	*<.0001
	Pre-%DM	22c	28b	27bc	23bc	25bc	23bc	23bc	39a	5.9	*0.0004
2	**% Consumed**	39	39	64	58	55	48	45	43	-	0.6799
	Pre-yield	1111ab	860bc	1342a	1218ab	1195ab	1453a	938bc	641c	376	*0.0171
	Pre-height	24bc	24bc	25b	24bc	25bc	28a	24bc	22c	2.4	*0.0103
	Pre-%DM	37	38	36	37	35	31	37a	37a	-	0.2076
3	**% Consumed**	31	24	35	39	32	43	41	35	-	0.6711
	Pre-yield	1261a	1013bc	1293a	1153ab	1121ab	1222a	1192ab	905c	204	*0.0462
	Pre-height	30a	28abc	29ab	25d	28abc	26dc	27bcd	25d	2.3	*0.009
	Pre-%DM	21	22	22	22	23	21	21	23	-	0.7277
4	**% Consumed**	45	47	30	64	59	51	50	49	-	0.3352
	Pre-yield	791ab	599bcde	492de	817a	746abc	645abcd	563cde	439e	199	*0.0203
	Pre-height	29	27	25	27	28	26	27	26	-	0.1003
	Pre-%DM	22c	23bc	23bc	25a	24ab	23bc	22c	25a	1.2	*0.0118
5	**% Consumed**	31cd	35bcd	47abc	43abc	59ab	18d	63a	58ab	24.6	*0.0432
	Pre-yield	417b	511b	866a	521b	371b	511b	511b	524b	224	*0.0356
	Pre-height	26ab	24abc	27a	24abc	21c	24abc	22c	23bc	3.2	*0.0722
	Pre-%DM	20	18	16	20	18	18	18	19	-	0.3471
6	**% Consumed**	55abc	41bc	46bc	39c	78a	38c	58abc	67ab	23	*0.0533
	Pre-yield	1140	1003	1078	1111	971	883	1202	1072	-	0.9568
	Pre-height	27a	24bc	24bc	25ab	22cd	24bc	24bc	21d	2.2	*0.0163
	Pre-%DM	29	25	25	29	29	29	30	30	-	0.6705

Orchardgrass

Consumption/Preference

Of the eight cultivars of orchardgrass used, no significant difference in consumption was found during trials 1-4. Trials 5 and 6 did show differences in consumption, with Profit (63%) and Prairie (59%) being the most consumed in Trial 5, and Prairie (78%) was most consumed in trial 6. Prodigy was the least consumed in both trial 5 (18%) and trial 6 (38%). Consistently high consumption was again not found for cultivars.

Yield

Orchardgrass yields were significantly different across trials 1-5, but not different in trial 6. Persist, Prodigy, and Benchmark Plus were the three cultivars of the eight tested that ranked as the greatest yielding cultivars from trial to trial. Tekapo was always the lowest yielding cultivar, but that is due to heavy stand loss over the first winter of the study post-planting (winter 2013-2014), indicating Tekapo has a lack of winter-hardiness compared to other cultivars.

Height

Cultivars within orchardgrass seem to exhibit the greatest variation in height, as cultivars were significantly different at every trial except trial 4. Prodigy, Persist, and Benchmark Plus all were ranked as the tallest cultivar in at least one trial. Tekapo and Prairie were consistently the shortest cultivars.

Dry matter Content

Cultivars were significantly different in trials 1 and 4, and at both trials Tekapo ranked as the cultivar with the greatest dry matter content (39% and 25% respectively.)

Table 2.3: Perennial Ryegrass Cultivar Morphological Characteristics: %Consumed= Percentage of forage consumed, Pre-Yield=Yield prior to grazing, Pre-height=Sward height prior to grazing, Pre-%DM=Percentage of dry matter content prior to grazing

		Perennial Ryegrass Cultivars						
Trial	**Variable**	**BG34**	**Calibra**	**Granddaddy**	**Linn**	**Power**	**$LSD_{\alpha=0.10}$**	**P-Value**
1	**% Consumed**	30	30	27	30	32	-	0.9982
	Pre-yield	1052a	847b	716bc	655c	870ab	190	*0.0166
	Pre-height	21b	21b	21b	17c	23a	1.4	*<.0001
	Pre-%DM	25a	20b	24a	25a	20b	2.4	*0.0004
2	**% Consumed**	38	47	45	38	45	-	0.745
	Pre-yield	1280a	993bc	883c	853c	1192ab	250	*0.0286
	Pre-height	21a	19ab	19ab	18b	21a	2	*0.0748
	Pre-%DM	36a	36a	38a	38a	28b	5.4	*0.0212
3	**% Consumed**	36	38	28	22	40	-	0.4417
	Pre-yield	1398a	1065c	1284ab	1222abc	1173bc	194	*0.0812
	Pre-height	23	22	23	23	23	-	0.4437
	Pre-%DM	22a	17d	20ab	19bc	18cd	1.5	*0.0017
4	**% Consumed**	49ab	59a	28cd	13d	40bc	16.7	*0.0013
	Pre-yield	635a	593ab	391bc	303c	417ab	223	*0.086
	Pre-height	21	20	19	18	20	-	0.1713
	Pre-%DM	25a	21b	22b	22b	20b	2.7	*0.0438
5	**% Consumed**	22	34	15	35	41	-	0.3417
	Pre-yield	576	563	671	638	531	-	0.5806
	Pre-height	21	18	19	18	19	-	0.2901
	Pre-%DM	17	15	16	16	16	-	0.322
6	**% Consumed**	36	57	22	31	51	-	0.1682
	Pre-yield	1111	1244	1290	1150	1225	-	0.9322
	Pre-height	17	17	17	16	17	-	0.7518
	Pre-%DM	29	28	28	30	29	-	0.2554

Perennial Ryegrass

Consumption/Preference

Cultivars of perennial ryegrass were only significantly different in consumption in trial 4. Calibra (59%) was found to be the most consumed cultivar, and Linn (13%) the least consumed. Calibra and Power fluctuate from trial to trial as being the cultivars with the greatest mean consumption.

Yield

Cultivars of perennial ryegrass were significantly different in yield due in trials 1-4. BG34 was very consistent as the greatest yielding cultivar at those trials, while Linn was the lowest yielding cultivar, except in trial 3.

Height

Cultivars were significantly different in trials 1 and 2. In trial 1 Power (23 cm) was the tallest and trial 2 Power and BG34 (both 21 cm)were found to be significantly taller than the other entries.

Dry Matter Content

Dry matter content was significantly different in trials 1-4. BG34 had the greatest amount in trials 1 (25%), 3 (22%), and 4 (25%). Linn and Granddaddy (both 38%) had the greatest amount in trial 2.

Table 2.4: Tall Fescue Cultivar Morphological Characteristics: %Consumed= Percentage of forage consumed, Pre-Yield=Yield prior to grazing, Pre-height=Sward height prior to grazing, Pre-%DM=Percentage of dry matter content prior to grazing

		Tall Fescue Cultivars						
Trial	**Variable**	**Bariane**	**Barolex**	**Jesup EF**	**KYFA9611**	**Select**	**$LSD_{\alpha=0.10}$**	**P-Value**
1	**% Consumed**	37	34	18	17	24	-	0.4298
	Pre-yield	837	798	733	746	791	-	0.9708
	Pre-height	23ab	22b	21b	24a	24a	1.7	*0.0291
	Pre-%DM	26	24	28	25	27	-	0.4738
2	**% Consumed**	79a	71ab	47c	48c	52bc	21.8	*0.0611
	Pre-yield	1075	1189	844	804	909	-	0.3402
	Pre-height	20	21	20	23	23	-	0.1915
	Pre-%DM	31	30	33	34	33	-	0.6803
3	**% Consumed**	50	36	28	38	31	-	0.2772
	Pre-yield	1300	1443	1531	1326	1352	-	0.2064
	Pre-height	23	24	25	25	25	-	0.1262
	Pre-%DM	21	20	20	20	21	-	0.1741
4	**% Consumed**	54	29	42	60	36	-	0.1312
	Pre-yield	433bc	668a	312c	485b	378bc	148	*0.0062
	Pre-height	19b	20ab	19b	22a	21a	1.7	*0.0524
	Pre-%DM	25	24	23	25	25	-	0.6389
5	**% Consumed**	46	11	45	41	27	-	0.2068
	Pre-yield	824	782	971	945	945	-	0.4359
	Pre-height	20c	22abc	21bc	23ab	24a	2.1	*0.068
	Pre-%DM	15	17	16	15	16	-	0.4572
6	**% Consumed**	24	13	30	36	34	-	0.3575
	Pre-yield	1251	1121	1417	1531	1156	-	0.2449
	Pre-height	21	21	22	22	23	-	0.212
	Pre-%DM	28	28	28	27	27	-	0.3194

Tall Fescue

Consumption/Preference

Cultivars within tall fescue only showed significant differences in consumption in trial 2. This is also the trial in which tall fescue was a species was the most significantly consumed species. Bariane (79%) and Barolex (71%) were the most consumed by a significant margin in trial 2. However, in the second year (Trials 4-6), Barolex became the least consumed species at every trial, despite having a thick stand and low weed pressure. Visual observations post-graze rate it as one of the lowest in terms of preference for those trials.

Yield

Tall fescue cultivars were only significantly different in trial 4. Barolex (668 kg/ha) was the greatest yielding cultivar, and Jesup EF (312 kg/ha) was the lowest yielding.

Height

Tall fescue cultivar heights were significantly different in trials 1, 4, and 5. Select was the tallest cultivar at every trial, while Bariane or Jesup EF were the shortest cultivars.

Dry Matter Contnet

No significant difference in dry matter content was present at any trial between tall fescue cultivars.

Chemical Analysis Data Relevant to Cultivars within Species

Table 2.5: Festulolium Cultivar Forage Quality: NDF=percent neutral detergent fiber, ADF=percent acid detergent fiber, IVTD=percent in-vitro true digestibility, CP=percent crude protein

		Festulolium Cultivars							
Trial	**Variable**	**Barfest**	**Duo**	**KYFA1015**	**KYFA1016**	**Perun**	**SpringGreen**	**$LSD_{\alpha=0.10}$**	**P-Value**
1	**NDF**	51ab	53a	50ab	51a	48b	50ab	2.7	*0.0793
	ADF	29	30	28	30	29	28	-	0.7935
	IVTD	83	84	83	83	83	85	-	0.3117
	CP	20ab	19b	20ab	20ab	19b	21a	1.3	*0.0647
2	**NDF**	51b	56a	52b	54ab	53b	54ab	2.2	*0.0212
	ADF	25b	27a	26b	26ab	25b	27ab	1.3	*0.0507
	IVTD	81	79	81	81	80	80	-	0.1409
	CP	19a	17b	19a	19a	18ab	18ab	1	*0.0755
3	**NDF**	47	47	47	48	47	47	-	0.9324
	ADF	23	24	23	23	23	24	-	0.7566
	IVTD	87a	87a	87a	87a	85b	87a	1.1	*0.0624
	CP	22	22	22	22	20	22	-	0.1409
4	**NDF**	57	56	56	56	55	54	-	0.2344
	ADF	26	26	26	25	25	25	-	0.6912
	IVTD	84	85	83	85	84	83	-	0.119
	CP	20ab	22a	19b	22a	20ab	22a	1.2	*0.0563
5	**NDF**	57	57	56	57	57	56	-	0.9647
	ADF	29	29	29	28	29	29	-	0.8297
	IVTD	80	81	80	80	79	80	-	0.8173
	CP	18	19	18	19	18	19	-	0.3605
6	**NDF**	69	67	67	66	64	66	-	0.2312
	ADF	30	29	29	29	29	29	-	0.356
	IVTD	74	74	74	74	74	73	-	0.9935
	CP	13	13	13	13	13	13	-	0.9842

Festulolium

NDF

Significant differences for NDF within festulolium cultivars were present in trials 1 and 2, but no other trials. Trial 1 and 2 both show Duo (53% and 56%) to have the greatest mean NDF value, equating to worse quality. Perun has the lowest NDF value (48%) in trial 1 and Barfest has the lowest (51%) in trial 2. The maximum range between values is similar to those of the among species treatment. Trial 1 and trial 2 both have a range of 5%, and all other trials range from 1-3%.

ADF

Cultivars show significant difference in ADF values only in trial 2. Duo has the greatest ADF value (27%) which matches its high NDF value on thin trial. Perun and Barfest have the lowest ADF (25%). Maximum range among all trials is only 1-2%.

IVTD

Trial 3 shows significant differences between cultivars with regard to IVTD. The cultivar with noticeably lower IVTD values is Perun (85%). All other cultivars were about equal (87%). Range between all trials never exceeds 1-2%.

CP

Cultivars were significantly different in CP values in trials 1, 2, and 4. SpringGreen is the greatest cultivar in trial 1 (21%). For trial 2, Barfest, KYFA1015, and KYFA1016 all share the greatest mean (19%). Finally, in trial 4, Duo, KYFA1016, and

SpringGreen have the greatest mean CP (22%). The greatest range is never more than 3% at any trial.

Table 2.6: Orchardgrass Cultivar Forage Quality: NDF=percent neutral detergent fiber, ADF, percent acid detergent fiber, IVTD=percent in-vitro true digestibility, CP=percent crude protein

		Orchardgrass Cultivars									
Trial	**Variable**	**Benchmark**	**Harvestar**	**Persist**	**Potomac**	**Prairie**	**Prodigy**	**Profit**	**Tekapo**	**$LSD_{\alpha=0.10}$**	**P-Value**
1	**NDF**	53	57	56	54	54	53	54	55	-	0.1666
	ADF	28	31	30	30	28	30	29	31	-	0.121
	IVTD	83	85	83	82	85	85	85	85	-	0.2604
	CP	20	20	20	19	20	21	21	20	-	0.616
2	**NDF**	56ab	56ab	51c	56ab	58a	54b	55b	54b	2.9	*0.0139
	ADF	26	27	25	27	27	25	26	26	-	0.5633
	IVTD	80	80	81	80	81	81	80	81	-	0.6066
	CP	19	19	19	19	19	20	19	19	-	0.6085
3	**NDF**	52	51	51	54	53	52	52	48	-	0.1219
	ADF	24	25	25	26	25	25	25	24	-	0.5428
	IVTD	84bc	85ab	83c	84bc	83c	85ab	85ab	86a	1.3	*0.0319
	CP	21b	22a	20c	20c	20c	21b	21b	22a	0.9	*0.032
4	**NDF**	59bc	58c	58c	60abc	61a	62a	59bc	58c	2.1	*0.0758
	ADF	26	25	26	26	27	27	25	26	-	0.2866
	IVTD	84ab	85a	85a	83b	84ab	84ab	85a	83b	1.4	*0.0715
	CP	22	22	23	21	22	22	23	21	-	0.158
5	**NDF**	57	58	58	63	60	61	60	61	-	0.2371
	ADF	28	29	30	31	29	31	29	30	-	0.23
	IVTD	81a	81a	78c	80ab	81a	79bc	80ab	80ab	1.2	*0.0066
	CP	20a	19ab	17c	18bc	19ab	18bc	18bc	19ab	1	*0.0238
6	**NDF**	64	65	66	65	66	67	66	66	-	0.764
	ADF	28	29	29	29	29	29	29	30	-	0.7845
	IVTD	76	75	75	76	77	77	76	75	-	0.6888
	CP	15	14	14	16	16	15	14	14	-	0.4054

NDF

Recall that orchardgrass had the highest mean NDF values at most of the trials, so cultivars in orchardgrass have greater NDF than cultivars in other species. Orchardgrass cultivars show significant differences in NDF in trials 2 and 4. In trial 2, Prairie (58%) has the greatest mean and Persist the lowest (51%). Trial 4 shows Prodigy (62%) and Prairie (61%) to have the greatest men NDF, and Harvestar, Persist, and Tekapo (58%) to have the lowest NDF. Ranges of means within orchardgrass were greater than other species, going from 3-7% across all trials.

ADF

Orchardgrass cultivars do not show significant difference in ADF at any trial. Ranges at each trial were either 2% or 3% at most.

IVTD

Cultivars show significant differences in IVTD in trials 3, 4, and 5. However, no one cultivar is consistently greater or lower in IVTD than others from one trial to the next. Orchardgrass does show a greater range in IVTD values, with ranges for trials 1, 3, and 5 reaching 3%.

CP

Cultivars were different in trials 3 and 5. Persist is one of the lowest cultivars at each of these trials (20% for trial 3 and 19% for trial 5). Harvestar and Tekapo rank in the top grouping for trial 3 (22%) and trial 5 (19%), and Benchmark Plus has the greatest CP mean in trial 5 (20%). Means have ranges of 1-3% across the trials.

Table 2.7: Perennial Ryegrass Cultivar Forage Quality: NDF=percent neutral detergent fiber, ADF=percent acid detergent fiber, IVTD=percent in-vitro true digestibility, CP=percent crude protein

		Perennial Ryegrass Cultivars						
Trial	**Variable**	**BG34**	**Calibra**	**Granddaddy**	**Linn**	**Power**	**$LSD_{\alpha=0.10}$**	**P-Value**
1	**NDF**	53ab	47c	52ab	54a	50bc	3.2	*0.0348
	ADF	29	27	28	30	27	-	0.1818
	IVTD	83	84	83	82	82	-	0.2468
	CP	18b	20a	19ab	18b	20a	1.5	*0.0333
2	**NDF**	53bc	52bc	56a	54ab	51b	2.9	*0.0817
	ADF	26	24	27	26	26	-	0.1729
	IVTD	80	80	80	81	82	-	0.2201
	CP	18c	19b	18c	19b	20a	0.9	*0.0428
3	**NDF**	48	47	46	48	47	-	0.6136
	ADF	23	23	23	23	23	-	0.7067
	IVTD	86	87	86	86	87	-	0.3333
	CP	21	21	22	21	22	-	0.927
4	**NDF**	59	57	57	57	55	-	0.3729
	ADF	27	26	26	26	25	-	0.3083
	IVTD	82	84	82	83	84	-	0.6346
	CP	19	20	20	20	20	-	0.7062
5	**NDF**	55	57	56	57	57	-	0.4549
	ADF	27	28	28	28	27	-	0.3083
	IVTD	81	82	80	80	82	-	0.2118
	CP	19	20	18	19	19	-	0.1051
6	**NDF**	63	66	65	66	64	-	0.585
	ADF	28	29	29	30	29	-	0.3305
	IVTD	76	75	76	74	75	-	0.693
	CP	15	14	15	14	13	-	0.4436

Perennial Ryegrass

NDF

Perennial ryegrass cultivars were exhibit significantly different NDF means in trials 1 and 2 only. In trial 1, Linn has the greatest mean (54%) and Calibra the lowest mean (48%). Trial 2 also has Linn grouped with the highest mean (54%), and calibra with the lowest (52%). Granddaddy has the greatest NDF mean for trial 2 (56%) and Power (51%) has the lowest. Ranges of the means from one trial to the next fell between 2-5%.

ADF

Cultivars do not exhibit significant difference in mean values for ADF at any trial. Linn appears to have one of the consistently higher means in trials 1, 5, and 6.

IVTD

No cultivars of perennial ryegrass display significant differences in IVTD at any trial. The maximum range for any trial is 3%.

CP

Crude protein values means between cultivars differ in trials 1 and 2. Trial 1 shows Power and Calibra (20%) and BG34 and Linn (18%) to be the cultivars with the greatest and lowest CP means, respectively. Trial 2 results show Power (20%) and BG34 and Granddaddy (18%) to be the cultivars with the greatest and lowest means respectively.

Table 2.8: Tall Fescue Cultivar Forage Quality: NDF=percent neutral detergent fiber, ADF=percent acid detergent fiber, IVTD=percent in-vitro true digestibility, CP=percent crude protein

		Tall Fescue Cultivars						
Trial	**Variable**	**Bariane**	**Barolex**	**Jesup EF**	**KYFA9611**	**Select**	**$LSD_{\alpha=0.10}$**	**P-Value**
1	**NDF**	52	51	51	50	51	-	0.9483
	ADF	27	27	28	28	27	-	0.8986
	IVTD	84	84	84	85	82	-	0.2264
	CP	19	19	19	20	19	-	0.756
2	**NDF**	53	53	50	52	52	-	0.3455
	ADF	24	24	23	25	24	-	0.478
	IVTD	81	81	81	81	81	-	0.8653
	CP	20	18	19	19	19	-	0.3801
3	**NDF**	49a	46b	46b	46b	49a	2	*0.0107
	ADF	22	22	22	22	22	-	0.9885
	IVTD	86	84	85	85	84	-	0.1354
	CP	21	20	21	21	20	-	0.3227
4	**NDF**	56	57	54	55	56	-	0.4632
	ADF	25	25	24	24	25	-	0.7792
	IVTD	83	81	83	82	82	-	0.53
	CP	20	19	21	20	20	-	0.6054
5	**NDF**	54	53	56	56	55	-	0.1494
	ADF	28	26	28	28	28	-	0.3696
	IVTD	80	81	79	80	80	-	0.477
	CP	19	19	18	19	19	-	0.3423
6	**NDF**	64a	59b	64a	63a	64a	2.8	*0.0532
	ADF	29a	26b	28a	28a	28a	1.2	*0.0382
	IVTD	74b	78a	75b	75b	75b	1.8	*0.0201
	CP	13b	16a	13b	14b	14b	1.5	*0.0249

Tall Fescue

NDF

Tall Fescue cultivars show significant NDF mean differences in trials 3 and 6. Bariane and Select (49%) have the greatest means in trial 3, with other cultivars being close in their means (about 46%). Trial 6 results have Barolex with significantly lower mean NDF than the other cultivars (59% compared to 6% or 63%). This is likely an effect of crabgrass being heavily present in all tall fescue plots except for Barolex, which had thick stands with little weed pressure.

ADF

Only trial 6 shows significant differences in ADF. Barolex has significantly lower mean ADF than the other cultivars (26% compared to 29% or 28%). Again an effect of crabgrass being heavily present in all tall fescue plots except for Barolex.

IVTD

Only trial 6 shows significant differences in IVTD. Barolex has significantly greater mean IVTD than the other cultivars (78% compared to 75% or 74%). Again this is likely an effect of crabgrass being heavily present in all tall fescue plots except for Barolex.

CP

Only trial 6 shows significant differences in CP. Barolex has significantly greater mean CP than the other cultivars (16% compared to 14% or 13%). Once again, this is likely an effect of crabgrass being heavily present in all tall fescue plots except for Barolex.

Coefficient of Variation with Regards to Consumption

Table 2.9: Coefficients of variation and percent variation of statistical model terms (replication, species, and cultivar, along with residual error)

Trial	CV	%Rep	%Species	%Cultivar	%Error
1	55	6.881269	75.08747	8.280849	9.750408
2	48	8.28039	68.21262	12.77001	10.73698
3	49	25	21.8985	23.7782	29.32331
4	45	20.07177	46.43541	22.44019	11.05263
5	66	53.76398	25.27334	12.3916	8.571069
6	56	28.25404	50.32601	14.27191	7.148032

Throughout all six of the trials conducted across 2014 and 2015, the coefficient of variation for the percentage consumption variable was extremely high. When examined on each of the trials with the species treatment, the CV's range from the lowest value of 45% (trial 4) to the greatest value of 66% (trial 5). When looking at each individual species, CV's still were high. Festulolium ranges from 32% to 57% across all trials, orchardgrass ranges from 44% to 56%, perennial ryegrass ranges from 34%-80%, and tall fescue ranges from 36-83%. This indicates that a high amount of variation was present when measuring consumption. To determine what aspects of our treatments were accounting for this variation, comparisons of each treatment and residual error (factors not accounted for in our statistical model such as randomness among animals, weather, etc.) were made to total variation.

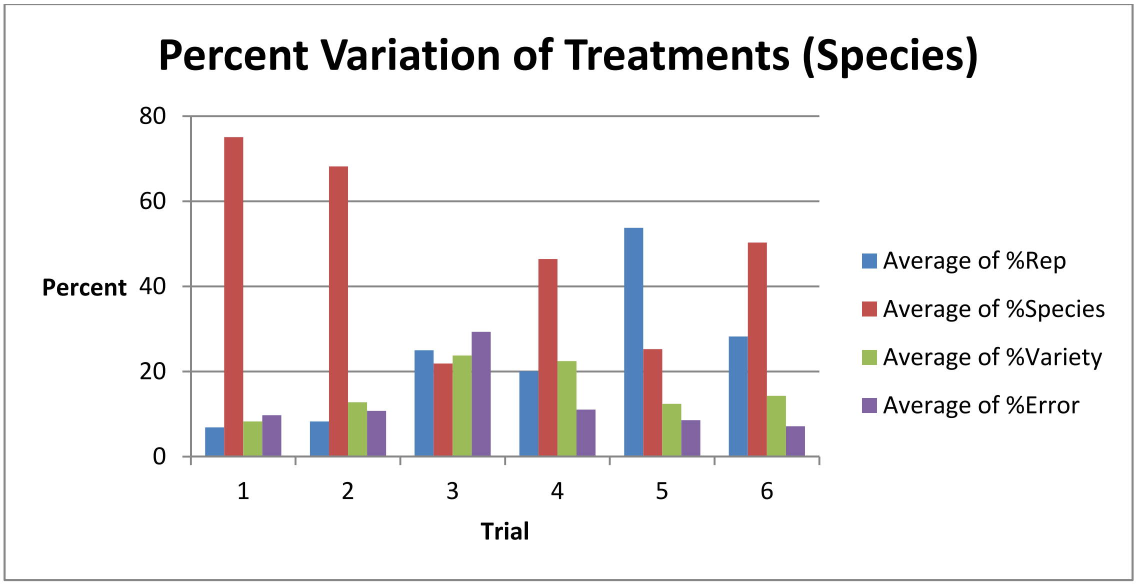

Figure 2.17: Variation of treatments at each trial, across all four species

In trials 1, 2, 4, and 6, the species treatment made up a majority of the variation seen among treatments. This matches up fairly well with the significance of the species treatment, where it was significant in trials 1, 2, and 6. Cultivar exhibits relatively little variation, at around 20% at maximum. Replication (i.e. location in the field) and residual error were high in trials 3 and 5. This shows that a high degree of randomness was associated with consumption at these trials.

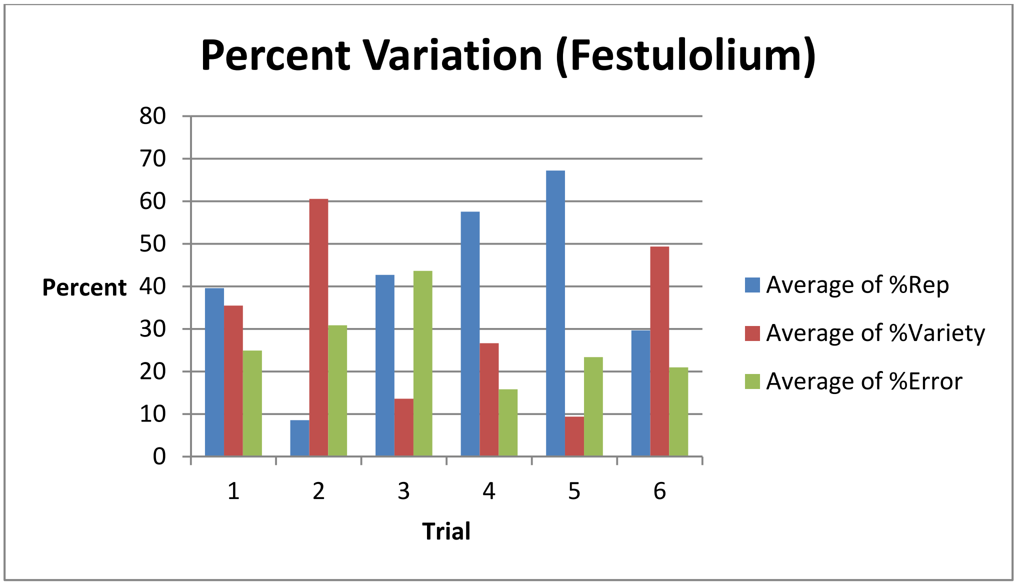

Figure 2.18: Variation of treatments at each trial, within festulolium

Within festulolium, cultivar was only a majority of varation in trials 2 and 6, but at all other trials represents less of the variation than residual error and replication.

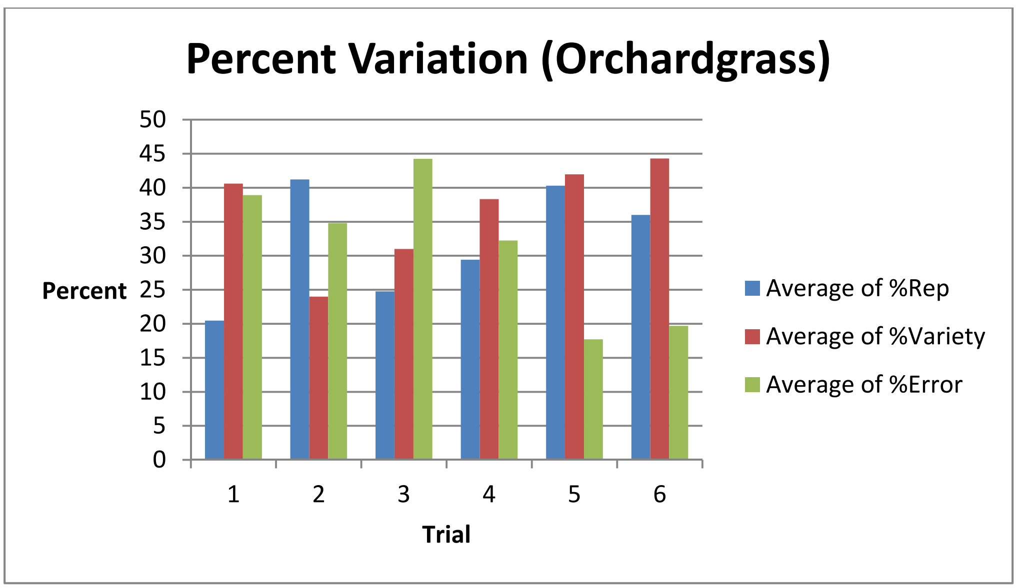

Figure 2.19: Variation of treatments at each trial, within orchardgrass

For orchardgrass, the cultivar treatment again does not represent a dominant source of variation at most of the trials. Residual error and location in the field seem to be accounting for more total variation than cultivar at every trial. Not once does cultivar exceed 50% of the variation.

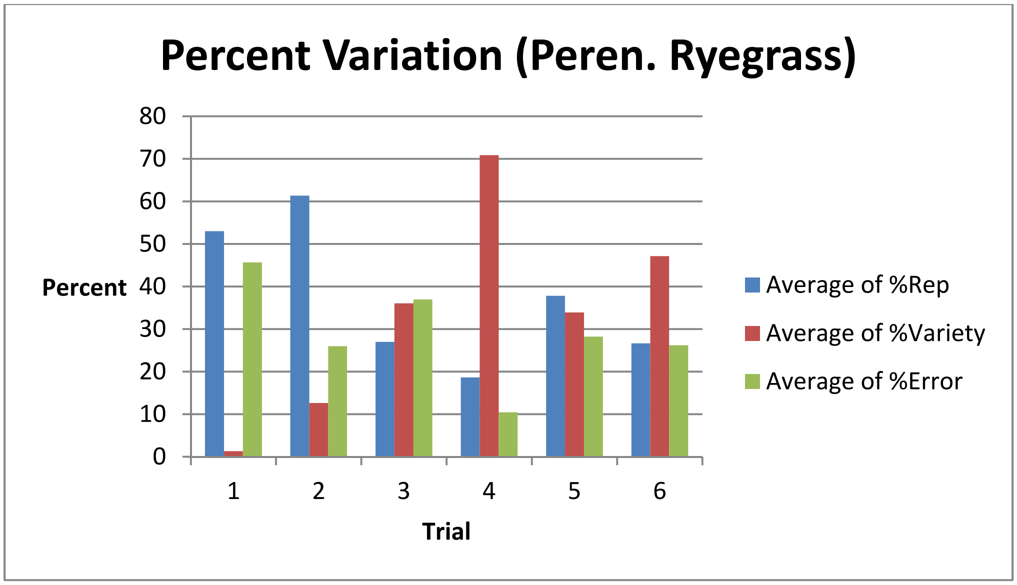

Figure 2.20: Variation of treatments at each trial, within perennial ryegrass

Perennial ryegrass does show trial 4 to have very high variation with regards to the cultivar treatment. However, no other treatment has a significant cultivar treatment effect, and this was backed up by the high variation seen from location in the field and residual error at all other trials.

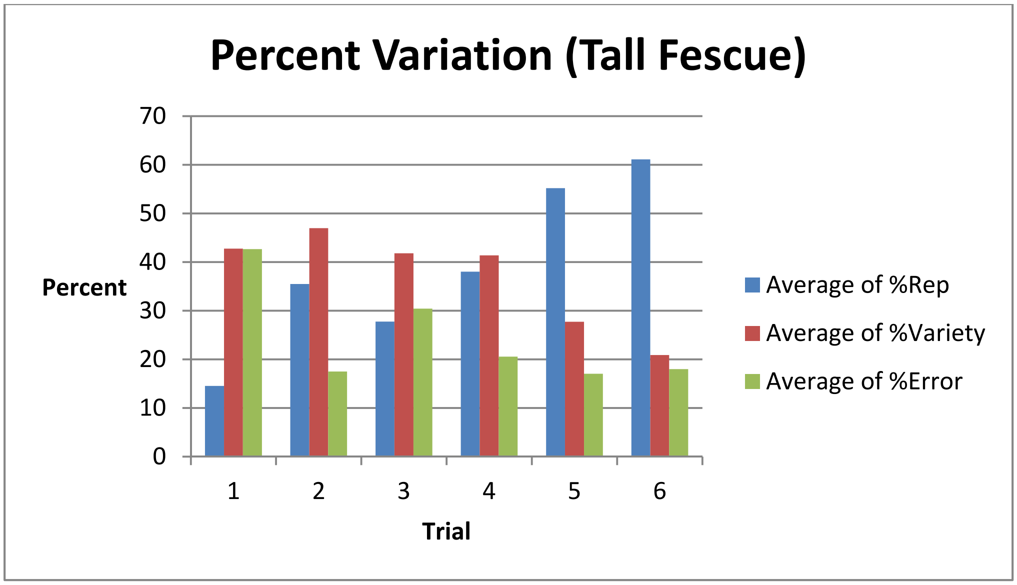

Figure 2.21: Variation of treatments at each trial, within tall fescue

Finally, tall fescue appears to show no instance where the cultivar treatment accounted for greater than 50% of the total variation. Location in the field (replication) and residual error (unmeasured variables) account for most of the variation in these trials. This makes sense, given that cultivar was not significant at any trial for consumption amongst tall fescue cultivars.

Discussion

Consumption and Preference

The major objective of this study was to determine the preference of cool-season forage grasses when grazed by dairy cattle. To that end, I measured the consumption of available forage at multiple time points over the course of two years. Palatability was not directly measured, as this would entail measuring minute plant factors that were highly variable and/or require some degree of qualitative measurement within plots such as leaf texture, leaf:stem ratio, etc. Preference was directly measured via measuring the amount of forage consumed in each plot, and converting that to a percentage value of total consumption/total available forage (on a per-plot basis) prior to grazing. Therefore, differences in consumption were synonymous to differences in preference. Various morphological factors (yield, sward height, and dry matter content) along with chemical analysis of forage quality components (NDF, ADF, IVTD, and CP) were measured in an attempt to explain any preference trends observed.

In general, throughout the study there was not a consistent species ranking for preference. This was contradictory to other such studies (Smit et al., 2006; Waldron et al., 2010; Solomon et. al, 2013). Figure 2.1 shows that consumption was only significant between species in trial 1 and 2, and not significant in trial 3 in 2014. Figure 2.2 shows that consumption was not significantly different with regards to the species treatment in trials 4 and 5, and was significant in trial 6. This means that during our trials, 50% of the time dairy cattle did show a statistically significant preference for one species over another, and 50% of the time they did not show significant preference. Preference is inherently difficult to measure, because variation among animals grazing the plots is difficult to account for (Shewmaker et al., 1997). As mentioned previously, coefficients of variation were very high for the consumption variable. Figure 2.17 shows a comparison of the various terms of our statistical model broken down by trial. While species represents most of the variation in trials where species was significantly different, trials 3, 4, and 5, have noticeably high amounts of variation associated with residual error and replication. This means that more of the variation seen in the trial was associated with randomness of animal behavior during grazing, and not our species and cultivar treatments, reiterating the difficulty in measuring preference.

Morphological Factors

I examined Pearson correlation coefficients to see if morphological data such as forage yield, sward height, and dry matter content were related to any preferences that I saw in trials 1, 2, and 6 (data not shown). However, there was no biologically consistent or significant coefficient (>0.60) that was positively or negatively correlated to consumption in a way that made sense. The amount of forage available at the onset of grazing, sward height at the onset of grazing, and dry matter content at the onset of grazing appear to be only mildly correlated at best to consumption and preference. Lack of correlation to yield can be explained by the fact that it is only significant in trials 3, 4, 5, and 6, and only in trial six was preference significantly different among species. Height was the most consistent morphological variable measured, and at every trial orchardgrass was the tallest species by a significant margin. Perennial ryegrass was always the shortest species. Despite a lack of correlation, it has been shown that animals tend to graze areas of the pasture that are taller than others first (Griffiths et al., 2003), which would make sense given orchardgrass' preference ranking in the top two in each trial, and perennial ryegrass ranking in the bottom two species at each trial. Percent dry matter from one species to the next, while significantly different in each trial, showed a very narrow range in all trials. All trials show less than 5% range in values between the four species for percent dry matter, showing that moisture is not likely to be a factor in determining their preference.

Forage Quality

Forage quality analysis lends some insight into the lack of consistent preference differences between species or cultivars within species. As with morphological variables, correlations to forage quality variables were not biologically relevant, despite results to the contrary in previous research (Smit et al., 2006). Forage quality values for NDF, ADF, IVTD, and CP do show statistically significant differences between species at most trials. Orchardgrass is consistently higher in NDF and ADF values than other species, indicating it has more fiber that lowers intake and digestibility by animals, and thus is poorer quality forage. However, these contradict orchardgrass' ranking of consumption previously mentioned. This can be explained in the relatively small range in the differences of forage quality constituents from one species to another. Across all trials, the maximum difference in NDF value between species is a mere 5% (Figures 2.9 and 2.10). ADF (Figures 2.11 and 2.12), IVTD (Figures 2.13 and 2.14), and CP (2.15 and 2.16) differences were even smaller, maxing out at about 3% between species at any one trial for ADF, 2% for IVTD, and 2% for CP. While statistically significant, these differences were likely not biologically significant, in that the animals cannot differentiate between forage that is so similar in their forage quality components. Animal performance differences may be observed with these small differences in quality, but the animal's willingness to consume forages likely will not change.

Reasons for Lack of Preference

These small relative differences in forage quality components between species and cultivars at various trials raise the question of why the variation between entries is small. One would assume that with 24 entries consisting of a wide range of genetic material and differing morphologies that species would be highly significant for preference in each trial. As mentioned in the methodology, one of the primary factors I eliminated from this study was maturity differences. The differing growth rates of different cool-season forage grass species is well documented, and cultivars selected and bred for differing maturity rates is common. By allowing plots to begin their reproductive cycles prior to any grazing, and subsequently removing that growth, this effectively put all of the entries on an even playing field in terms of their growth habit. At the time of the first grazing in both 2014 and 2015, almost all of the plots were entirely vegetative, with little to no stem material being present. This inherently results in higher quality forage, as seen by the NDF, ADF, IVTD, and CP values at each trial, which are good values for cool-season forage grasses. It has been observed that forage quality values for NDF and IVTD decline in acceptability as plants mature (Karn et al., 2006). Because I eliminated maturity differences, this could explain the lack of large difference in measured variables. In addition to removing vegetative growth, plots were always uniformly fertilized between grazing trials with 13.6kg of nitrogen fertilizer per hectare in the form of granular urea. This uniform fertilization of vegetative regrowth shows that the species and cultivars used differ only marginally when managed effectively. By taking away the issue of varying maturity rates, controlling weeds, and fertilizing plots adequately, I prove that producers who can practice good management strategies will not have to worry about their animals exhibiting preferential grazing on a mixed pasture, even at lower stocking rates. Good management can overcome some of the inherent variation present between cultivars and species, and thus result in fairly uniform grazing among dairy cattle in the pasture.

Some potential drawbacks to acknowledge with this study were the small plot size, limited time allotted for grazing, and uneven number of entries per species. As mentioned in the methods section, plots were 1m x 3m, and no border was between plots on the left or right, only at the ends of plots which separated different ranges. It is possible that animals ate indiscriminately because they were adjacent to other plots. The small plot size leads directly into the second issue, which was the short time period allowed for grazing. Because the total area of the study was only about one tenth of a hectare, there was not enough forage to allow the animals to graze for more than 5-6 hours. Our goal was to achieve roughly 50% of total forage consumption over the whole study, and this was achieved using 3-4 animals over 5-6 hours. This does not allow animals to acclimate themselves to the plots prior to beginning grazing. Other studies have shown significant preference differences by incorporating some form of acclimating animals to the specific entries used in their experiments (Shewmaker et al., 1997; Mayland et al., 2000). However, these animals were pastured in a field where they had multiple other grazing trials consisting of the same species in this study that were open at all times for them to graze, so this was a lesser issue. Other studies (Smit et al., 2006; Waldron et al., 2010) conducted water soluble carbohydrate analysis, and found it to be highly correlated to what the animals were consuming. However, I did not look at this factor of forage quality in this study, and it might be useful to examine within our particular samples. It has been found that maturity plays a large role in affecting WSC levels in cool-season grasses (Zhao et al., 2008), but because this was accounted for, it is likely the WSC levels are not biologically significant for animals to detect, based on other forage quality results.

Conclusions

While consistent preference was not observed I have identified a number of possible reasons as to why this might have occurred which are beneficial both to producers and to plant breeders. Observed preference in previous studies was likely a result of not accounting for differing maturity levels, and the fact that they allowed animals to be conditioned on specific pastures prior to grazing their experimental plots resulting in animals learning to graze over time, rather than observing their preferences without conditioning. I have shown that harvesting forage in its vegetative state leads to a high quality forage that is relatively uniform in quality, even across multiple cultivars and species. Adding good weed control and adequate fertilization to this can also aid in vastly improving overall forage quality, and serves to make the difference between different cool-season grasses smaller. Producers wishing to improve the intake of their cattle on previously established pasture can implement these strategies in order to allow for more efficient utilization of their pasture. Granted, most growers would not want to let their pastures go completely into reproductive growth in the first flush of spring growth, as that is where most of their yield occurs for cool-season species. Utilizing it for lower quality hay would be an option in order to achieve better forage utilization for the remainder of the year. Additionally, because preference was not consistently observed due to small variation in forage quality, producers would benefit from selecting an array of species or varieties based on agronomic traits such as yield during the season, persistence, drought tolerance, etc. Plant breeders should recognize that the differences in forage quality between cool-season grasses in vegetative state of growth are small, and that they should focus on selecting for improved morphological traits such as biomass and height if working with species in a vegetative state.

Chapter 3: Comparison of Dairy Cattle Preference Among Orchardgrass Cultivars

Introduction

Orchardgrass (*Dactylis glomerata* L.) is one of the most prolific cool-season grasses used in modern forage-livestock grazing and hay operations. Dairy herdsmen have adopted the species in much of the temperate midwest and northern United States due to its strong positive response to nitrogen fertilization, rapid and vigorous regrowth following grazing or cutting for hay, and lack of toxic endophytes that might result in production decline in their herds (Mortensen et al., 1964; Clay 1996). Orchardgrass is known for being one of the earliest maturing cool-season forage grasses that is commonly used in livestock operations (Van Santen and Sleper, 1996). Seed-head emergence from the boot often occurs by the end of April. In a grazing situation, this usually means that orchardgrass is less preferred in the first flush of reproductive spring growth than other species (Baron et al., 2000). However, within orchardgrass exclusively, animal preference has not been examined, especially when maturity is not a confounding factor. Within-species studies looking at perennial ryegrass and forage kochia have shown that animals selectively graze and exhibit preferences for some cultivars within the same species (Smit et al., 2006, Waldron et al., 2010). This leads one to suspect that there could be such preference exhibited and observable between orchardgrass cultivars.

In the second chapter of this thesis, preference of multiple cool-season grass species was analyzed. This study is in tandem with the second chapter, and is attempting to determine if cattle preference exists within a single species. The objective of this study was to determine if within-species preference for different cultivars of orchardgrass exists when grazed by dairy cattle, and if so, to determine what factors influence preference. I hypothesize that there will be a preference shown among the differing cultivars, and that forage morphology and nutritive value will play a role in explaining those preferences.

Materials and Methods

This study was planted on April 1st 2014. Winter of 2013-2014 at the University of Kentucky's Spindletop Research Farm in Lexington, Kentucky was extremely cold compared to average conditions in prior years. This resulted in some mild stand loss in plots from the study described in Chapter 2. In an effort to accommodate for this, I decided to sow larger plots of only a single species, orchardgrass, using ten different cultivars: Baraula, Tekapo, Hallmark, Potomac, Harvestar, Persist, Shiloh II, Profit, Benchmark Plus, and Latar. All cultivars except Shiloh II and Latar were used in the Chapter 2 experiment.

The total area for the study is 73m long by 45m wide, with each plot being 12m long and 4.5m wide, and 1.5m of border between each range. There were a total of six replications, with each replication existing as a range that is ten plots wide. The total area was roughly 0.4 ha. An Almaco seven-row forage seed drill was used to plant plots at a rate of 23 kg/ha on April 1st at the University of Kentucky's Spindletop Research Farm in Lexington, KY, and the plots were located adjacent to the smaller plot study from Chapter 2.

Due to being planted in early spring, grazing was witheld until fall to allow the new seeding time to build up enough growth and vigor to withstand dairy cattle grazing. For this reason, only one grazing was conducted in 2014 during mid-September. Because vernalization did not occur in the first year of growth, maturity was not a confounding factor. In 2015, two grazing sessions occurred, one at the end of June, and another in mid-August. Maturity was accounted for in 2015 by following a similar protocol as in Chapter 2, in which all plots reached full seed-head emergence, before mowing off that growth in order to negate maturity as a confounding factor in animal preference.

The size of the plots meant that larger equipment was necessary to conduct harvests. A Hege 212 forage harvester with a 1.5m header was used to harvest strips of the plots at a cutting height of 7.5cm for both pre and post yields. Material from the hopper was then collected and weighed on a scale to determine the yield of each plot. This yield was converted to dry matter yield by taking a subsample of each plot for moisture content and applying that percent dry matter to the total pre-grazing and post-grazing yields. The difference between the pre-grazing forage yields and post-grazing yields were used to determine percent consumption, which for our purposes is synonymous with preference, e.g. the most consumed plots were the most preferred. Sward heights were taken both pre-graze and post-graze, as well as visual ratings for preference following grazing on a scale of 1-9, with 1 being least preferred and 9 being the most preferred. The subsamples used to determine percent dry matter were also ground to determine forage quality parameters of neutral detergent fiber (NDF), acid detergent fiber (ADF), in-vitro true digestibility (IVTD), and crude protein (CP).

Statistical analysis was conducted in a similar manner to the preference trials in Chapter 2, with the only exception being that species was removed from the model as orchardgrass is the only species present, and thus cultivar is no longer a nested factor. Therefore, the statistical model is: $Y_{ijk}=\mu+B_i+V_j+BV_{ij}+T_k+BT_{ik}+VT_{jk}+BVT_{ijk}$ in which

B=replication, V=cultivar, and T=trial. As with Chapter 2, results showed Trial to be highly significant ($P<.0001$), so each trial was analyzed separately. The model tested for each trial therefore is: $Y_{ij}=\mu+B_i+V_j+BV_{ij}$

Results

Cultivar Treatment

As with Chapter 2 of this thesis, the primary variable of interest in this study is percentage of forage consumed, which is equivalent to preference in our trials. Unlike the study in Chapter 2, I attempted to examine only cultivars within a single species. Trial was highly significant (P<.0001) and therefore results from each of the three trials were presented separately, similar to the analysis in Chapter 2. Within each trial, percent consumption, other morphological variables, and chemical analysis were examined for differences among cultivars.

Morphological Data among Cultivars

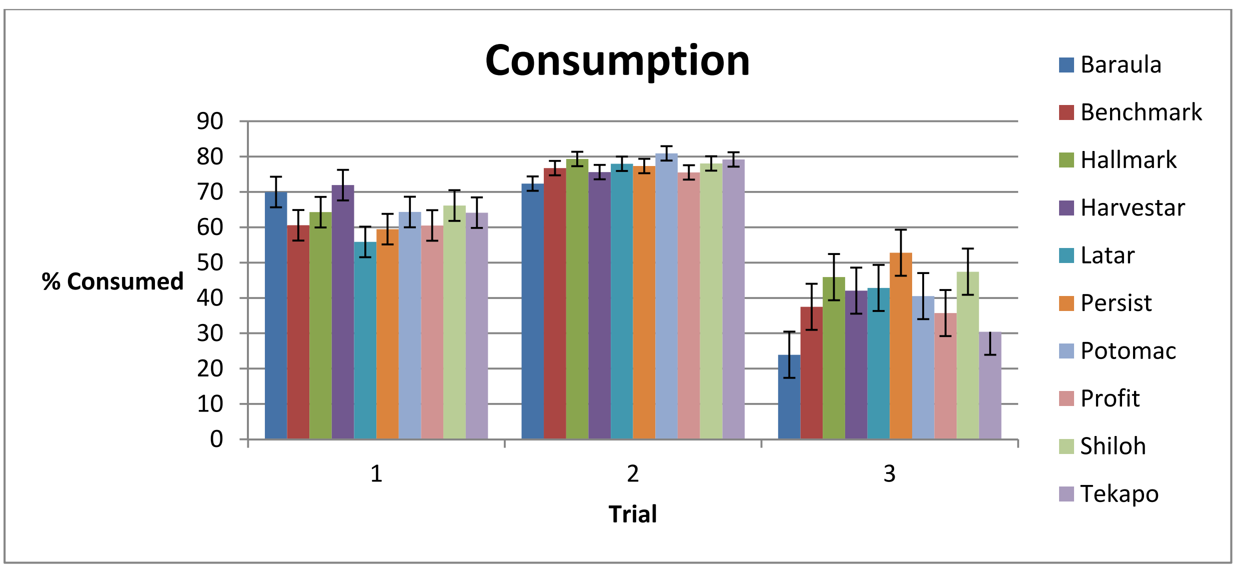

Figure 3.1: Orchardgrass Cultivar Consumption

Consumption and Preference

At no trial was percentage of consumption significantly different (P<.10) (Figure 3.1). There is a distinct lack of consistent highly consumed cultivars. Consumption as a whole appears to be greater in trials 1 and 2 compared to trial 3, this is likely because trial 1 and 2 utilized 20 animals, whereas trial 3 used only 12 because animals were removed in July 2015 between trials 2 and 3.

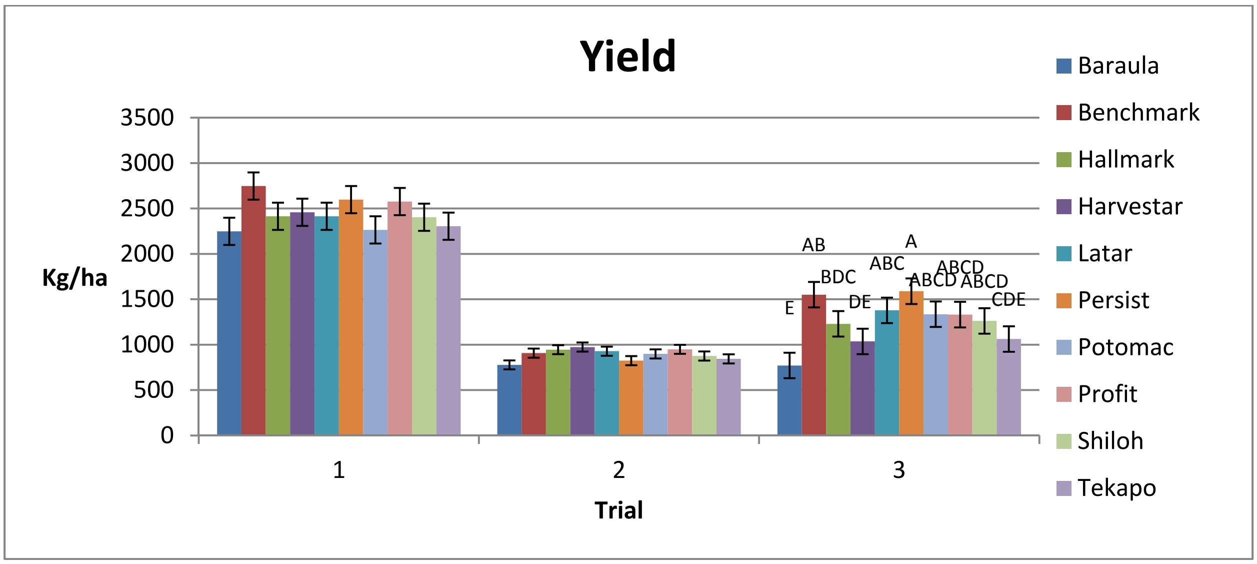

Figure 3.2: Orchardgrass Cultivar Yield

Yield

Significant differences in yield between cultivars were not present in trial 1 or trial 2, but were present in trial 3 (Figure 3.2). Trial 3 shows Persist to be the highest yielding cultivar, but it was not different from Benchmark Plus, Potomac, Profit, or Shiloh II. Yield is much higher across all cultivars in trial 1 than in trials 2 and 3 because the forage in trial 1 was allowed to grow for the duration of the growing season, only being mowed once in early June. This was because the plots were seeded in April 2014, and needed adequate time to establish prior to the first grazing trial in September 2014. Trials 2 and 3 occurred about a month apart, with trial 2 occurring at the end of June/early July and trial 3 occurring the second week of August.

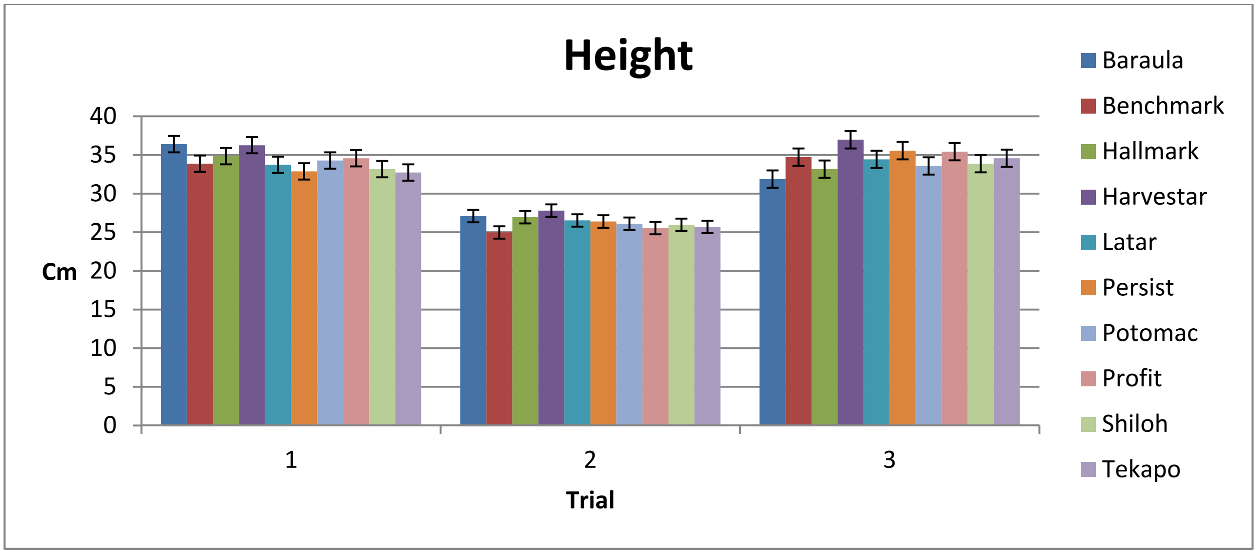

Figure 3.3: Orchardgrass Cultivar Height

Height

Cultivars of orchardgrass appeared to have little variation in mean height (Figure 3.3). While Chapter 2 of this thesis shows orchardgrass as a whole to be consistently taller than other cool-season grass species, within species comparisons show most of the orchardgrass entries to be of similar heights. When looking at the plots, it was often difficult to tell where plots separated from each other because heights were so similar from one plot to the next.

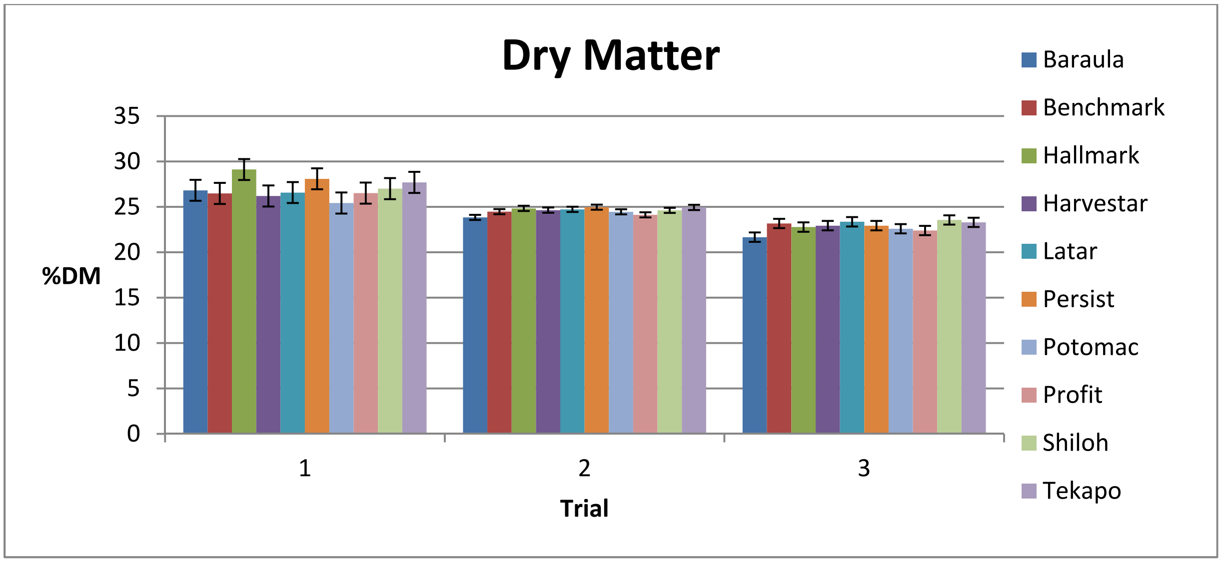

Figure 3.4: Orchardgrass Cultivar Dry Matter Content

Dry Matter

As with height and consumption, at no trial is dry matter significantly different between cultivars (Figure 3.4). The range in differences is extremely narrow, with trial 1 having the widest range of about 4%. Trials 2 and 3 have ranges of only about 2%.

Forage Quality/Chemical Analysis among Cultivars

In Chapter 2, Orchardgrass was shown to have consistently greater NDF and ADF values, than other species. However, CP and IVTD values were somewhat inconsistent from one trial to the next, and did not always negatively correlate to NDF and ADF. Within orchardgrass, differences in NDF, IVTD, and CP were observed, but not consistently across trials, and the ranges of results were very narrow. Results of this study support this information.

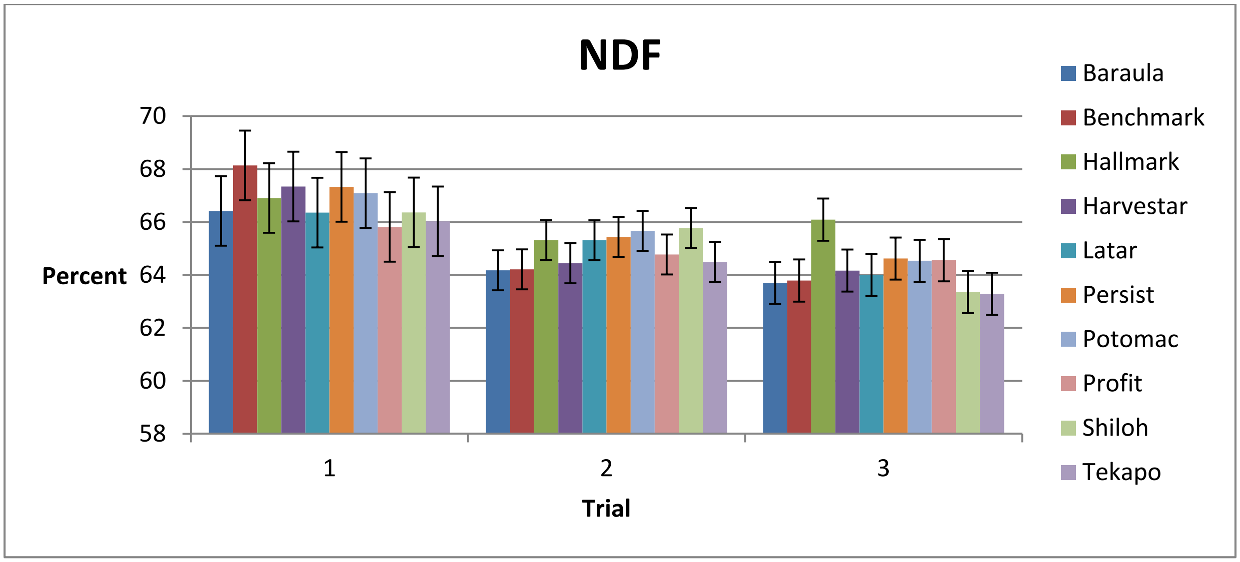

Figure 3.5: Orchardgrass Cultivar NDF

NDF

While no significant differences were recorded for NDF values between cultivars in this study (Figure 3.5), it was the forage quality constituent with the most observable variation. Similarly to results of Chapter 2, the maximum range at any one trial between cultivar means was about 3%.

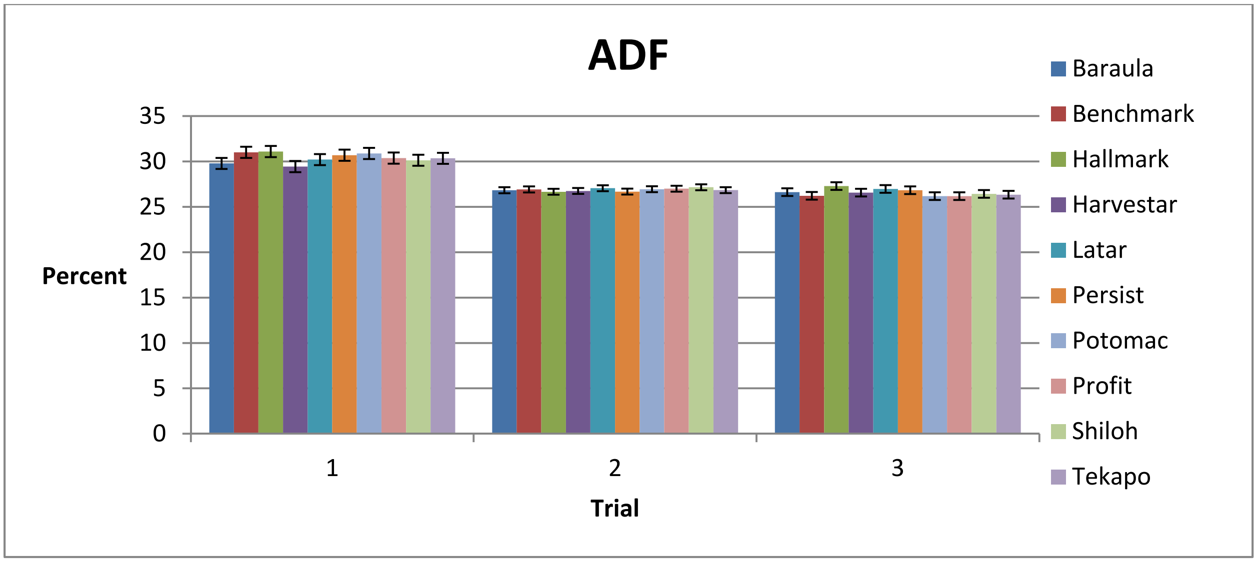

Figure 3.6: Orchardgrass Cultivar ADF

ADF

ADF values between cultivars were extremely similar, and not significantly different in any trial (Figure 3.6). This indicates the relative digestibility of these entries to the animals consuming them would be about the same. ADF values were higher in trial 1 than trials 2 and 3 because the plots had been allowed to grow for a longer period of time prior to grazing.

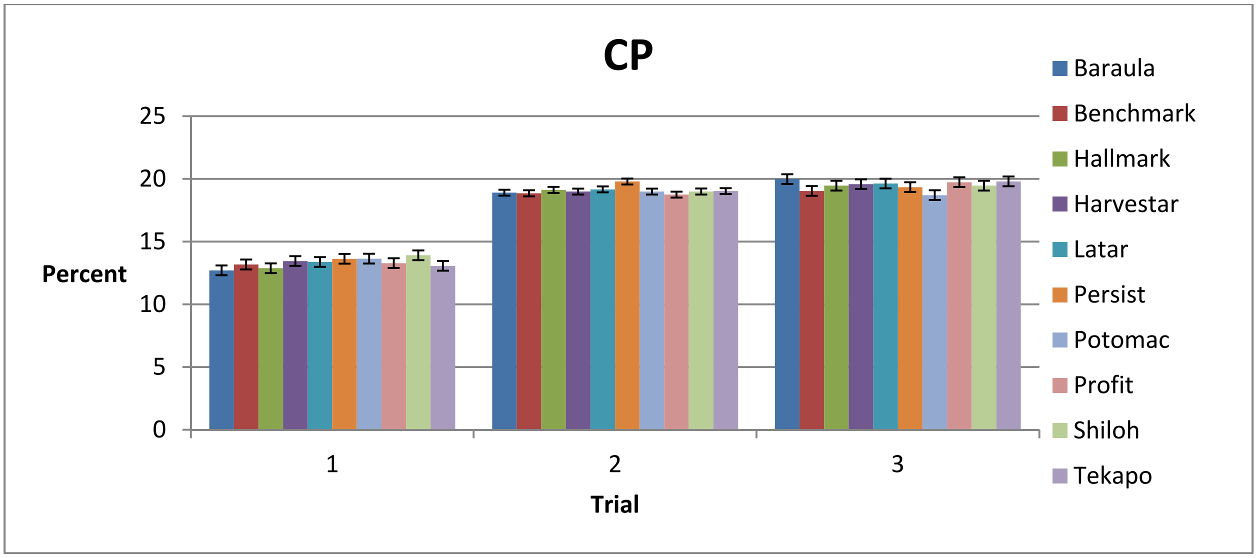

Figure 3.7: Orchardgrass Cultivar CP

CP

Crude protein values between entries were also very similar, with no significantly different cultivars observed at any one trial (Figure 3.7). As with other variable measured, CP is lower in trial 1 because of the greater time between cuttings prior to the first trial's grazing event. Trials 2 and 3 show very similar values due to the identical time between cuttings of roughly one month.

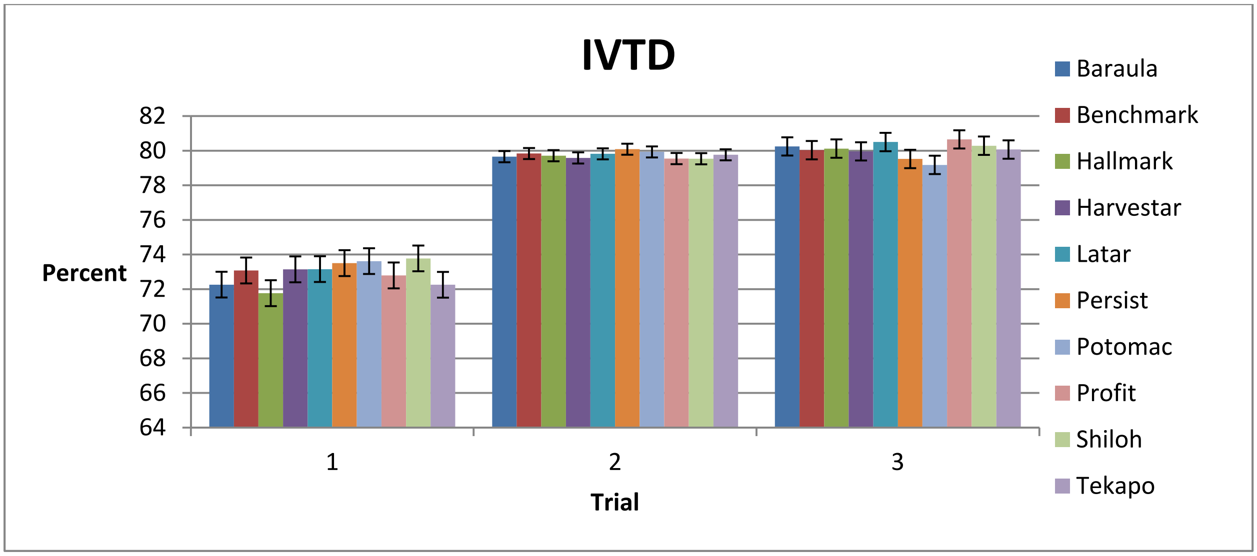

Figure 3.8: Orchardgrass Cultivar IVTD

IVTD

As expected by the similar ADF values, IVTD is not statistically different between cultivars at any trial (Figure 3.8). This means that digestibility was largely the same between entries, and that the animals likely received little dietary benefit form consuming one entry over another. Similar to results of Chapter 2, IVTD exhibits an extremely narrow range of values between cultivars in each trial, with the maximum range occurring between cultivar means across all three trials being about 2% in trial 1.

Discussion

Consumption and Preference

The major objective of this study was to determine the preference of orchardgrass cultivars when grazed by dairy cattle. Consumption of available forage at multiple time points was measured over the course of two years. Palatability was not directly measured, as this would entail measuring minute plant factors that are highly variable and/or require some degree of qualitative measurement within plots such as leaf texture, leaf:stem ratio, etc. Preference was directly measured via measuring the amount of forage consumed in each plot, and converting that to a percentage value of total consumption/total available forage prior to grazing. Therefore, consumption is synonymous with preference. Various morphological factors (yield, sward height, and dry matter content) along with chemical analysis of forage quality components (NDF, ADF, IVTD, and CP) were measured in an attempt to explain any preference trends observed.

Results of this study were similar to those of Chapter 2 in which animals appeared to be unselective, although preference was significantly observed in 50% of the total trials. However, this was only when comparing preference across species. When examining within species comparisons of cultivar for orchardgrass in Chapter 2, only 2 of 6 trials showed significant preference among orchardgrass cultivars. However, this was at the final two trials (5 and 6), where prior to trial 5, animals broke through the fence and heavily trampled plots which caused many orchardgrass stands to be negatively affected.

In this study, significant preference between cultivars was not observed at any of the three trials (Figure 3.1). Again, preference is a difficult variable to accurately measure given individual variation between animals being used in the study. These results match up fairly well with those of the study from Chapter 2, as animals still did not seem to consume any one cultivar significantly more than another at any one time. The individual cultivars show little consistency in ranking from one trial to the next, which makes drawing accurate identification of a strong or poor performing cultivar difficult.

Morphological Factors

Yield at the onset of grazing, height at the onset of grazing, and percent dry matter were examined to determine if a correlation to preference was present. No biologically significant coefficient (>.60) was found to relate to percentage of consumption. Yield was significantly different between cultivars in trial 3 (Figure 3.2), but despite this no significant preference was found. Benchmark Plus and Persist were cultivars that were high yielding in trials 1 and 3, but they were not different from three other cultivars (Potomac, Profit, and Shiloh II). Height was not significantly different between any cultivars at any trial (Figure 3.3), and thus could account for a lack of correlation and why I did not observe preference by the cattle. Dry matter was also not statistically different (Figure 3.4) and as such does not seem to have played a role in affecting animal preference.

Forage Quality/Chemical Analysis

As with the morphological factors measured, forage quality variables did not show any biologically significant correlation to consumption. This is likely because forage quality was remarkably similar across all cultivars at each trial. NDF, ADF, IVTD, and CP were not statistically different at any one trial between the cultivars tested. The study from Chapter 2 utilized six of the cultivars used in this study and found similar results, as only a few instances of different NDF, IVTD, and CP values were present, but still show a very small range of difference between cultivar means. The widest range between cultivar means at any trial occurs for NDF (Figure 3.5) in Trial 1, with a range of 3%. ADF, IVTD, and CP have ranges between cultivar means at any one trial that do not exceed 2%. As with Chapter 2, these results were likely too similar to each other for animals to detect any differences in palatability, thus making their lack of preference unsurprising.

Identifying Causes for Lack of Preference

Lack of observable preference between orchardgrass cultivars, despite other research showing clear preference between forage grass cultivars within a species (Mayland et al., 2000; Smit et al., 2006; Waldron et al. 2010) does lead us to consider what might have caused results that differ from those findings. The most probable explanation is that removal of the reproductive flush of growth that cool season forage grasses (i.e. orchardgrass) all undergo during the spring leads to much more uniform forage quality across cultivars that might not otherwise show similar values. This means that forage quality is heavily impacted by rate of maturity of said forage grasses. Without that confounding factor, the cultivars exhibit extremely narrow ranges between means at any one trial. Animals likely cannot discern such small differences, although from a performance standpoint they would probably still benefit. Uniform fertilization of nitrogen fertilizer between each cutting also can make CP very similar between entries. This tells us those orchardgrass cultivars all appear to respond to nitrogen fertilization in a similar manner. Stands in these plots were very good, being thick and heavily vegetative with little weed pressure and bare ground present. In addition to forage quality, the morphological factors measured showed little marked differences between cultivars tested. Height, and dry matter were very similar, and height differences in particular were not easily noticed when looking at the plots prior to grazing. Unlike the species comparisons in Chapter 2, there were no noticeable and consistent height differences between entries. Yield differences were found only in Trial 3 and there was a high degree of overlap in the mean groupings for comparing the cultivars (Figure 3.2).

A number of issues mentioned with the study in Chapter 2 were addressed within this experiment. Primarily, plot size is much greater; dimensions of each plot were 5x12m, compared to the 1x3m dimensions of plots in the previous study. The total study was about 10 times as large, at 0.4 hectare in size, whereas the Chapter 2 study was only 0.04 hectare. This directly increased the amount of forage present in the whole study, and allowed a greater number of animals to graze for a much longer time period to achieve roughly 50% consumption. Trials 1 and 2 utilized 20 animals over a period of 24-36 hours. Trial 3 utilized 12 animals over 36 hours. Even at these stocking densities, Trial 3 only reached about 40% consumption. Water soluble carbohydrates (WSC) which have been consistently found to be correlated to preference in other research (Smit et al., 2006; Waldron et al., 2010) were not measured. However, given the similar results in forage quality in this study and that of Chapter 2, it is unlikely that values of WSC were substantially different between entries. Another aspect that differs from other studies that have found preference (Shewmaker et al., 1997; Smit et al., 2006) is that these animals were not conditioned on plots identical to those they were grazing prior to allowing them to graze our experimental plots. These other studies show that the animals can be taught to graze one entry more than another, but in the present study the objective was to determine if animals were selective initially, without any form of conditioning.

Conclusions

The results of this study were indicative of there being a lack of observable preference by dairy cattle when grazing cool-season forage grasses that are in a completely vegetative state of growth. This supports the findings of the study in Chapter 2 in which multiple species were tested along with a greater total number of cultivars. It is likely that any observed preference in previous studies was a direct result of not accounting for these differing maturity levels, and the fact that they allowed animals to be conditioned to specific pastures prior to grazing their experimental plots. Differing forage quality is known to exist between grasses that are in a reproductive state of growth and producing stems and tillers higher in lignin and secondary cell wall components, and vegetative grasses which only possess leaves and pseudostems. Morphologically, cattle also dislike plants with a low leaf:stem ratio (i.e. more stems than leaves) and grasses in their reproductive state of growth tend to exhibit these low leaf:stem ratios. Producers wishing to have pastures in which dairy cattle are not selective and will graze a majority of the field, even at low stocking rates, can obtain this result by allowing their fields to begin heading out and remove that growth for a low quality hay. The remainder of the growing season their grass pastures will be in vegetative state of growth and animals will likely graze more uniformly than they would otherwise. Plant breeders should recognize that making selections based on forage quality after plants are in a vegetative state of growth will likely not achieve significantly different results, and that any selections for differing forage quality should be done prior to the end of reproductive growth.

Appendices

Appendix A: Cultivar Summary

The 24 cultivars utilized in the Chapter 2 study were selected in order to achieve a wide, representative range of varying maturities and previously established factors such as preference, maturity, and genetic lineage. What follows is a brief summary of each cultivar in regards to its release and general agronomic advantages.

Eight cultivars of orchardgrass are represented in this study. Benchmark Plus was released through FFR Cooperative, through mass selection of 66 clones of the cultivar Benchmark (Xie et al., 2014) for persistence under grazing. It is early maturing and has strong rust resistance like its parent cultivar Benchmark. The cultivar Harvestar was developed as a five-clone synthetic from cultivars Dawn, Arly, Lude, and Berber, released through Radix Research (Xie et al., 2014). It was selected for improved yields and cold tolerance. Persist is a widely known cultivar developed by Dr. Bob Conger and the University of Tennessee. It was developed as a 6-clone synthetic from old stands in Tennessee with selection primarily focusing on improved persistence under grazing (Xie et al., 2014). Potomac is the oldest cultivar of orchardgrass tested. It was released in 1954 by the USDA-ARS, with its origins beginning in 1935 from selections in old pastures located in Maryland, Virginia, West Virginia, and Pennsylvania (Alderson and Sharp, 1994). Potomac is the third cycle of mass selection for leafiness, persistence, and vigor from a nursery started in 1945 from the original 1935 selections. The cultivar Prairie was developed and released at the University of Kentucky as a synthetic from older, high yielding cultivars in Kentucky (Xie et al., 2014). It was selected for later maturity and strong seedling vigor. Prodigy is a cultivar released in 2007 from Blue Moon Farms LLC by Dr. Virginia Lehman. It is a six-clone synthetic with parent material originating in Missouri and selected for stem rust resistance. The cultivar Profit, released through AMPAC Seed is derived from a synthetic population beginning from the cultivar Justus (Xie et al., 2014). It was selected mainly for increased biomass yields, and is also later maturing and disease resistant. The final orchardgrass cultivar, Tekapo, originated from material collected in Portugal and Spain, then bred and selected for improved persistence under grazing and drought tolerance in New Zealand (Lolicato and Rumball, 1994).

Four additional cultivars of orchardgrass were used in Chapter 3. Latar is an older cultivar released in 1957 by the USDA-SCS and Washington State University. It originated from selections in 1934 in Leningrad (St. Petersburg), Russia (Alderson and Sharp, 1994). It was selected as a much later maturing cultivar, maturing 10-14 days later than many other cultivars. Shiloh II. Developed by Radix Research, Inc., Shiloh II is an early maturing cultivar that was selected for winter hardiness and good persistence. Baruala is a cultivar marketed through Barenbrug Seeds. It was selected for later maturity to grow with alfalfa hay, winter hardiness, and greater leaf:stem ratio. Finally, Hallmark is a cultivar developed from selections in Indiana in the 1969 by the Farmers Forage Research Cooperative using clones of Boone, Potomac, and germplasm from the University of Illinois and Eastern States Farmers Exchange. It is widely adapted to climates across the temperate United States.

Six festulolium cultivars were utilized for Chapter 2. Barfest is a cultivar that orginated from introgression of perennial ryegrass with meadow fescue (*Festuca pratensis* Huds.) (Ghesquière et al., 2009). It was released through Barenbrug Seed and was selected for improved persistence and later maturity. Duo is another festulolium cultivar developed through introgression of perennial ryegrass and meadow fescue (Ghesquière et al., 2009). Duo exhibits phenotypes of both tetraploid perennial ryegrasses (high sugar content) and meadow fescue (increased persistence). KYFA1015 is an unreleased polycross population of festuloliums originating from three cycles of selection for grazing tolerance of the Kemal cultivar. KYFA1016 also originates from the same parent cultivar as KYFA1015, Kemal, except this population came from three cycles of selection of Kemal from plants persisting after three years of harvest for hay, rather than grazing (Phillips, 2015). Perun is the result of an amphiploidy from crossing annual ryegrass (*Lolium multiflorum* Lam.) with meadow fescue (Ghesquière et al., 2009). The phenotype is predominately akin to annual ryegrass, but has the deep rooting of meadow fescue. Finally, SpringGreen originates from an amphiploidy cross between perennial ryegrass and meadow fescue (Ghesquière et al., 2009). SpringGreen was specifically selected for improved cold tolerance compared to other festulolium cultivars.

Five perennial ryegrass cultivars were selected for the grazing trials. Marketed through Barenbrug Seed, BG34 is a blend of four diploid perennial ryegrass cultivars: Barnhem, Barmoco, Bartlet, and Mara, and the ratio of each vary from year to year (Liu, 2005). Calibra is a tetraploid perennial ryegrass (Bolaric et al., 2008) that has been selected for increased winter hardiness and sugar content and originated from parent material in Western Europe. Granddaddy is a tetraploid cultivar originating from material in the United States, and is an early maturing variety of perennial ryegrass bred for improved forage quality (Sokolovi´c et al., 2010). The cultivar Linn is also an older cultivar released in 1961, originating from New Zealand, and selected in Oregon for improved perennial crop characteristics such as stand persistence and winter hardiness (Alderson and Sharp, 1994). The final cultivar, Power, is a tetraploid cultivar which is later maturing than other ryegrasses and marketed through Ampac Seed Company (Olson et al., 2013).

Lastly, five tall fescue cultivars were chosen to represent the species in this study. All are endophyte free cultivars. Bariane and Barolex are two cultivars marketed through Barenbrug Seed. Both are soft leaf fescues, and originate from material in the Netherlands. Both have been shown to perform well in preference trials and are very winter-hardy (Shaefer et al., 2014). Jesup EF (Endophyte Free) is a cultivar developed by Joe Bouton at the University of Georgia as a 15 clone synthetic cultivar, developed from over five generations. It was selected for high forage quality to use as animal fodder in the upper south. Select is a cultivar released in 1999, originating from selections of old stands of KY31 tall fescue, and treated to be endophyte free. It is still largely similar to KY31 in regards to agronomic characteristics. Lastly, KYFA9611 is a 20 clone synthetic of giant fescue and Kenhy tall fescue lines. It was originally developed in 1996 and will be released in 2016. It has greater succulence and leafiness (Phillips, 2015).

Appendix B: Crabgrass and Stand Ratings for Trial 6

Table B.1: Crabgrass and Stand Rating for Species

Species Crabgrass and Stand, Trial 6		
Species	**Crabgrass Rating**	**Stand Rating**
Festul	5.1a	4.3b
OG	3.3b	6.6a
PRG	4.9a	6.2a
TF	3.3b	6.5a
Mean	4.2	5.9
Significance	**	**

* *Significant at p<0.05

Table B.2: Festulolium Cultivar Crabgrass and Stand Rating

Festulolium Crabgrass and Stand, Trial 6		
Cultivar	**Crabgrass Rating**	**Stand Rating**
Barfest	5.5a	4.6ab
Duo	6.1a	4bc
KYFA1015	6.1a	4.1b
KYFA1016	4.6ab	6a
Perun	3.5b	2.3c
SpringGreen	4.6ab	4.8ab
Mean	5.1	4.3
Significance	*	*

*Significant at p<0.10

Table B.3: Orchardgrass Cultivar Crabgrass and Stand Rating

Orchardgrass Crabgrass and Stand, Trial 6

Cultivar	**Crabgrass Rating**	**Stand Rating**
Benchmark_Plus	2c	8.1a
Harvestar	3.8b	5.8b
Persist	2.1c	7ab
Potomac	2c	8.1a
Prairie	3.8b	6.8b
Prodigy	2.6bc	7ab
Profit	3.8b	6.5b
Tekapo	5.8a	3.6c
Mean	3.2	6.6
Significance	***	***

***Significant at p<.01

Table B.4: Perennial Ryegrass Cultivar Crabgrass and Stand Rating

Perennial Ryegrass Crabgrass and Stand, Trial 6

Cultivar	**Crabgrass Rating**	**Stand Rating**
BG34	3.1	7.8a
Calibra	5.3	6.3ab
Granddaddy	5.8	4.5b
Linn	5.5	5.8b
Power	4.5	6.3ab
Mean	4.8	6.1
Significance	NS	*

*Significant at p<0.10

NS, Not significant

Table B.5: Tall Fescue Cultivar Crabgrass and Stand Rating

Tall Fescue Crabgrass and Stand, Trial 6		
Cultivar	**Crabgrass Rating**	**Stand Rating**
Bariane	3.6	6.1b
Barolex	1.8	8.8a
Jesup EF	4.1	5.1b
KYFA9611	3.8	5.6b
Select	3.0	6.8b
Mean	3.3	6.5
Significance	NS	**

**Significant at p<.05

NS, Not significant

Appendix C: Post Grazing Agronomic Raw Data

Table C.1: Post Grazing Agronomic Raw Data

Plot	Rep	Variety	Species	Year	Trial	Post Yield Kg/ha	Post_height cm	Rating
101	1	Duo	Festul	1	1	527.9	11.9	4
102	1	Perun	Festul	1	1	508.4	10.2	6
103	1	Harvestar	OG	1	1	723.5	13.5	6
104	1	Potomac	OG	1	1	332.4	11.9	7
105	1	KYFA1015	Festul	1	1	567.0	9.3	7
106	1	Granddaddy	PRG	1	1	430.2	11.9	2
107	1	BG34	PRG	1	1	1192.7	13.5	2
108	1	Barolex	TF	1	1	391.1	11.9	2
109	1	Jesup_EF	TF	1	1	312.8	9.3	1
110	1	SpringGreen	Festul	1	1	527.9	11.9	4
111	1	KYFA1016	Festul	1	1	449.7	10.2	6
112	1	KYFA9611	TF	1	1	1075.4	10.2	2
113	1	Calibra	PRG	1	1	684.3	11.9	3
114	1	Profit	OG	1	1	586.6	12.7	7
115	1	Power	PRG	1	1	273.7	11.0	5
116	1	Prodigy	OG	1	1	527.9	15.2	5
117	1	Prairie	OG	1	1	684.3	16.1	5
118	1	Barfest	Festul	1	1	410.6	13.5	5
119	1	Tekapo	OG	1	1	156.4	11.9	7

120	1	Persist	OG	1	1	391.1	13.5	8
121	1	Bariane	TF	1	1	723.5	12.7	7
122	1	Select	TF	1	1	743.0	12.7	4
123	1	Benchmark_Plus	OG	1	1	391.1	16.1	7
124	1	Linn	PRG	1	1	410.6	11.9	5
201	2	KYFA1016	Festul	1	1	215.1	11.0	6
202	2	SpringGreen	Festul	1	1	449.7	11.0	6
203	2	Barolex	TF	1	1	567.0	12.7	3
204	2	Prodigy	OG	1	1	469.3	12.7	6
205	2	Linn	PRG	1	1	430.2	9.3	1
206	2	Duo	Festul	1	1	449.7	12.7	4
207	2	Prairie	OG	1	1	469.3	11.9	5
208	2	Tekapo	OG	1	1	195.5	10.2	3
209	2	Perun	Festul	1	1	547.5	14.4	5
210	2	KYFA1015	Festul	1	1	547.5	13.5	8
211	2	Potomac	OG	1	1	371.5	10.2	6
212	2	Select	TF	1	1	371.5	11.0	3
213	2	Granddaddy	PRG	1	1	703.9	16.1	2
214	2	Bariane	TF	1	1	645.2	14.4	7
215	2	Profit	OG	1	1	195.5	13.5	7
216	2	Benchmark_Plus	OG	1	1	273.7	12.7	6
217	2	Harvestar	OG	1	1	293.3	10.2	5
218	2	Barfest	Festul	1	1	469.3	12.7	4
219	2	Power	PRG	1	1	449.7	12.7	5
220	2	Persist	OG	1	1	371.5	11.9	8
221	2	KYFA9611	TF	1	1	664.8	12.7	4
222	2	BG34	PRG	1	1	703.9	12.7	1
223	2	Jesup_EF	TF	1	1	430.2	11.9	2
224	2	Calibra	PRG	1	1	684.3	13.5	5
301	3	KYFA9611	TF	1	1	801.7	18.6	4
302	3	Barfest	Festul	1	1	625.7	11.9	6
303	3	Duo	Festul	1	1	293.3	11.9	6
304	3	Perun	Festul	1	1	586.6	15.2	8
305	3	Barolex	TF	1	1	586.6	11.9	4
306	3	Calibra	PRG	1	1	527.9	14.4	4
307	3	Prairie	OG	1	1	410.6	16.9	8
308	3	Granddaddy	PRG	1	1	508.4	10.2	2
309	3	Persist	OG	1	1	410.6	11.9	3
310	3	Benchmark_Plus	OG	1	1	508.4	16.1	8
311	3	Harvestar	OG	1	1	351.9	13.5	8
312	3	Linn	PRG	1	1	430.2	12.7	2
313	3	Potomac	OG	1	1	527.9	11.9	4
314	3	KYFA1016	Festul	1	1	371.5	11.9	7
315	3	Tekapo	OG	1	1	176.0	7.6	8
316	3	KYFA1015	Festul	1	1	567.0	11.9	7

317	3	Profit	OG	1	1	469.3	11.9	6
318	3	SpringGreen	Festul	1	1	469.3	10.2	3
319	3	BG34	PRG	1	1	547.5	11.0	2
320	3	Prodigy	OG	1	1	977.6	11.0	4
321	3	Bariane	TF	1	1	586.6	9.3	7
322	3	Power	PRG	1	1	743.0	12.7	2
323	3	Select	TF	1	1	664.8	19.5	4
324	3	Jesup_EF	TF	1	1	488.8	11.9	1
401	4	Bariane	TF	1	1	332.4	10.2	3
402	4	Linn	PRG	1	1	567.0	11.9	1
403	4	KYFA9611	TF	1	1	469.3	15.2	5
404	4	Jesup_EF	TF	1	1	1036.3	16.1	1
405	4	Persist	OG	1	1	508.4	11.0	7
406	4	Benchmark_Plus	OG	1	1	371.5	11.0	6
407	4	Profit	OG	1	1	156.4	12.7	5
408	4	Harvestar	OG	1	1	567.0	16.1	5
409	4	SpringGreen	Festul	1	1	547.5	11.9	6
410	4	Duo	Festul	1	1	410.6	13.5	5
411	4	Calibra	PRG	1	1	430.2	11.9	6
412	4	Select	TF	1	1	391.1	11.0	2
413	4	Prodigy	OG	1	1	508.4	12.7	4
414	4	Barfest	Festul	1	1	508.4	13.5	5
415	4	Barolex	TF	1	1	547.5	16.9	2
416	4	Perun	Festul	1	1	156.4	11.9	7
417	4	KYFA1015	Festul	1	1	195.5	11.0	2
418	4	Prairie	OG	1	1	312.8	12.7	7
419	4	Tekapo	OG	1	1	97.8	7.6	8
420	4	BG34	PRG	1	1	684.3	11.9	4
421	4	KYFA1016	Festul	1	1	449.7	8.5	5
422	4	Power	PRG	1	1	743.0	15.2	3
423	4	Granddaddy	PRG	1	1	430.2	11.9	4
424	4	Potomac	OG	1	1	449.7	15.2	6
501	5	Bariane	TF	1	1	527.9	10.2	6
502	5	Persist	OG	1	1	195.5	11.0	6
503	5	Tekapo	OG	1	1	58.7	13.5	8
504	5	Perun	Festul	1	1	391.1	14.4	8
505	5	Barolex	TF	1	1	586.6	14.4	2
506	5	BG34	PRG	1	1	938.5	14.4	2
507	5	Profit	OG	1	1	293.3	11.9	5
508	5	Prairie	OG	1	1	156.4	10.2	4
509	5	Linn	PRG	1	1	391.1	12.7	1
510	5	Benchmark_Plus	OG	1	1	371.5	14.4	6
511	5	Potomac	OG	1	1	332.4	12.7	7
512	5	Power	PRG	1	1	860.3	13.5	5
513	5	SpringGreen	Festul	1	1	449.7	14.4	5

514	5	Jesup_EF	TF	1	1	997.2	17.8	1
515	5	Select	TF	1	1	782.1	14.4	3
516	5	Calibra	PRG	1	1	664.8	11.0	4
517	5	Granddaddy	PRG	1	1	684.3	13.5	5
518	5	KYFA9611	TF	1	1	586.6	14.4	4
519	5	Duo	Festul	1	1	508.4	12.7	3
520	5	Barfest	Festul	1	1	625.7	13.5	5
521	5	Prodigy	OG	1	1	567.0	15.2	6
522	5	KYFA1015	Festul	1	1	430.2	11.9	8
523	5	KYFA1016	Festul	1	1	547.5	11.0	7
524	5	Harvestar	OG	1	1	234.6	11.0	8
601	6	KYFA1015	Festul	1	1	332.4	9.3	7
602	6	Profit	OG	1	1	371.5	10.2	6
603	6	Linn	PRG	1	1	391.1	11.9	1
604	6	Barfest	Festul	1	1	606.1	13.5	4
605	6	Prodigy	OG	1	1	508.4	14.4	4
606	6	Harvestar	OG	1	1	312.8	10.2	8
607	6	Power	PRG	1	1	469.3	12.7	5
608	6	Benchmark_Plus	OG	1	1	508.4	15.2	4
609	6	Jesup_EF	TF	1	1	782.1	16.1	2
610	6	Prairie	OG	1	1	215.1	13.5	7
611	6	BG34	PRG	1	1	430.2	14.4	2
612	6	Select	TF	1	1	664.8	14.4	2
613	6	Duo	Festul	1	1	527.9	12.7	5
614	6	KYFA1016	Festul	1	1	449.7	12.7	6
615	6	Perun	Festul	1	1	449.7	14.4	6
616	6	Granddaddy	PRG	1	1	371.5	11.9	5
617	6	Barolex	TF	1	1	391.1	12.7	3
618	6	Potomac	OG	1	1	234.6	11.0	8
619	6	Tekapo	OG	1	1	176.0	6.8	9
620	6	Calibra	PRG	1	1	410.6	10.2	4
621	6	SpringGreen	Festul	1	1	371.5	11.0	5
622	6	Bariane	TF	1	1	312.8	8.5	5
623	6	Persist	OG	1	1	410.6	11.0	5
624	6	KYFA9611	TF	1	1	625.7	18.6	3
101	1	Duo	Festul	1	2	547.5	10.2	3
102	1	Perun	Festul	1	2	567.0	11.9	4
103	1	Harvestar	OG	1	2	449.7	13.5	6
104	1	Potomac	OG	1	2	430.2	14.4	6
105	1	KYFA1015	Festul	1	2	762.6	15.2	4
106	1	Granddaddy	PRG	1	2	488.8	10.2	3
107	1	BG34	PRG	1	2	606.1	13.5	2
108	1	Barolex	TF	1	2	332.4	10.2	3
109	1	Jesup_EF	TF	1	2	254.2	9.3	5
110	1	SpringGreen	Festul	1	2	879.9	13.5	5

111	1	KYFA1016	Festul	1	2	723.5	12.7	4
112	1	KYFA9611	TF	1	2	293.3	10.2	3
113	1	Calibra	PRG	1	2	391.1	7.6	2
114	1	Profit	OG	1	2	782.1	11.9	6
115	1	Power	PRG	1	2	273.7	11.0	8
116	1	Prodigy	OG	1	2	1075.4	10.2	7
117	1	Prairie	OG	1	2	586.6	12.7	5
118	1	Barfest	Festul	1	2	586.6	15.2	2
119	1	Tekapo	OG	1	2	332.4	12.7	6
120	1	Persist	OG	1	2	723.5	13.5	7
121	1	Bariane	TF	1	2	176.0	8.5	8
122	1	Select	TF	1	2	547.5	15.2	6
123	1	Benchmark_Plus	OG	1	2	723.5	13.5	5
124	1	Linn	PRG	1	2	312.8	10.2	3
201	2	KYFA1016	Festul	1	2	371.5	11.0	3
202	2	SpringGreen	Festul	1	2	645.2	11.0	4
203	2	Barolex	TF	1	2	488.8	9.3	5
204	2	Prodigy	OG	1	2	508.4	12.7	2
205	2	Linn	PRG	1	2	508.4	11.0	1
206	2	Duo	Festul	1	2	762.6	11.0	3
207	2	Prairie	OG	1	2	371.5	11.9	3
208	2	Tekapo	OG	1	2	645.2	10.2	4
209	2	Perun	Festul	1	2	469.3	11.9	6
210	2	KYFA1015	Festul	1	2	664.8	15.2	3
211	2	Potomac	OG	1	2	703.9	12.7	4
212	2	Select	TF	1	2	195.5	10.2	7
213	2	Granddaddy	PRG	1	2	1016.7	15.2	1
214	2	Bariane	TF	1	2	410.6	10.2	7
215	2	Profit	OG	1	2	430.2	16.1	5
216	2	Benchmark_Plus	OG	1	2	312.8	12.7	3
217	2	Harvestar	OG	1	2	254.2	13.5	5
218	2	Barfest	Festul	1	2	919.0	13.5	2
219	2	Power	PRG	1	2	977.6	11.9	7
220	2	Persist	OG	1	2	567.0	14.4	5
221	2	KYFA9611	TF	1	2	254.2	11.0	7
222	2	BG34	PRG	1	2	919.0	11.0	3
223	2	Jesup_EF	TF	1	2	234.6	10.2	2
224	2	Calibra	PRG	1	2	645.2	10.2	6
301	3	KYFA9611	TF	1	2	449.7	14.4	7
302	3	Barfest	Festul	1	2	860.3	11.0	3
303	3	Duo	Festul	1	2	625.7	12.7	2
304	3	Perun	Festul	1	2	508.4	9.3	7
305	3	Barolex	TF	1	2	293.3	11.9	7
306	3	Calibra	PRG	1	2	840.8	13.5	3
307	3	Prairie	OG	1	2	762.6	14.4	4

308	3	Granddaddy	PRG	1	2	645.2	13.5	3
309	3	Persist	OG	1	2	273.7	11.9	4
310	3	Benchmark_Plus	OG	1	2	801.7	16.1	5
311	3	Harvestar	OG	1	2	351.9	13.5	3
312	3	Linn	PRG	1	2	840.8	12.7	2
313	3	Potomac	OG	1	2	469.3	12.7	5
314	3	KYFA1016	Festul	1	2	586.6	9.3	3
315	3	Tekapo	OG	1	2	136.9	11.0	7
316	3	KYFA1015	Festul	1	2	606.1	13.5	3
317	3	Profit	OG	1	2	391.1	12.7	4
318	3	SpringGreen	Festul	1	2	567.0	14.4	3
319	3	BG34	PRG	1	2	1075.4	15.2	2
320	3	Prodigy	OG	1	2	527.9	11.0	5
321	3	Bariane	TF	1	2	234.6	10.2	8
322	3	Power	PRG	1	2	743.0	14.4	4
323	3	Select	TF	1	2	782.1	16.1	3
324	3	Jesup_EF	TF	1	2	234.6	14.4	2
401	4	Bariane	TF	1	2	156.4	5.9	8
402	4	Linn	PRG	1	2	703.9	12.7	2
403	4	KYFA9611	TF	1	2	254.2	9.3	7
404	4	Jesup_EF	TF	1	2	586.6	11.9	3
405	4	Persist	OG	1	2	430.2	11.0	7
406	4	Benchmark_Plus	OG	1	2	645.2	11.9	4
407	4	Profit	OG	1	2	136.9	12.7	4
408	4	Harvestar	OG	1	2	469.3	10.2	4
409	4	SpringGreen	Festul	1	2	488.8	14.4	3
410	4	Duo	Festul	1	2	371.5	12.7	3
411	4	Calibra	PRG	1	2	410.6	10.2	3
412	4	Select	TF	1	2	97.8	9.3	2
413	4	Prodigy	OG	1	2	293.3	10.2	7
414	4	Barfest	Festul	1	2	547.5	15.2	3
415	4	Barolex	TF	1	2	332.4	11.0	5
416	4	Perun	Festul	1	2	508.4	14.4	6
417	4	KYFA1015	Festul	1	2	743.0	15.2	2
418	4	Prairie	OG	1	2	547.5	13.5	5
419	4	Tekapo	OG	1	2	19.6	10.2	3
420	4	BG34	PRG	1	2	782.1	10.2	3
421	4	KYFA1016	Festul	1	2	488.8	10.2	5
422	4	Power	PRG	1	2	625.7	9.3	4
423	4	Granddaddy	PRG	1	2	351.9	11.0	4
424	4	Potomac	OG	1	2	195.5	11.0	5
501	5	Bariane	TF	1	2	97.8	9.3	8
502	5	Persist	OG	1	2	176.0	11.9	4
503	5	Tekapo	OG	1	2	1427.4	11.0	8
504	5	Perun	Festul	1	2	273.7	10.2	3

505	5	Barolex	TF	1	2	293.3	11.9	4
506	5	BG34	PRG	1	2	664.8	14.4	2
507	5	Profit	OG	1	2	606.1	13.5	4
508	5	Prairie	OG	1	2	215.1	11.0	4
509	5	Linn	PRG	1	2	254.2	12.7	1
510	5	Benchmark_Plus	OG	1	2	606.1	12.7	4
511	5	Potomac	OG	1	2	645.2	12.7	4
512	5	Power	PRG	1	2	938.5	12.7	6
513	5	SpringGreen	Festul	1	2	782.1	15.2	3
514	5	Jesup_EF	TF	1	2	801.7	13.5	3
515	5	Select	TF	1	2	351.9	9.3	4
516	5	Calibra	PRG	1	2	391.1	9.3	4
517	5	Granddaddy	PRG	1	2	312.8	11.9	1
518	5	KYFA9611	TF	1	2	371.5	11.9	6
519	5	Duo	Festul	1	2	410.6	13.5	2
520	5	Barfest	Festul	1	2	606.1	11.9	2
521	5	Prodigy	OG	1	2	723.5	15.2	7
522	5	KYFA1015	Festul	1	2	547.5	14.4	2
523	5	KYFA1016	Festul	1	2	782.1	13.5	2
524	5	Harvestar	OG	1	2	527.9	14.4	7
601	6	KYFA1015	Festul	1	2	606.1	12.7	3
602	6	Profit	OG	1	2	606.1	11.0	4
603	6	Linn	PRG	1	2	567.0	9.3	1
604	6	Barfest	Festul	1	2	645.2	13.5	3
605	6	Prodigy	OG	1	2	1329.6	16.9	4
606	6	Harvestar	OG	1	2	860.3	13.5	5
607	6	Power	PRG	1	2	391.1	9.3	5
608	6	Benchmark_Plus	OG	1	2	625.7	14.4	4
609	6	Jesup_EF	TF	1	2	293.3	8.5	3
610	6	Prairie	OG	1	2	293.3	12.7	6
611	6	BG34	PRG	1	2	664.8	14.4	4
612	6	Select	TF	1	2	508.4	16.1	2
613	6	Duo	Festul	1	2	586.6	12.7	3
614	6	KYFA1016	Festul	1	2	469.3	13.5	4
615	6	Perun	Festul	1	2	645.2	13.5	2
616	6	Granddaddy	PRG	1	2	195.5	11.0	3
617	6	Barolex	TF	1	2	254.2	7.6	5
618	6	Potomac	OG	1	2	508.4	11.9	5
619	6	Tekapo	OG	1	2	351.9	9.3	7
620	6	Calibra	PRG	1	2	469.3	7.6	6
621	6	SpringGreen	Festul	1	2	645.2	10.2	3
622	6	Bariane	TF	1	2	136.9	6.8	9
623	6	Persist	OG	1	2	664.8	11.0	5
624	6	KYFA9611	TF	1	2	410.6	10.2	4
101	1	Duo	Festul	1	3	547.5	11.9	4

102	1	Perun	Festul	1	3	801.7	11.9	4
103	1	Harvestar	OG	1	3	1075.4	17.8	4
104	1	Potomac	OG	1	3	547.5	14.4	5
105	1	KYFA1015	Festul	1	3	410.6	10.2	8
106	1	Granddaddy	PRG	1	3	508.4	11.0	5
107	1	BG34	PRG	1	3	821.2	16.1	2
108	1	Barolex	TF	1	3	1525.1	23.7	1
109	1	Jesup_EF	TF	1	3	1270.9	18.6	3
110	1	SpringGreen	Festul	1	3	625.7	9.3	7
111	1	KYFA1016	Festul	1	3	371.5	9.3	7
112	1	KYFA9611	TF	1	3	469.3	11.9	2
113	1	Calibra	PRG	1	3	508.4	9.3	2
114	1	Profit	OG	1	3	703.9	12.7	7
115	1	Power	PRG	1	3	860.3	11.0	7
116	1	Prodigy	OG	1	3	606.1	11.9	6
117	1	Prairie	OG	1	3	879.9	15.2	6
118	1	Barfest	Festul	1	3	703.9	12.7	7
119	1	Tekapo	OG	1	3	1388.2	17.8	3
120	1	Persist	OG	1	3	762.6	16.9	4
121	1	Bariane	TF	1	3	547.5	11.9	3
122	1	Select	TF	1	3	664.8	14.4	2
123	1	Benchmark_Plus	OG	1	3	1055.8	17.8	7
124	1	Linn	PRG	1	3	1622.9	19.5	5
201	2	KYFA1016	Festul	1	3	1036.3	16.1	5
202	2	SpringGreen	Festul	1	3	684.3	11.0	6
203	2	Barolex	TF	1	3	586.6	11.0	7
204	2	Prodigy	OG	1	3	488.8	13.5	7
205	2	Linn	PRG	1	3	743.0	11.0	2
206	2	Duo	Festul	1	3	801.7	12.7	4
207	2	Prairie	OG	1	3	684.3	11.9	6
208	2	Tekapo	OG	1	3	782.1	14.4	4
209	2	Perun	Festul	1	3	801.7	12.7	6
210	2	KYFA1015	Festul	1	3	743.0	12.7	3
211	2	Potomac	OG	1	3	899.4	16.9	4
212	2	Select	TF	1	3	1075.4	15.2	3
213	2	Granddaddy	PRG	1	3	1016.7	16.1	2
214	2	Bariane	TF	1	3	332.4	9.3	8
215	2	Profit	OG	1	3	919.0	13.5	4
216	2	Benchmark_Plus	OG	1	3	1075.4	22.9	6
217	2	Harvestar	OG	1	3	821.2	20.3	8
218	2	Barfest	Festul	1	3	782.1	12.7	5
219	2	Power	PRG	1	3	684.3	11.0	3
220	2	Persist	OG	1	3	606.1	17.8	5
221	2	KYFA9611	TF	1	3	1095.0	11.9	4
222	2	BG34	PRG	1	3	879.9	13.5	2

223	2	Jesup_EF	TF	1	3	1134.1	13.5	1
224	2	Calibra	PRG	1	3	1075.4	15.2	3
301	3	KYFA9611	TF	1	3	1075.4	16.9	3
302	3	Barfest	Festul	1	3	645.2	9.3	7
303	3	Duo	Festul	1	3	821.2	11.0	5
304	3	Perun	Festul	1	3	743.0	13.5	6
305	3	Barolex	TF	1	3	958.1	13.5	4
306	3	Calibra	PRG	1	3	840.8	13.5	5
307	3	Prairie	OG	1	3	743.0	16.1	4
308	3	Granddaddy	PRG	1	3	1583.8	16.9	4
309	3	Persist	OG	1	3	1270.9	19.5	2
310	3	Benchmark_Plus	OG	1	3	958.1	16.9	2
311	3	Harvestar	OG	1	3	782.1	16.9	3
312	3	Linn	PRG	1	3	801.7	14.4	4
313	3	Potomac	OG	1	3	801.7	12.7	5
314	3	KYFA1016	Festul	1	3	762.6	11.0	4
315	3	Tekapo	OG	1	3	684.3	14.4	6
316	3	KYFA1015	Festul	1	3	547.5	11.9	3
317	3	Profit	OG	1	3	606.1	14.4	5
318	3	SpringGreen	Festul	1	3	684.3	12.7	7
319	3	BG34	PRG	1	3	1036.3	12.7	2
320	3	Prodigy	OG	1	3	1192.7	16.1	4
321	3	Bariane	TF	1	3	743.0	11.9	8
322	3	Power	PRG	1	3	782.1	10.2	5
323	3	Select	TF	1	3	1427.4	18.6	4
324	3	Jesup_EF	TF	1	3	1446.9	18.6	4
401	4	Bariane	TF	1	3	1075.4	16.1	6
402	4	Linn	PRG	1	3	1173.2	16.9	3
403	4	KYFA9611	TF	1	3	977.6	11.9	4
404	4	Jesup_EF	TF	1	3	919.0	11.9	3
405	4	Persist	OG	1	3	1153.6	13.5	4
406	4	Benchmark_Plus	OG	1	3	567.0	14.4	5
407	4	Profit	OG	1	3	586.6	12.7	3
408	4	Harvestar	OG	1	3	547.5	13.5	5
409	4	SpringGreen	Festul	1	3	645.2	11.9	6
410	4	Duo	Festul	1	3	488.8	10.2	7
411	4	Calibra	PRG	1	3	527.9	11.9	5
412	4	Select	TF	1	3	821.2	14.4	3
413	4	Prodigy	OG	1	3	567.0	13.5	5
414	4	Barfest	Festul	1	3	625.7	11.0	3
415	4	Barolex	TF	1	3	1055.8	16.9	3
416	4	Perun	Festul	1	3	782.1	19.5	3
417	4	KYFA1015	Festul	1	3	684.3	14.4	6
418	4	Prairie	OG	1	3	1036.3	16.9	6
419	4	Tekapo	OG	1	3	449.7	11.0	2

420	4	BG34	PRG	1	3	782.1	14.4	3
421	4	KYFA1016	Festul	1	3	684.3	11.9	6
422	4	Power	PRG	1	3	703.9	11.0	6
423	4	Granddaddy	PRG	1	3	645.2	10.2	3
424	4	Potomac	OG	1	3	664.8	13.5	7
501	5	Bariane	TF	1	3	547.5	9.3	7
502	5	Persist	OG	1	3	782.1	15.2	4
503	5	Tekapo	OG	1	3	117.3	13.5	7
504	5	Perun	Festul	1	3	430.2	11.9	3
505	5	Barolex	TF	1	3	821.2	12.7	2
506	5	BG34	PRG	1	3	821.2	12.7	4
507	5	Profit	OG	1	3	469.3	15.2	4
508	5	Prairie	OG	1	3	801.7	17.8	4
509	5	Linn	PRG	1	3	801.7	15.2	2
510	5	Benchmark_Plus	OG	1	3	801.7	17.8	3
511	5	Potomac	OG	1	3	684.3	14.4	6
512	5	Power	PRG	1	3	703.9	14.4	5
513	5	SpringGreen	Festul	1	3	606.1	13.5	7
514	5	Jesup_EF	TF	1	3	919.0	14.4	2
515	5	Select	TF	1	3	938.5	15.2	4
516	5	Calibra	PRG	1	3	469.3	12.7	2
517	5	Granddaddy	PRG	1	3	703.9	12.7	4
518	5	KYFA9611	TF	1	3	625.7	11.0	3
519	5	Duo	Festul	1	3	469.3	11.0	4
520	5	Barfest	Festul	1	3	567.0	13.5	5
521	5	Prodigy	OG	1	3	723.5	16.1	6
522	5	KYFA1015	Festul	1	3	703.9	12.7	4
523	5	KYFA1016	Festul	1	3	977.6	15.2	4
524	5	Harvestar	OG	1	3	840.8	16.9	2
601	6	KYFA1015	Festul	1	3	958.1	15.2	6
602	6	Profit	OG	1	3	821.2	14.4	7
603	6	Linn	PRG	1	3	821.2	14.4	1
604	6	Barfest	Festul	1	3	703.9	14.4	6
605	6	Prodigy	OG	1	3	664.8	16.1	6
606	6	Harvestar	OG	1	3	801.7	18.6	4
607	6	Power	PRG	1	3	430.2	10.2	7
608	6	Benchmark_Plus	OG	1	3	743.0	16.1	5
609	6	Jesup_EF	TF	1	3	938.5	15.2	2
610	6	Prairie	OG	1	3	351.9	14.4	3
611	6	BG34	PRG	1	3	782.1	14.4	3
612	6	Select	TF	1	3	703.9	14.4	2
613	6	Duo	Festul	1	3	625.7	16.1	5
614	6	KYFA1016	Festul	1	3	625.7	14.4	2
615	6	Perun	Festul	1	3	840.8	16.9	4
616	6	Granddaddy	PRG	1	3	1134.1	17.8	3

617	6	Barolex	TF	1	3	625.7	15.2	3
618	6	Potomac	OG	1	3	547.5	15.2	5
619	6	Tekapo	OG	1	3	527.9	11.0	6
620	6	Calibra	PRG	1	3	547.5	9.3	6
621	6	SpringGreen	Festul	1	3	645.2	12.7	7
622	6	Bariane	TF	1	3	527.9	8.5	8
623	6	Persist	OG	1	3	488.8	9.3	8
624	6	KYFA9611	TF	1	3	664.8	10.2	6
101	1	Duo	Festul	2	4	19.6	12.7	7
102	1	Perun	Festul	2	4	117.3	11.0	7
103	1	Harvestar	OG	2	4	254.2	11.9	6
104	1	Potomac	OG	2	4	351.9	15.2	4
105	1	KYFA1015	Festul	2	4	136.9	9.3	4
106	1	Granddaddy	PRG	2	4	371.5	13.5	3
107	1	BG34	PRG	2	4	351.9	13.5	2
108	1	Barolex	TF	2	4	449.7	15.2	3
109	1	Jesup_EF	TF	2	4	351.9	15.2	2
110	1	SpringGreen	Festul	2	4	117.3	11.0	4
111	1	KYFA1016	Festul	2	4	136.9	11.0	3
112	1	KYFA9611	TF	2	4	351.9	12.7	4
113	1	Calibra	PRG	2	4	351.9	14.4	3
114	1	Profit	OG	2	4	234.6	11.9	7
115	1	Power	PRG	2	4	58.7	10.2	7
116	1	Prodigy	OG	2	4	195.5	13.5	5
117	1	Prairie	OG	2	4	195.5	15.2	3
118	1	Barfest	Festul	2	4	97.8	9.3	5
119	1	Tekapo	OG	2	4	195.5	13.5	6
120	1	Persist	OG	2	4	488.8	13.5	6
121	1	Bariane	TF	2	4	293.3	13.5	5
122	1	Select	TF	2	4	332.4	16.9	4
123	1	Benchmark_Plus	OG	2	4	567.0	16.1	4
124	1	Linn	PRG	2	4	234.6	10.2	2
201	2	KYFA1016	Festul	2	4	97.8	11.9	8
202	2	SpringGreen	Festul	2	4	234.6	8.5	7
203	2	Barolex	TF	2	4	723.5	17.8	2
204	2	Prodigy	OG	2	4	430.2	14.4	7
205	2	Linn	PRG	2	4	312.8	11.0	3
206	2	Duo	Festul	2	4	97.8	9.3	7
207	2	Prairie	OG	2	4	351.9	16.1	6
208	2	Tekapo	OG	2	4	136.9	13.5	7
209	2	Perun	Festul	2	4	117.3	9.3	8
210	2	KYFA1015	Festul	2	4	78.2	11.9	7
211	2	Potomac	OG	2	4	195.5	16.1	6
212	2	Select	TF	2	4	195.5	16.1	2
213	2	Granddaddy	PRG	2	4	234.6	12.7	4

214	2	Bariane	TF	2	4	215.1	13.5	4
215	2	Profit	OG	2	4	215.1	16.1	5
216	2	Benchmark_Plus	OG	2	4	293.3	13.5	7
217	2	Harvestar	OG	2	4	430.2	12.7	8
218	2	Barfest	Festul	2	4	156.4	10.2	6
219	2	Power	PRG	2	4	234.6	10.2	7
220	2	Persist	OG	2	4	293.3	11.0	8
221	2	KYFA9611	TF	2	4	234.6	12.7	4
222	2	BG34	PRG	2	4	195.5	10.2	4
223	2	Jesup_EF	TF	2	4	97.8	12.7	2
224	2	Calibra	PRG	2	4	97.8	11.9	5
301	3	KYFA9611	TF	2	4	136.9	13.5	3
302	3	Barfest	Festul	2	4	117.3	9.3	8
303	3	Duo	Festul	2	4	195.5	11.9	6
304	3	Perun	Festul	2	4	449.7	13.5	7
305	3	Barolex	TF	2	4	430.2	12.7	4
306	3	Calibra	PRG	2	4	371.5	13.5	6
307	3	Prairie	OG	2	4	391.1	14.4	5
308	3	Granddaddy	PRG	2	4	273.7	12.7	3
309	3	Persist	OG	2	4	293.3	12.7	7
310	3	Benchmark_Plus	OG	2	4	586.6	14.4	5
311	3	Harvestar	OG	2	4	391.1	13.5	5
312	3	Linn	PRG	2	4	449.7	11.9	2
313	3	Potomac	OG	2	4	351.9	16.9	4
314	3	KYFA1016	Festul	2	4	273.7	12.7	6
315	3	Tekapo	OG	2	4	410.6	14.4	7
316	3	KYFA1015	Festul	2	4	39.1	9.3	7
317	3	Profit	OG	2	4	58.7	11.0	8
318	3	SpringGreen	Festul	2	4	97.8	8.5	8
319	3	BG34	PRG	2	4	156.4	11.9	5
320	3	Prodigy	OG	2	4	410.6	11.9	7
321	3	Bariane	TF	2	4	332.4	11.9	4
322	3	Power	PRG	2	4	215.1	11.9	7
323	3	Select	TF	2	4	371.5	14.4	5
324	3	Jesup_EF	TF	2	4	293.3	14.4	3
401	4	Bariane	TF	2	4	195.5	11.0	7
402	4	Linn	PRG	2	4	97.8	11.9	4
403	4	KYFA9611	TF	2	4	254.2	14.4	4
404	4	Jesup_EF	TF	2	4	97.8	15.2	2
405	4	Persist	OG	2	4	312.8	12.7	6
406	4	Benchmark_Plus	OG	2	4	332.4	11.9	6
407	4	Profit	OG	2	4	156.4	13.5	8
408	4	Harvestar	OG	2	4	136.9	14.4	7
409	4	SpringGreen	Festul	2	4	97.8	10.2	8
410	4	Duo	Festul	2	4	58.7	13.5	5

411	4	Calibra	PRG	2	4	97.8	10.2	6
412	4	Select	TF	2	4	195.5	15.2	5
413	4	Prodigy	OG	2	4	215.1	13.5	5
414	4	Barfest	Festul	2	4	176.0	12.7	7
415	4	Barolex	TF	2	4	293.3	17.8	3
416	4	Perun	Festul	2	4	156.4	12.7	8
417	4	KYFA1015	Festul	2	4	254.2	12.7	5
418	4	Prairie	OG	2	4	293.3	13.5	4
419	4	Tekapo	OG	2	4	176.0	13.5	6
420	4	BG34	PRG	2	4	410.6	12.7	3
421	4	KYFA1016	Festul	2	4	176.0	9.3	7
422	4	Power	PRG	2	4	176.0	11.0	8
423	4	Granddaddy	PRG	2	4	97.8	12.7	6
424	4	Potomac	OG	2	4	97.8	12.7	6
501	5	Bariane	TF	2	4	19.6	10.2	7
502	5	Persist	OG	2	4	254.2	15.2	5
503	5	Tekapo	OG	2	4	78.2	11.9	8
504	5	Perun	Festul	2	4	234.6	12.7	7
505	5	Barolex	TF	2	4	567.0	18.6	4
506	5	BG34	PRG	2	4	547.5	16.9	2
507	5	Profit	OG	2	4	351.9	12.7	6
508	5	Prairie	OG	2	4	391.1	16.9	5
509	5	Linn	PRG	2	4	234.6	11.0	2
510	5	Benchmark_Plus	OG	2	4	488.8	16.9	3
511	5	Potomac	OG	2	4	410.6	14.4	5
512	5	Power	PRG	2	4	469.3	13.5	3
513	5	SpringGreen	Festul	2	4	176.0	11.9	4
514	5	Jesup_EF	TF	2	4	332.4	16.1	2
515	5	Select	TF	2	4	97.8	13.5	2
516	5	Calibra	PRG	2	4	136.9	11.9	4
517	5	Granddaddy	PRG	2	4	136.9	10.2	3
518	5	KYFA9611	TF	2	4	136.9	13.5	3
519	5	Duo	Festul	2	4	39.1	11.0	7
520	5	Barfest	Festul	2	4	97.8	10.2	8
521	5	Prodigy	OG	2	4	312.8	13.5	8
522	5	KYFA1015	Festul	2	4	136.9	12.7	7
523	5	KYFA1016	Festul	2	4	136.9	11.9	7
524	5	Harvestar	OG	2	4	293.3	16.1	6
601	6	KYFA1015	Festul	2	4	293.3	11.9	5
602	6	Profit	OG	2	4	430.2	10.2	5
603	6	Linn	PRG	2	4	293.3	15.2	1
604	6	Barfest	Festul	2	4	273.7	10.2	7
605	6	Prodigy	OG	2	4	176.0	11.9	5
606	6	Harvestar	OG	2	4	430.2	14.4	4
607	6	Power	PRG	2	4	195.5	12.7	6

608	6	Benchmark_Plus	OG	2	4	351.9	16.1	4
609	6	Jesup_EF	TF	2	4	19.6	14.4	1
610	6	Prairie	OG	2	4	156.4	16.1	3
611	6	BG34	PRG	2	4	215.1	16.1	2
612	6	Select	TF	2	4	293.3	11.9	1
613	6	Duo	Festul	2	4	254.2	12.7	3
614	6	KYFA1016	Festul	2	4	351.9	11.0	5
615	6	Perun	Festul	2	4	312.8	13.5	6
616	6	Granddaddy	PRG	2	4	586.6	14.4	4
617	6	Barolex	TF	2	4	391.1	16.9	2
618	6	Potomac	OG	2	4	391.1	14.4	5
619	6	Tekapo	OG	2	4	391.1	11.9	7
620	6	Calibra	PRG	2	4	488.8	10.2	8
621	6	SpringGreen	Festul	2	4	430.2	11.9	8
622	6	Bariane	TF	2	4	215.1	9.3	7
623	6	Persist	OG	2	4	234.6	12.7	7
624	6	KYFA9611	TF	2	4	78.2	11.0	5
101	1	Duo	Festul	2	5	371.5	10.2	4
102	1	Perun	Festul	2	5	234.6	10.2	6
103	1	Harvestar	OG	2	5	234.6	13.5	4
104	1	Potomac	OG	2	5	410.6	13.5	3
105	1	KYFA1015	Festul	2	5	1349.1	16.9	3
106	1	Granddaddy	PRG	2	5	879.9	16.9	2
107	1	BG34	PRG	2	5	586.6	16.9	1
108	1	Barolex	TF	2	5	1446.9	22.0	3
109	1	Jesup_EF	TF	2	5	1798.9	15.2	3
110	1	SpringGreen	Festul	2	5	645.2	11.0	4
111	1	KYFA1016	Festul	2	5	743.0	12.7	4
112	1	KYFA9611	TF	2	5	1388.2	22.0	2
113	1	Calibra	PRG	2	5	430.2	11.9	4
114	1	Profit	OG	2	5	234.6	11.9	7
115	1	Power	PRG	2	5	430.2	9.3	6
116	1	Prodigy	OG	2	5	332.4	11.9	7
117	1	Prairie	OG	2	5	39.1	12.7	4
118	1	Barfest	Festul	2	5	293.3	13.5	4
119	1	Tekapo	OG	2	5	293.3	14.4	5
120	1	Persist	OG	2	5	273.7	10.2	6
121	1	Bariane	TF	2	5	625.7	19.5	2
122	1	Select	TF	2	5	645.2	17.8	3
123	1	Benchmark_Plus	OG	2	5	254.2	15.2	7
124	1	Linn	PRG	2	5	782.1	14.4	1
201	2	KYFA1016	Festul	2	5	586.6	14.4	3
202	2	SpringGreen	Festul	2	5	195.5	11.9	6
203	2	Barolex	TF	2	5	625.7	15.2	4
204	2	Prodigy	OG	2	5	860.3	20.3	2

205	2	Linn	PRG	2	5	625.7	12.7	5
206	2	Duo	Festul	2	5	215.1	9.3	7
207	2	Prairie	OG	2	5	97.8	9.3	8
208	2	Tekapo	OG	2	5	254.2	10.2	7
209	2	Perun	Festul	2	5	977.6	16.1	3
210	2	KYFA1015	Festul	2	5	176.0	9.3	5
211	2	Potomac	OG	2	5	117.3	9.3	7
212	2	Select	TF	2	5	1310.0	21.2	2
213	2	Granddaddy	PRG	2	5	723.5	17.8	1
214	2	Bariane	TF	2	5	449.7	13.5	3
215	2	Profit	OG	2	5	97.8	11.0	8
216	2	Benchmark_Plus	OG	2	5	860.3	16.9	5
217	2	Harvestar	OG	2	5	1290.5	16.9	4
218	2	Barfest	Festul	2	5	254.2	9.3	5
219	2	Power	PRG	2	5	547.5	15.2	3
220	2	Persist	OG	2	5	625.7	22.0	2
221	2	KYFA9611	TF	2	5	1622.9	21.2	2
222	2	BG34	PRG	2	5	508.4	15.2	2
223	2	Jesup_EF	TF	2	5	410.6	11.0	4
224	2	Calibra	PRG	2	5	547.5	15.2	2
301	3	KYFA9611	TF	2	5	1427.4	20.3	1
302	3	Barfest	Festul	2	5	332.4	11.0	7
303	3	Duo	Festul	2	5	782.1	17.8	3
304	3	Perun	Festul	2	5	1505.6	20.3	2
305	3	Barolex	TF	2	5	2092.1	19.5	2
306	3	Calibra	PRG	2	5	488.8	11.9	4
307	3	Prairie	OG	2	5	117.3	13.5	8
308	3	Granddaddy	PRG	2	5	762.6	11.9	2
309	3	Persist	OG	2	5	606.1	15.2	3
310	3	Benchmark_Plus	OG	2	5	234.6	11.0	5
311	3	Harvestar	OG	2	5	215.1	11.0	8
312	3	Linn	PRG	2	5	312.8	14.4	1
313	3	Potomac	OG	2	5	606.1	16.9	3
314	3	KYFA1016	Festul	2	5	567.0	17.8	4
315	3	Tekapo	OG	2	5	332.4	13.5	5
316	3	KYFA1015	Festul	2	5	2326.8	14.4	2
317	3	Profit	OG	2	5	391.1	12.7	4
318	3	SpringGreen	Festul	2	5	351.9	11.0	5
319	3	BG34	PRG	2	5	469.3	16.1	1
320	3	Prodigy	OG	2	5	1231.8	22.9	2
321	3	Bariane	TF	2	5	782.1	14.4	2
322	3	Power	PRG	2	5	293.3	11.0	6
323	3	Select	TF	2	5	1016.7	13.5	3
324	3	Jesup_EF	TF	2	5	1114.5	15.2	3
401	4	Bariane	TF	2	5	606.1	12.7	4

402	4	Linn	PRG	2	5	840.8	12.7	1
403	4	KYFA9611	TF	2	5	195.5	10.2	7
404	4	Jesup_EF	TF	2	5	97.8	13.5	3
405	4	Persist	OG	2	5	899.4	14.4	5
406	4	Benchmark_Plus	OG	2	5	273.7	13.5	6
407	4	Profit	OG	2	5	312.8	11.9	7
408	4	Harvestar	OG	2	5	606.1	17.8	3
409	4	SpringGreen	Festul	2	5	547.5	12.7	4
410	4	Duo	Festul	2	5	606.1	16.9	2
411	4	Calibra	PRG	2	5	176.0	11.9	3
412	4	Select	TF	2	5	625.7	12.7	4
413	4	Prodigy	OG	2	5	430.2	11.0	
414	4	Barfest	Festul	2	5	78.2	7.6	8
415	4	Barolex	TF	2	5	664.8	16.1	3
416	4	Perun	Festul	2	5	508.4	14.4	6
417	4	KYFA1015	Festul	2	5	254.2	9.3	7
418	4	Prairie	OG	2	5	156.4	12.7	5
419	4	Tekapo	OG	2	5	58.7	7.6	8
420	4	BG34	PRG	2	5	606.1	16.9	1
421	4	KYFA1016	Festul	2	5	351.9	11.0	3
422	4	Power	PRG	2	5	215.1	10.2	4
423	4	Granddaddy	PRG	2	5	547.5	11.9	1
424	4	Potomac	OG	2	5	371.5	13.5	4
501	5	Bariane	TF	2	5	234.6	10.2	3
502	5	Persist	OG	2	5	117.3	12.7	6
503	5	Tekapo	OG	2	5	176.0	11.0	4
504	5	Perun	Festul	2	5	273.7	9.3	5
505	5	Barolex	TF	2	5	743.0	17.8	1
506	5	BG34	PRG	2	5	645.2	14.4	1
507	5	Profit	OG	2	5	78.2	10.2	6
508	5	Prairie	OG	2	5	97.8	11.0	8
509	5	Linn	PRG	2	5	117.3	11.0	3
510	5	Benchmark_Plus	OG	2	5	176.0	11.9	5
511	5	Potomac	OG	2	5	371.5	16.1	4
512	5	Power	PRG	2	5	254.2	19.5	2
513	5	SpringGreen	Festul	2	5	332.4	11.9	4
514	5	Jesup_EF	TF	2	5	215.1	8.5	6
515	5	Select	TF	2	5	97.8	11.9	5
516	5	Calibra	PRG	2	5	391.1	10.2	2
517	5	Granddaddy	PRG	2	5	332.4	11.0	1
518	5	KYFA9611	TF	2	5	58.7	11.9	8
519	5	Duo	Festul	2	5	19.6	9.3	9
520	5	Barfest	Festul	2	5	176.0	10.2	8
521	5	Prodigy	OG	2	5	19.6	16.9	4
522	5	KYFA1015	Festul	2	5	293.3	11.0	6

523	5	KYFA1016	Festul	2	5	97.8	7.6	5
524	5	Harvestar	OG	2	5	312.8	13.5	7
601	6	KYFA1015	Festul	2	5	430.2	11.0	3
602	6	Profit	OG	2	5	39.1	9.3	8
603	6	Linn	PRG	2	5	293.3	14.4	2
604	6	Barfest	Festul	2	5	136.9	8.5	7
605	6	Prodigy	OG	2	5	469.3	11.9	5
606	6	Harvestar	OG	2	5	58.7	9.3	7
607	6	Power	PRG	2	5	58.7	11.0	7
608	6	Benchmark_Plus	OG	2	5	293.3	12.7	6
609	6	Jesup_EF	TF	2	5	332.4	12.7	4
610	6	Prairie	OG	2	5	215.1	14.4	7
611	6	BG34	PRG	2	5	136.9	11.0	2
612	6	Select	TF	2	5	899.4	16.9	3
613	6	Duo	Festul	2	5	58.7	9.3	7
614	6	KYFA1016	Festul	2	5	254.2	13.5	3
615	6	Perun	Festul	2	5	97.8	10.2	8
616	6	Granddaddy	PRG	2	5	449.7	12.7	5
617	6	Barolex	TF	2	5	234.6	13.5	3
618	6	Potomac	OG	2	5	58.7	11.9	7
619	6	Tekapo	OG	2	5	136.9	10.2	8
620	6	Calibra	PRG	2	5	136.9	9.3	8
621	6	SpringGreen	Festul	2	5	625.7	7.6	7
622	6	Bariane	TF	2	5	58.7	9.3	7
623	6	Persist	OG	2	5	312.8	13.5	6
624	6	KYFA9611	TF	2	5	293.3	12.7	5
101	1	Duo	Festul	2	6	371.5	11.9	6
102	1	Perun	Festul	2	6	977.6	7.6	5
103	1	Harvestar	OG	2	6	645.2	15.2	4
104	1	Potomac	OG	2	6	997.2	16.9	6
105	1	KYFA1015	Festul	2	6	1838.0	14.4	2
106	1	Granddaddy	PRG	2	6	1622.9	11.0	2
107	1	BG34	PRG	2	6	762.6	11.9	3
108	1	Barolex	TF	2	6	1486.0	16.1	3
109	1	Jesup_EF	TF	2	6	1290.5	15.2	5
110	1	SpringGreen	Festul	2	6	449.7	9.3	7
111	1	KYFA1016	Festul	2	6	1036.3	11.9	5
112	1	KYFA9611	TF	2	6	1564.2	14.4	3
113	1	Calibra	PRG	2	6	547.5	12.7	4
114	1	Profit	OG	2	6	293.3	13.5	7
115	1	Power	PRG	2	6	567.0	11.0	8
116	1	Prodigy	OG	2	6	254.2	11.9	7
117	1	Prairie	OG	2	6	19.6	13.5	7
118	1	Barfest	Festul	2	6	391.1	13.5	6
119	1	Tekapo	OG	2	6	488.8	18.6	5

120	1	Persist	OG	2	6	508.4	16.9	6
121	1	Bariane	TF	2	6	1114.5	20.3	3
122	1	Select	TF	2	6	1134.1	20.3	2
123	1	Benchmark_Plus	OG	2	6	586.6	17.8	6
124	1	Linn	PRG	2	6	1153.6	11.9	1
201	2	KYFA1016	Festul	2	6	782.1	8.5	6
202	2	SpringGreen	Festul	2	6	625.7	11.9	3
203	2	Barolex	TF	2	6	1290.5	18.6	2
204	2	Prodigy	OG	2	6	762.6	17.8	2
205	2	Linn	PRG	2	6	821.2	11.0	2
206	2	Duo	Festul	2	6	645.2	8.5	4
207	2	Prairie	OG	2	6	254.2	11.9	8
208	2	Tekapo	OG	2	6	97.8	10.2	7
209	2	Perun	Festul	2	6	156.4	10.2	5
210	2	KYFA1015	Festul	2	6	410.6	12.7	8
211	2	Potomac	OG	2	6	703.9	12.7	4
212	2	Select	TF	2	6	997.2	16.1	4
213	2	Granddaddy	PRG	2	6	1759.7	16.1	1
214	2	Bariane	TF	2	6	1134.1	15.2	3
215	2	Profit	OG	2	6	215.1	12.7	6
216	2	Benchmark_Plus	OG	2	6	684.3	13.5	6
217	2	Harvestar	OG	2	6	1212.3	10.2	5
218	2	Barfest	Festul	2	6	586.6	10.2	6
219	2	Power	PRG	2	6	1329.6	12.7	2
220	2	Persist	OG	2	6	1192.7	22.9	2
221	2	KYFA9611	TF	2	6	899.4	16.9	4
222	2	BG34	PRG	2	6	1114.5	13.5	2
223	2	Jesup_EF	TF	2	6	1134.1	11.0	7
224	2	Calibra	PRG	2	6	293.3	11.0	4
301	3	KYFA9611	TF	2	6	1290.5	16.9	3
302	3	Barfest	Festul	2	6	586.6	8.5	7
303	3	Duo	Festul	2	6	1759.7	12.7	1
304	3	Perun	Festul	2	6	1329.6	16.1	2
305	3	Barolex	TF	2	6	1642.4	22.0	1
306	3	Calibra	PRG	2	6	1153.6	13.5	1
307	3	Prairie	OG	2	6	391.1	13.5	8
308	3	Granddaddy	PRG	2	6	997.2	11.0	3
309	3	Persist	OG	2	6	684.3	13.5	7
310	3	Benchmark_Plus	OG	2	6	469.3	15.2	6
311	3	Harvestar	OG	2	6	332.4	15.2	5
312	3	Linn	PRG	2	6	801.7	17.8	2
313	3	Potomac	OG	2	6	860.3	22.0	4
314	3	KYFA1016	Festul	2	6	1016.7	16.1	3
315	3	Tekapo	OG	2	6	547.5	15.2	7
316	3	KYFA1015	Festul	2	6	1564.2	12.7	2

317	3	Profit	OG	2	6	1446.9	16.1	3
318	3	SpringGreen	Festul	2	6	1153.6	11.9	3
319	3	BG34	PRG	2	6	645.2	15.2	2
320	3	Prodigy	OG	2	6	840.8	16.1	5
321	3	Bariane	TF	2	6	1525.1	16.1	3
322	3	Power	PRG	2	6	879.9	15.2	4
323	3	Select	TF	2	6	840.8	16.9	3
324	3	Jesup_EF	TF	2	6	782.1	17.8	3
401	4	Bariane	TF	2	6	332.4	11.9	6
402	4	Linn	PRG	2	6	860.3	11.0	1
403	4	KYFA9611	TF	2	6	879.9	16.1	7
404	4	Jesup_EF	TF	2	6	1114.5	18.6	3
405	4	Persist	OG	2	6	723.5	11.0	7
406	4	Benchmark_Plus	OG	2	6	273.7	13.5	8
407	4	Profit	OG	2	6	586.6	11.9	8
408	4	Harvestar	OG	2	6	664.8	16.1	5
409	4	SpringGreen	Festul	2	6	899.4	13.5	3
410	4	Duo	Festul	2	6	919.0	10.2	3
411	4	Calibra	PRG	2	6	469.3	13.5	5
412	4	Select	TF	2	6	488.8	15.2	2
413	4	Prodigy	OG	2	6	723.5	16.1	7
414	4	Barfest	Festul	2	6	195.5	11.0	8
415	4	Barolex	TF	2	6	762.6	15.2	4
416	4	Perun	Festul	2	6	606.1	12.7	6
417	4	KYFA1015	Festul	2	6	410.6	12.7	4
418	4	Prairie	OG	2	6	136.9	11.9	8
419	4	Tekapo	OG	2	6	312.8	8.5	7
420	4	BG34	PRG	2	6	449.7	12.7	3
421	4	KYFA1016	Festul	2	6	899.4	14.4	4
422	4	Power	PRG	2	6	430.2	9.3	7
423	4	Granddaddy	PRG	2	6	586.6	9.3	6
424	4	Potomac	OG	2	6	606.1	11.9	7
501	5	Bariane	TF	2	6	547.5	11.0	5
502	5	Persist	OG	2	6	58.7	11.0	8
503	5	Tekapo	OG	2	6	97.8	11.9	5
504	5	Perun	Festul	2	6	1055.8	16.1	3
505	5	Barolex	TF	2	6	488.8	16.1	3
506	5	BG34	PRG	2	6	743.0	16.9	1
507	5	Profit	OG	2	6	410.6	11.9	6
508	5	Prairie	OG	2	6	97.8	12.7	9
509	5	Linn	PRG	2	6	176.0	10.2	8
510	5	Benchmark_Plus	OG	2	6	430.2	10.2	6
511	5	Potomac	OG	2	6	469.3	12.7	8
512	5	Power	PRG	2	6	234.6	15.2	2
513	5	SpringGreen	Festul	2	6	469.3	12.7	4

514	5	Jesup_EF	TF	2	6	762.6	15.2	3
515	5	Select	TF	2	6	234.6	10.2	7
516	5	Calibra	PRG	2	6	723.5	8.5	4
517	5	Granddaddy	PRG	2	6	762.6	6.8	3
518	5	KYFA9611	TF	2	6	234.6	14.4	6
519	5	Duo	Festul	2	6	156.4	10.2	7
520	5	Barfest	Festul	2	6	430.2	11.0	6
521	5	Prodigy	OG	2	6	195.5	13.5	6
522	5	KYFA1015	Festul	2	6	684.3	12.7	6
523	5	KYFA1016	Festul	2	6	488.8	13.5	4
524	5	Harvestar	OG	2	6	488.8	16.1	7
601	6	KYFA1015	Festul	2	6	782.1	11.9	3
602	6	Profit	OG	2	6	136.9	11.0	8
603	6	Linn	PRG	2	6	684.3	13.5	3
604	6	Barfest	Festul	2	6	58.7	11.0	6
605	6	Prodigy	OG	2	6	527.9	12.7	5
606	6	Harvestar	OG	2	6	117.3	12.7	8
607	6	Power	PRG	2	6	176.0	8.5	7
608	6	Benchmark_Plus	OG	2	6	508.4	15.2	4
609	6	Jesup_EF	TF	2	6	821.2	13.5	2
610	6	Prairie	OG	2	6	312.8	14.4	5
611	6	BG34	PRG	2	6	273.7	14.4	2
612	6	Select	TF	2	6	1388.2	18.6	2
613	6	Duo	Festul	2	6	97.8	10.2	7
614	6	KYFA1016	Festul	2	6	371.5	13.5	4
615	6	Perun	Festul	2	6	527.9	14.4	3
616	6	Granddaddy	PRG	2	6	743.0	11.0	3
617	6	Barolex	TF	2	6	547.5	11.0	1
618	6	Potomac	OG	2	6	254.2	9.3	8
619	6	Tekapo	OG	2	6	508.4	11.0	7
620	6	Calibra	PRG	2	6	97.8	10.2	6
621	6	SpringGreen	Festul	2	6	645.2	15.2	2
622	6	Bariane	TF	2	6	1231.8	12.7	2
623	6	Persist	OG	2	6	449.7	10.2	9
624	6	KYFA9611	TF	2	6	840.8	12.7	3

Appendix D: Post Grazing Forage Quality Raw Data

Table D.1: Post Grazing Forage Quality Raw Data (Trial 6 not included due to crabgrass)

Plot	Rep	Variety	Species	Year	Trial	Post_NDF	Post_CP	Post_ADF	Post_IVTD
101	1	Duo	Festul	1	1	57.5	15.3	33.2	79.6
102	1	Perun	Festul	1	1	58.7	11.0	36.1	75.3
103	1	Harvestar	OG	1	1	61.6	16.5	37.2	81.7
104	1	Potomac	OG	1	1	58.9	13.7	38.3	76.4
105	1	KYFA1015	Festul	1	1	61.3	13.7	40.9	75.4
106	1	Granddaddy	PRG	1	1	56.3	15.5	33.3	80.3
107	1	BG34	PRG	1	1	60.9	13.0	35.2	75.3
108	1	Barolex	TF	1	1	58.4	16.2	31.3	83.5
109	1	Jesup_EF	TF	1	1	49.3	20.1	28.3	86.0
110	1	SpringGreen	Festul	1	1	57.6	16.4	31.9	81.3
111	1	KYFA1016	Festul	1	1	61.4	16.2	32.2	80.0
112	1	KYFA9611	TF	1	1	61.6	10.8	37.8	75.5
113	1	Calibra	PRG	1	1	68.1	14.5	37.3	80.7
114	1	Profit	OG	1	1	65.3	10.1	46.1	76.8
115	1	Power	PRG	1	1	63.5	14.8	35.6	78.8
116	1	Prodigy	OG	1	1	61.0	15.6	33.6	79.5
117	1	Prairie	OG	1	1	66.9	17.2	33.7	80.2
118	1	Barfest	Festul	1	1	61.6	14.2	37.2	79.0
119	1	Tekapo	OG	1	1	66.7	14.0	36.0	77.8
120	1	Persist	OG	1	1	60.2	16.3	33.4	77.7
121	1	Bariane	TF	1	1	57.0	13.8	32.7	76.4
122	1	Select	TF	1	1	57.2	15.6	35.3	80.0
124	1	Benchmark_Plus	OG	1	1	61.4	15.3	31.9	78.3
134	1	Linn	PRG	1	1	62.2	14.4	34.5	79.1
201	2	KYFA1016	Festul	1	1	60.9	12.2	34.8	77.3
202	2	SpringGreen	Festul	1	1	57.2	15.3	31.6	79.9
203	2	Barolex	TF	1	1	56.3	16.2	32.2	79.8
204	2	Prodigy	OG	1	1	49.3	18.0	27.4	82.7
205	2	Linn	PRG	1	1	62.5	13.4	37.4	78.2
206	2	Duo	Festul	1	1	67.3	14.2	36.5	79.5
207	2	Prairie	OG	1	1	59.9	14.9	34.3	82.3
208	2	Tekapo	OG	1	1	62.4	13.2	35.6	76.1
209	2	Perun	Festul	1	1	62.3	15.5	36.5	82.3
210	2	KYFA1015	Festul	1	1	57.5	15.9	32.5	80.8
211	2	Potomac	OG	1	1	54.8	15.9	32.6	81.6
212	2	Select	TF	1	1	67.6	14.1	36.1	77.1

213	2	Granddaddy	PRG	1	1	57.0	15.6	31.1	81.1
214	2	Bariane	TF	1	1	53.1	16.5	29.4	81.0
215	2	Profit	OG	1	1	54.1	14.7	29.8	78.0
216	2	Benchmark_Plus	OG	1	1	60.4	15.8	32.3	78.6
217	2	Harvestar	OG	1	1	63.6	13.7	34.4	77.6
218	2	Barfest	Festul	1	1	66.7	14.9	36.2	80.0
219	2	Power	PRG	1	1	56.6	17.0	31.5	82.3
220	2	Persist	OG	1	1	53.1	17.3	30.5	83.8
221	2	KYFA9611	TF	1	1	66.0	14.6	35.1	77.0
222	2	BG34	PRG	1	1	59.5	13.5	32.1	78.5
223	2	Jesup_EF	TF	1	1	61.3	14.0	35.3	76.8
224	2	Calibra	PRG	1	1	57.3	15.6	31.2	80.6
301	3	KYFA9611	TF	1	1	60.2	19.0	32.2	83.1
302	3	Barfest	Festul	1	1	52.3	18.4	29.8	81.4
303	3	Duo	Festul	1	1	74.2	14.4	43.5	81.5
304	3	Perun	Festul	1	1	54.0	15.6	32.8	79.3
305	3	Barolex	TF	1	1	59.6	12.5	36.0	78.8
306	3	Calibra	PRG	1	1	54.3	17.1	29.2	80.8
307	3	Prairie	OG	1	1	56.9	16.7	30.5	80.9
308	3	Granddaddy	PRG	1	1	57.0	16.2	33.6	81.0
309	3	Persist	OG	1	1	54.0	19.6	31.2	86.9
310	3	Benchmark_Plus	OG	1	1	64.4	14.9	38.2	80.8
311	3	Harvestar	OG	1	1	61.2	14.6	35.6	78.0
312	3	Linn	PRG	1	1	54.5	15.8	32.1	80.2
313	3	Potomac	OG	1	1	62.3	15.4	34.0	81.3
314	3	KYFA1016	Festul	1	1	57.0	15.4	39.0	79.3
315	3	Tekapo	OG	1	1	58.1	15.6	31.7	78.9
316	3	KYFA1015	Festul	1	1	60.0	14.9	36.0	77.4
317	3	Profit	OG	1	1	52.1	18.9	28.9	83.7
318	3	SpringGreen	Festul	1	1	64.8	18.3	35.1	79.9
319	3	BG34	PRG	1	1	56.2	16.5	32.2	82.9
320	3	Prodigy	OG	1	1	52.5	19.3	32.7	85.7
321	3	Bariane	TF	1	1	72.6	12.0	42.7	76.2
322	3	Power	PRG	1	1	57.6	16.8	31.4	84.2
323	3	Select	TF	1	1	56.0	15.5	32.8	80.5
324	3	Jesup_EF	TF	1	1	52.4	17.2	27.9	81.1
401	4	Bariane	TF	1	1	55.2	16.4	30.5	82.1
402	4	Linn	PRG	1	1	55.4	13.7	30.4	79.6
403	4	KYFA9611	TF	1	1	56.6	15.8	31.1	78.2
404	4	Jesup_EF	TF	1	1	54.4	15.9	30.9	82.0
405	4	Persist	OG	1	1	50.7	18.4	29.0	82.8
406	4	Benchmark_Plus	OG	1	1	60.0	14.8	34.5	80.4
407	4	Profit	OG	1	1	61.8	15.3	34.7	78.5
408	4	Harvestar	OG	1	1	61.6	17.1	35.7	78.6
409	4	SpringGreen	Festul	1	1	61.2	16.7	35.8	78.9

410	4	Duo	Festul	1	1	59.4	13.5	34.0	79.0
411	4	Calibra	PRG	1	1	58.9	14.4	33.5	79.7
412	4	Select	TF	1	1	53.8	15.2	32.5	81.4
413	4	Prodigy	OG	1	1	59.9	14.5	32.4	77.5
414	4	Barfest	Festul	1	1	58.2	15.5	33.3	80.2
415	4	Barolex	TF	1	1	57.6	14.1	29.7	78.0
416	4	Perun	Festul	1	1	54.6	13.8	32.0	79.6
417	4	KYFA1015	Festul	1	1	59.5	17.1	32.2	83.0
418	4	Prairie	OG	1	1	65.0	14.6	34.7	78.8
419	4	Tekapo	OG	1	1	55.4	15.5	32.1	80.6
420	4	BG34	PRG	1	1	60.1	14.6	33.0	79.0
421	4	KYFA1016	Festul	1	1	56.3	16.3	30.6	82.3
422	4	Power	PRG	1	1	51.1	17.0	30.8	83.4
423	4	Granddaddy	PRG	1	1	61.6	15.7	33.5	81.2
424	4	Potomac	OG	1	1	63.0	17.1	33.4	80.2
501	5	Bariane	TF	1	1	53.3	16.6	28.6	83.2
502	5	Persist	OG	1	1	58.3	14.5	34.7	79.7
503	5	Tekapo	OG	1	1	54.5	24.2	26.4	86.4
504	5	Perun	Festul	1	1	56.0	15.5	31.3	81.6
505	5	Barolex	TF	1	1	55.9	17.1	30.9	81.7
506	5	BG34	PRG	1	1	62.4	14.9	33.4	78.0
507	5	Profit	OG	1	1	68.3	14.9	38.1	77.9
508	5	Prairie	OG	1	1	62.0	14.9	34.6	79.1
509	5	Linn	PRG	1	1	54.5	17.6	30.2	81.3
510	5	Benchmark_Plus	OG	1	1	63.0	14.6	34.8	76.3
511	5	Potomac	OG	1	1	62.8	14.1	33.9	77.4
512	5	Power	PRG	1	1	54.3	18.4	34.6	81.0
513	5	SpringGreen	Festul	1	1	53.9	16.7	32.5	81.1
514	5	Jesup_EF	TF	1	1	51.5	18.8	28.3	83.8
515	5	Select	TF	1	1	56.7	16.1	31.5	80.9
516	5	Calibra	PRG	1	1	54.9	17.5	28.3	83.4
517	5	Granddaddy	PRG	1	1	54.7	16.7	29.3	79.2
518	5	KYFA9611	TF	1	1	52.0	16.6	29.7	81.2
519	5	Duo	Festul	1	1	63.0	18.1	34.0	80.7
520	5	Barfest	Festul	1	1	55.5	14.0	32.5	78.3
521	5	Prodigy	OG	1	1	55.8	16.2	32.3	80.4
522	5	KYFA1015	Festul	1	1	64.0	16.3	35.2	79.8
523	5	KYFA1016	Festul	1	1	54.7	17.6	30.1	81.8
524	5	Harvestar	OG	1	1	59.6	16.2	33.3	80.0
601	6	KYFA1015	Festul	1	1	55.5	15.1	32.6	78.8
602	6	Profit	OG	1	1	59.7	17.4	32.8	83.3
603	6	Linn	PRG	1	1	62.3	15.8	33.3	79.2
604	6	Barfest	Festul	1	1	61.2	15.6	34.6	79.9
605	6	Prodigy	OG	1	1	58.2	16.6	31.4	79.9
606	6	Harvestar	OG	1	1	61.5	15.6	34.2	79.8

607	6	Power	PRG	1	1	65.9	16.5	36.1	81.1
608	6	Benchmark_Plus	OG	1	1	56.2	15.3	31.3	80.4
609	6	Jesup_EF	TF	1	1	61.6	15.6	33.4	79.7
610	6	Prairie	OG	1	1	53.5	17.9	29.4	81.8
611	6	BG34	PRG	1	1	60.7	14.8	35.0	79.1
612	6	Select	TF	1	1	60.6	14.1	32.9	76.8
613	6	Duo	Festul	1	1	55.7	15.3	31.1	78.6
614	6	KYFA1016	Festul	1	1	56.3	16.1	33.9	83.2
615	6	Perun	Festul	1	1	64.7	12.0	37.0	74.2
616	6	Granddaddy	PRG	1	1	60.4	12.5	31.9	74.8
617	6	Barolex	TF	1	1	55.4	15.3	32.1	81.1
618	6	Potomac	OG	1	1	55.2	16.1	32.2	81.1
619	6	Tekapo	OG	1	1	69.4	12.8	37.4	76.5
620	6	Calibra	PRG	1	1	61.6	16.2	36.6	78.0
621	6	SpringGreen	Festul	1	1	67.3	16.9	36.5	81.8
622	6	Bariane	TF	1	1	59.0	15.0	30.5	80.9
623	6	Persist	OG	1	1	64.1	15.1	35.9	77.2
624	6	KYFA9611	TF	1	1	52.3	17.3	27.9	82.2
101	1	Duo	Festul	1	2	58.8	16.4	27.2	77.0
102	1	Perun	Festul	1	2	60.0	14.0	29.5	76.9
103	1	Harvestar	OG	1	2	56.1	17.5	28.8	78.6
104	1	Potomac	OG	1	2	63.6	14.8	30.7	75.4
105	1	KYFA1015	Festul	1	2	65.4	17.2	31.6	77.2
106	1	Granddaddy	PRG	1	2	63.0	15.8	29.5	77.6
107	1	BG34	PRG	1	2	60.4	14.2	31.2	77.1
108	1	Barolex	TF	1	2	53.5	15.8	25.2	77.7
109	1	Jesup_EF	TF	1	2	52.4	18.0	24.0	79.9
110	1	SpringGreen	Festul	1	2	63.5	16.0	32.9	78.5
111	1	KYFA1016	Festul	1	2	64.9	16.6	30.4	78.6
112	1	KYFA9611	TF	1	2	53.7	16.1	24.8	79.1
113	1	Calibra	PRG	1	2	56.1	15.8	28.9	79.2
114	1	Profit	OG	1	2	61.3	17.3	31.2	79.0
115	1	Power	PRG	1	2	57.3	17.1	26.5	80.7
116	1	Prodigy	OG	1	2	58.7	15.9	31.2	76.6
117	1	Prairie	OG	1	2	63.0	17.5	29.6	77.3
118	1	Barfest	Festul	1	2	58.9	16.9	28.9	79.1
119	1	Tekapo	OG	1	2	58.0	17.9	27.5	79.2
119	1	Persist	OG	1	2	66.0	16.3	31.4	76.6
120	1	Bariane	TF	1	2	58.0	17.9	25.8	79.1
121	1	Select	TF	1	2	58.9	17.2	25.6	78.5
122	1	Benchmark_Plus	OG	1	2	62.7	17.7	30.5	78.4
123	1	Linn	PRG	1	2	48.5	18.3	23.1	80.1
124	2	KYFA1016	Festul	1	2	55.8	17.6	26.3	80.4
201	2	SpringGreen	Festul	1	2	56.4	18.0	26.8	78.5
202	2	Barolex	TF	1	2	53.7	17.9	24.7	80.7

203	2	Prodigy	OG	1	2	64.8	16.6	31.1	77.8
204	2	Linn	PRG	1	2	56.1	17.1	28.1	80.1
205	2	Duo	Festul	1	2	58.6	18.2	27.7	80.4
206	2	Prairie	OG	1	2	63.0	17.3	31.2	77.9
207	2	Tekapo	OG	1	2	61.3	16.1	31.8	76.3
208	2	Perun	Festul	1	2	55.8	17.5	27.6	79.2
209	2	KYFA1015	Festul	1	2	62.2	17.0	29.8	77.2
210	2	Potomac	OG	1	2	65.3	18.5	30.6	79.3
211	2	Select	TF	1	2	56.0	16.1	25.1	77.6
212	2	Granddaddy	PRG	1	2	56.1	20.2	27.3	82.3
213	2	Bariane	TF	1	2	54.0	17.5	24.2	78.1
214	2	Profit	OG	1	2	67.9	17.7	30.7	77.6
215	2	Benchmark_Plus	OG	1	2	57.9	18.6	27.1	80.7
216	2	Harvestar	OG	1	2	54.7	17.7	25.3	79.3
217	2	Barfest	Festul	1	2	56.1	18.3	26.0	81.6
218	2	Power	PRG	1	2	55.8	18.6	26.3	80.6
219	2	Persist	OG	1	2	66.0	16.4	31.5	77.1
220	2	KYFA9611	TF	1	2	57.1	16.1	26.9	78.7
221	2	BG34	PRG	1	2	59.8	16.6	27.7	79.8
222	2	Jesup_EF	TF	1	2	53.4	17.2	24.0	78.0
223	2	Calibra	PRG	1	2	48.7	18.9	24.9	80.1
224	3	KYFA9611	TF	1	2	52.3	16.4	25.5	77.9
301	3	Barfest	Festul	1	2	56.9	16.2	30.5	78.5
302	3	Duo	Festul	1	2	60.2	14.8	28.0	75.5
303	3	Perun	Festul	1	2	61.3	15.7	29.2	77.6
304	3	Barolex	TF	1	2	60.0	14.9	27.4	77.2
305	3	Calibra	PRG	1	2	56.6	17.3	26.0	79.4
306	3	Prairie	OG	1	2	60.7	17.5	30.2	78.9
307	3	Granddaddy	PRG	1	2	52.6	17.0	25.6	78.1
308	3	Persist	OG	1	2	55.0	16.3	27.7	76.0
309	3	Benchmark_Plus	OG	1	2	61.6	18.3	30.9	78.5
310	3	Harvestar	OG	1	2	60.6	17.3	30.3	77.5
311	3	Linn	PRG	1	2	60.9	17.7	30.7	79.7
312	3	Potomac	OG	1	2	63.1	17.7	32.6	78.3
313	3	KYFA1016	Festul	1	2	64.1	16.7	29.6	78.8
314	3	Tekapo	OG	1	2	59.0	15.8	32.4	75.1
315	3	KYFA1015	Festul	1	2	57.6	15.6	30.7	74.4
316	3	Profit	OG	1	2	59.6	18.1	29.6	78.1
317	3	SpringGreen	Festul	1	2	58.5	17.5	30.0	78.1
318	3	BG34	PRG	1	2	54.2	20.0	25.1	82.4
319	3	Prodigy	OG	1	2	64.1	17.4	33.4	78.3
320	3	Bariane	TF	1	2	57.3	16.9	26.2	77.7
321	3	Power	PRG	1	2	57.0	16.4	29.0	77.0
322	3	Select	TF	1	2	56.1	16.4	23.9	78.1
323	3	Jesup_EF	TF	1	2	48.8	16.1	24.4	78.1

324	4	Bariane	TF	1	2	54.6	16.8	26.3	77.5
401	4	Linn	PRG	1	2	54.6	16.4	27.0	77.5
402	4	KYFA9611	TF	1	2	55.9	16.6	25.2	78.4
403	4	Jesup_EF	TF	1	2	57.6	16.1	26.7	77.3
404	4	Persist	OG	1	2	58.8	16.4	30.9	76.8
405	4	Benchmark_Plus	OG	1	2	63.5	17.3	29.9	78.1
406	4	Profit	OG	1	2	57.9	16.8	30.2	75.8
407	4	Harvestar	OG	1	2	55.4	17.9	29.3	75.7
409	4	SpringGreen	Festul	1	2	55.8	16.5	27.6	77.3
410	4	Duo	Festul	1	2	57.5	14.7	29.1	75.4
411	4	Calibra	PRG	1	2	55.1	16.4	26.8	79.6
412	4	Select	TF	1	2	57.9	14.9	25.8	75.9
413	4	Prodigy	OG	1	2	57.1	15.0	29.7	74.9
414	4	Barfest	Festul	1	2	62.1	15.5	29.5	76.5
415	4	Barolex	TF	1	2	51.7	16.2	25.3	77.8
416	4	Perun	Festul	1	2	59.5	13.4	29.9	74.0
417	4	KYFA1015	Festul	1	2	64.0	15.6	31.1	76.3
418	4	Prairie	OG	1	2	62.5	16.5	29.8	75.8
419	4	Tekapo	OG	1	2	55.2	16.3	27.5	76.7
420	4	BG34	PRG	1	2	63.8	15.3	32.0	77.9
421	4	KYFA1016	Festul	1	2	63.2	15.9	29.7	78.1
422	4	Power	PRG	1	2	54.6	16.8	29.4	79.5
423	4	Granddaddy	PRG	1	2	57.4	15.1	26.1	75.9
424	4	Potomac	OG	1	2	56.9	15.6	27.0	73.8
501	5	Bariane	TF	1	2	60.5	16.8	27.6	76.9
502	5	Persist	OG	1	2	57.0	16.8	27.3	76.5
503	5	Tekapo	OG	1	2	65.3	16.8	35.5	78.1
504	5	Perun	Festul	1	2	61.0	14.2	30.2	75.8
505	5	Barolex	TF	1	2	60.8	15.2	26.2	77.6
506	5	BG34	PRG	1	2	59.7	15.8	29.8	77.9
507	5	Profit	OG	1	2	67.8	17.0	32.8	77.4
508	5	Prairie	OG	1	2	61.1	16.9	28.9	78.0
509	5	Linn	PRG	1	2	54.0	17.8	25.4	79.4
510	5	Benchmark_Plus	OG	1	2	63.8	16.8	31.1	76.4
511	5	Potomac	OG	1	2	64.0	15.4	30.1	75.9
512	5	Power	PRG	1	2	56.9	17.5	26.9	79.7
513	5	SpringGreen	Festul	1	2	62.3	15.9	29.4	77.4
514	5	Jesup_EF	TF	1	2	53.4	16.3	24.5	77.9
515	5	Select	TF	1	2	54.6	15.9	24.3	77.6
516	5	Calibra	PRG	1	2	55.0	18.4	26.2	81.2
517	5	Granddaddy	PRG	1	2	56.5	17.6	27.0	80.6
518	5	KYFA9611	TF	1	2	52.8	16.0	24.8	77.1
519	5	Duo	Festul	1	2	53.4	19.3	25.0	80.7
520	5	Barfest	Festul	1	2	62.4	17.7	29.4	78.1
521	5	Prodigy	OG	1	2	66.4	15.9	31.6	76.6

522	5	KYFA1015	Festul	1	2	61.5	16.9	27.0	78.1
523	5	KYFA1016	Festul	1	2	57.6	16.6	29.5	78.3
524	5	Harvestar	OG	1	2	62.5	17.1	29.6	76.8
601	6	KYFA1015	Festul	1	2	58.7	19.0	28.3	80.3
602	6	Profit	OG	1	2	65.0	16.6	32.4	78.3
603	6	Linn	PRG	1	2	54.6	17.3	26.2	79.4
604	6	Barfest	Festul	1	2	61.0	17.3	31.4	77.8
605	6	Prodigy	OG	1	2	60.0	19.3	29.2	79.7
606	6	Harvestar	OG	1	2	59.4	18.0	28.2	79.2
607	6	Power	PRG	1	2	54.8	17.4	27.1	79.5
608	6	Benchmark_Plus	OG	1	2	62.3	16.2	30.6	75.4
609	6	Jesup_EF	TF	1	2	54.1	16.7	24.5	78.4
610	6	Prairie	OG	1	2	60.6	16.9	30.4	75.9
611	6	BG34	PRG	1	2	58.9	15.5	29.3	78.3
612	6	Select	TF	1	2	54.3	17.3	24.9	77.9
613	6	Duo	Festul	1	2	62.8	15.7	29.1	75.1
614	6	KYFA1016	Festul	1	2	55.2	17.3	27.1	79.2
615	6	Perun	Festul	1	2	61.7	15.9	29.8	77.7
616	6	Granddaddy	PRG	1	2	51.8	19.5	23.6	82.2
617	6	Barolex	TF	1	2	54.5	15.1	25.1	76.3
618	6	Potomac	OG	1	2	63.3	15.2	30.7	75.7
619	6	Tekapo	OG	1	2	57.4	13.6	33.4	78.0
620	6	Calibra	PRG	1	2	54.3	16.9	28.2	79.6
621	6	SpringGreen	Festul	1	2	57.7	17.5	27.7	79.1
622	6	Bariane	TF	1	2	57.5	15.9	25.3	77.4
623	6	Persist	OG	1	2	62.9	15.6	32.6	75.1
624	6	KYFA9611	TF	1	2	55.7	17.9	27.1	79.1
101	1	Duo	Festul	1	3	56.7	20.2	27.4	84.8
102	1	Perun	Festul	1	3	54.1	17.6	27.7	82.4
103	1	Harvestar	OG	1	3	64.4	16.6	33.3	77.4
104	1	Potomac	OG	1	3	61.2	17.3	30.3	80.3
105	1	KYFA1015	Festul	1	3	59.5	16.6	30.7	78.9
106	1	Granddaddy	PRG	1	3	56.8	18.6	27.4	82.1
107	1	BG34	PRG	1	3	58.1	18.9	26.8	83.7
108	1	Barolex	TF	1	3	44.8	19.8	23.7	83.4
109	1	Jesup_EF	TF	1	3	49.0	19.4	24.3	82.6
110	1	SpringGreen	Festul	1	3	56.7	17.5	27.9	83.1
111	1	KYFA1016	Festul	1	3	52.9	18.0	27.3	81.5
112	1	KYFA9611	TF	1	3	55.8	16.6	26.1	80.2
113	1	Calibra	PRG	1	3	58.1	17.9	28.4	84.4
114	1	Profit	OG	1	3	54.7	19.3	29.9	81.5
115	1	Power	PRG	1	3	46.5	19.1	27.6	83.8
116	1	Prodigy	OG	1	3	62.2	18.7	28.7	80.6
117	1	Prairie	OG	1	3	63.1	17.3	29.2	80.6
118	1	Barfest	Festul	1	3	55.1	19.6	28.3	84.9

119	1	Tekapo	OG	1	3	56.4	18.9	30.9	79.1
120	1	Persist	OG	1	3	57.8	17.4	29.4	79.5
121	1	Bariane	TF	1	3	55.0	18.0	26.9	80.9
122	1	Select	TF	1	3	55.5	17.1	25.4	79.7
123	1	Benchmark_Plus	OG	1	3	59.7	18.0	29.6	81.4
124	1	Linn	PRG	1	3	53.9	18.4	25.9	82.1
201	2	KYFA1016	Festul	1	3	53.4	19.4	25.5	83.1
202	2	SpringGreen	Festul	1	3	53.5	19.5	27.4	83.4
203	2	Barolex	TF	1	3	52.2	16.7	25.7	79.9
204	2	Prodigy	OG	1	3	56.9	18.8	30.0	82.4
205	2	Linn	PRG	1	3	57.9	19.5	28.8	84.3
206	2	Duo	Festul	1	3	54.8	20.3	27.7	83.9
207	2	Prairie	OG	1	3	60.7	18.0	27.9	80.6
208	2	Tekapo	OG	1	3	58.2	18.8	28.8	81.7
209	2	Perun	Festul	1	3	52.3	20.8	26.3	84.6
210	2	KYFA1015	Festul	1	3	55.7	19.2	26.6	84.0
211	2	Potomac	OG	1	3	62.6	17.0	31.0	78.6
212	2	Select	TF	1	3	54.3	17.4	25.1	80.4
213	2	Granddaddy	PRG	1	3	52.7	18.9	24.6	83.0
214	2	Bariane	TF	1	3	58.6	18.1	26.4	81.3
215	2	Profit	OG	1	3	59.3	20.4	30.7	81.3
216	2	Benchmark_Plus	OG	1	3	55.1	18.0	27.0	81.7
217	2	Harvestar	OG	1	3	56.0	20.1	27.8	84.1
218	2	Barfest	Festul	1	3	50.7	19.7	25.3	84.8
219	2	Power	PRG	1	3	55.5	18.4	26.9	83.8
220	2	Persist	OG	1	3	63.2	17.5	28.6	80.1
221	2	KYFA9611	TF	1	3	57.0	16.9	26.3	80.6
222	2	BG34	PRG	1	3	56.6	18.7	26.9	82.4
223	2	Jesup_EF	TF	1	3	53.5	18.6	25.2	82.5
224	2	Calibra	PRG	1	3	55.6	22.2	28.6	86.7
301	3	KYFA9611	TF	1	3	56.4	18.2	25.3	81.6
302	3	Barfest	Festul	1	3	53.9	17.3	27.3	81.9
303	3	Duo	Festul	1	3	59.5	17.1	29.4	80.9
304	3	Perun	Festul	1	3	51.5	17.6	26.6	83.1
305	3	Barolex	TF	1	3	57.8	17.8	26.1	81.2
306	3	Calibra	PRG	1	3	56.7	17.8	28.5	83.3
307	3	Prairie	OG	1	3	63.2	18.3	29.6	81.6
308	3	Granddaddy	PRG	1	3	51.3	20.5	27.2	82.3
309	3	Persist	OG	1	3	58.5	17.0	29.1	80.6
310	3	Benchmark_Plus	OG	1	3	57.2	17.5	28.5	80.8
311	3	Harvestar	OG	1	3	62.4	19.1	29.0	82.6
312	3	Linn	PRG	1	3	54.6	18.5	25.8	82.9
313	3	Potomac	OG	1	3	67.3	19.6	36.9	83.8
314	3	KYFA1016	Festul	1	3	58.6	18.3	27.3	83.2
315	3	Tekapo	OG	1	3	60.3	17.2	32.6	79.1

316	3	KYFA1015	Festul	1	3	53.0	18.8	26.4	83.0
317	3	Profit	OG	1	3	55.9	18.7	28.8	81.6
318	3	SpringGreen	Festul	1	3	50.0	19.7	26.9	83.3
319	3	BG34	PRG	1	3	58.8	18.4	26.7	82.8
320	3	Prodigy	OG	1	3	63.9	16.3	32.6	82.4
321	3	Bariane	TF	1	3	63.6	17.9	27.5	81.0
322	3	Power	PRG	1	3	54.3	18.2	25.8	83.5
323	3	Select	TF	1	3	53.3	18.9	24.7	81.0
324	3	Jesup_EF	TF	1	3	46.8	19.9	22.5	84.5
401	4	Bariane	TF	1	3	50.5	21.5	25.5	85.5
402	4	Linn	PRG	1	3	51.8	20.1	24.2	85.0
403	4	KYFA9611	TF	1	3	58.2	16.6	26.0	78.3
404	4	Jesup_EF	TF	1	3	53.3	18.4	25.1	80.8
405	4	Persist	OG	1	3	58.8	19.3	27.4	82.8
406	4	Benchmark_Plus	OG	1	3	58.2	19.1	28.3	82.1
407	4	Profit	OG	1	3	62.8	19.4	30.7	81.8
408	4	Harvestar	OG	1	3	61.7	17.8	30.6	79.4
409	4	SpringGreen	Festul	1	3	54.4	17.3	27.7	81.8
410	4	Duo	Festul	1	3	54.1	18.5	27.5	83.4
411	4	Calibra	PRG	1	3	59.1	18.5	27.7	83.8
412	4	Select	TF	1	3	55.0	18.7	25.5	82.7
413	4	Prodigy	OG	1	3	54.2	19.1	27.5	82.5
414	4	Barfest	Festul	1	3	57.4	18.2	26.9	82.5
415	4	Barolex	TF	1	3	51.5	20.3	24.2	84.9
416	4	Perun	Festul	1	3	53.2	19.3	26.6	83.8
417	4	KYFA1015	Festul	1	3	61.8	17.7	30.9	82.0
418	4	Prairie	OG	1	3	60.2	18.5	28.4	82.1
419	4	Tekapo	OG	1	3	60.0	16.5	30.8	80.3
420	4	BG34	PRG	1	3	59.1	18.1	28.1	82.1
421	4	KYFA1016	Festul	1	3	50.4	20.5	27.1	85.2
422	4	Power	PRG	1	3	54.5	17.7	26.9	83.1
423	4	Granddaddy	PRG	1	3	54.3	18.3	26.9	83.3
424	4	Potomac	OG	1	3	64.0	19.6	30.6	81.9
501	5	Bariane	TF	1	3	56.1	18.9	26.5	81.6
502	5	Persist	OG	1	3	63.3	15.6	32.1	79.6
503	5	Tekapo	OG	1	3	53.1	21.1	27.9	86.5
504	5	Perun	Festul	1	3	56.3	16.9	26.1	82.0
505	5	Barolex	TF	1	3	56.2	18.6	25.0	82.0
506	5	BG34	PRG	1	3	58.1	16.8	26.2	82.3
507	5	Profit	OG	1	3	57.4	19.6	27.4	84.5
508	5	Prairie	OG	1	3	59.2	16.6	28.9	79.4
509	5	Linn	PRG	1	3	55.8	17.7	26.9	81.9
510	5	Benchmark_Plus	OG	1	3	57.7	16.9	29.8	80.2
511	5	Potomac	OG	1	3	65.5	16.5	29.8	78.8
512	5	Power	PRG	1	3	52.7	18.0	26.0	82.2

513	5	SpringGreen	Festul	1	3	59.1	17.7	27.4	82.6
514	5	Jesup_EF	TF	1	3	55.6	17.0	24.9	80.3
515	5	Select	TF	1	3	57.9	17.6	27.0	80.7
516	5	Calibra	PRG	1	3	56.8	18.0	25.6	83.0
517	5	Granddaddy	PRG	1	3	52.1	19.6	24.0	84.7
518	5	KYFA9611	TF	1	3	57.4	17.2	25.0	80.3
519	5	Duo	Festul	1	3	51.1	17.0	26.6	81.4
520	5	Barfest	Festul	1	3	56.9	17.6	29.5	80.7
521	5	Prodigy	OG	1	3	60.2	17.4	28.2	80.6
522	5	KYFA1015	Festul	1	3	61.8	17.1	29.4	81.7
523	5	KYFA1016	Festul	1	3	56.6	18.4	27.9	83.3
524	5	Harvestar	OG	1	3	61.5	17.5	29.2	80.1
601	6	KYFA1015	Festul	1	3	56.4	19.5	28.2	83.1
602	6	Profit	OG	1	3	63.2	17.3	29.3	80.3
603	6	Linn	PRG	1	3	58.2	18.1	29.4	82.7
604	6	Barfest	Festul	1	3	56.0	17.3	28.0	81.4
605	6	Prodigy	OG	1	3	62.1	17.5	29.8	79.8
606	6	Harvestar	OG	1	3	61.3	18.5	28.8	81.8
607	6	Power	PRG	1	3	60.3	17.7	30.0	82.9
608	6	Benchmark_Plus	OG	1	3	62.1	16.2	29.6	79.2
609	6	Jesup_EF	TF	1	3	54.7	18.3	25.4	82.6
610	6	Prairie	OG	1	3	62.9	16.8	29.8	79.1
611	6	BG34	PRG	1	3	57.3	17.3	28.8	80.8
612	6	Select	TF	1	3	59.2	16.5	27.1	79.1
613	6	Duo	Festul	1	3	54.1	17.8	27.3	81.8
614	6	KYFA1016	Festul	1	3	55.7	17.7	27.0	82.7
615	6	Perun	Festul	1	3	59.8	15.3	28.0	78.7
616	6	Granddaddy	PRG	1	3	51.1	19.6	25.3	84.4
617	6	Barolex	TF	1	3	58.4	17.6	25.6	80.9
618	6	Potomac	OG	1	3	62.7	16.0	31.3	78.7
619	6	Tekapo	OG	1	3	59.1	16.1	30.4	78.9
620	6	Calibra	PRG	1	3	55.6	17.2	27.0	82.2
621	6	SpringGreen	Festul	1	3	54.9	17.1	27.5	82.1
622	6	Bariane	TF	1	3	60.2	17.1	27.6	80.5
623	6	Persist	OG	1	3	65.0	17.5	29.5	80.0
624	6	KYFA9611	TF	1	3	55.5	17.4	25.9	80.1
101	1	Duo	Festul	2	4	57.3	18.8	25.5	81.9
102	1	Perun	Festul	2	4	55.3	17.9	26.0	80.9
103	1	Harvestar	OG	2	4	58.6	18.5	26.1	81.2
104	1	Potomac	OG	2	4	62.0	17.8	28.4	79.3
105	1	KYFA1015	Festul	2	4	60.3	18.6	26.8	81.1
106	1	Granddaddy	PRG	2	4	62.0	18.7	27.6	81.5
107	1	BG34	PRG	2	4	55.3	17.7	27.9	80.4
108	1	Barolex	TF	2	4	55.5	21.0	24.2	83.0
109	1	Jesup_EF	TF	2	4	57.4	19.1	26.1	81.6

110	1	SpringGreen	Festul	2	4	54.9	18.9	24.8	82.7
111	1	KYFA1016	Festul	2	4	57.3	16.7	28.1	78.6
112	1	KYFA9611	TF	2	4	60.3	14.5	29.1	74.7
113	1	Calibra	PRG	2	4	62.1	16.4	27.5	80.3
114	1	Profit	OG	2	4	63.7	16.9	30.2	78.6
115	1	Power	PRG	2	4	57.0	18.8	25.2	82.2
116	1	Prodigy	OG	2	4	60.5	17.2	27.3	79.0
117	1	Prairie	OG	2	4	62.2	17.2	27.1	79.6
118	1	Barfest	Festul	2	4	55.5	19.5	24.7	83.3
119	1	Tekapo	OG	2	4	61.3	17.7	27.8	79.3
120	1	Persist	OG	2	4	63.8	17.4	29.6	78.0
121	1	Bariane	TF	2	4	60.9	17.4	27.1	79.1
122	1	Select	TF	2	4	56.8	17.5	25.9	78.8
123	1	Benchmark_Plus	OG	2	4	60.5	17.7	29.1	78.9
124	1	Linn	PRG	2	4	52.8	17.6	25.0	79.3
201	2	KYFA1016	Festul	2	4	53.1	19.7	25.3	83.1
202	2	SpringGreen	Festul	2	4	56.2	19.9	26.0	82.5
203	2	Barolex	TF	2	4	54.9	18.4	25.0	80.1
204	2	Prodigy	OG	2	4	62.4	17.4	28.8	78.1
205	2	Linn	PRG	2	4	60.9	17.0	29.5	79.4
206	2	Duo	Festul	2	4	53.8	21.2	23.0	84.9
207	2	Prairie	OG	2	4	61.0	18.7	26.4	80.9
208	2	Tekapo	OG	2	4	64.0	18.4	29.4	81.0
209	2	Perun	Festul	2	4	56.9	18.1	25.7	81.9
210	2	KYFA1015	Festul	2	4	57.1	19.9	25.0	82.1
211	2	Potomac	OG	2	4	64.8	18.0	28.1	80.0
212	2	Select	TF	2	4	53.4	17.7	24.6	79.9
213	2	Granddaddy	PRG	2	4	59.3	17.4	27.8	81.5
214	2	Bariane	TF	2	4	60.1	19.2	25.5	81.3
215	2	Profit	OG	2	4	61.5	19.2	27.9	81.3
216	2	Benchmark_Plus	OG	2	4	60.7	18.0	29.1	78.6
217	2	Harvestar	OG	2	4	60.9	20.6	27.8	80.9
218	2	Barfest	Festul	2	4	59.4	18.8	26.5	82.1
219	2	Power	PRG	2	4	56.8	18.3	26.6	82.2
220	2	Persist	OG	2	4	60.7	18.4	27.2	80.2
221	2	KYFA9611	TF	2	4	57.0	18.0	24.6	79.6
222	2	BG34	PRG	2	4	58.9	19.6	26.0	84.0
223	2	Jesup_EF	TF	2	4	56.3	18.7	25.9	81.2
224	2	Calibra	PRG	2	4	55.5	20.2	25.5	83.6
301	3	KYFA9611	TF	2	4	54.6	19.6	25.9	81.4
302	3	Barfest	Festul	2	4	51.9	20.5	26.7	83.9
303	3	Duo	Festul	2	4	63.1	18.9	28.1	82.3
304	3	Perun	Festul	2	4	59.9	15.5	27.1	77.9
305	3	Barolex	TF	2	4	55.4	18.2	25.6	79.7
306	3	Calibra	PRG	2	4	58.5	18.0	28.5	81.2

307	3	Prairie	OG	2	4	64.9	18.6	28.3	80.0
308	3	Granddaddy	PRG	2	4	57.7	19.2	27.9	80.7
309	3	Persist	OG	2	4	62.4	16.6	28.6	77.6
310	3	Benchmark_Plus	OG	2	4	63.4	16.5	31.5	77.1
311	3	Harvestar	OG	2	4	67.6	18.8	30.9	80.1
312	3	Linn	PRG	2	4	62.2	14.8	30.1	74.8
313	3	Potomac	OG	2	4	63.7	18.0	28.9	78.7
314	3	KYFA1016	Festul	2	4	58.3	19.4	26.4	82.9
315	3	Tekapo	OG	2	4	67.1	17.4	32.8	78.0
316	3	KYFA1015	Festul	2	4	58.6	21.2	27.8	84.4
317	3	Profit	OG	2	4	59.6	21.4	27.9	83.5
318	3	SpringGreen	Festul	2	4	69.7	17.6	32.1	80.1
319	3	BG34	PRG	2	4	58.0	20.1	26.2	83.9
320	3	Prodigy	OG	2	4	66.5	17.4	32.3	78.6
321	3	Bariane	TF	2	4	60.5	17.4	26.1	78.8
322	3	Power	PRG	2	4	56.8	18.0	27.4	80.7
323	3	Select	TF	2	4	57.3	17.1	25.1	79.8
324	3	Jesup_EF	TF	2	4	57.1	17.2	25.9	79.0
401	4	Bariane	TF	2	4	57.7	18.4	24.4	81.2
402	4	Linn	PRG	2	4	61.6	18.4	30.1	80.4
403	4	KYFA9611	TF	2	4	60.6	16.2	26.8	77.6
404	4	Jesup_EF	TF	2	4	59.0	16.7	25.2	79.2
405	4	Persist	OG	2	4	62.1	19.2	27.5	81.2
406	4	Benchmark_Plus	OG	2	4	61.5	18.4	27.2	81.0
407	4	Profit	OG	2	4	62.4	19.3	27.6	81.0
408	4	Harvestar	OG	2	4	60.5	20.7	26.6	82.4
409	4	SpringGreen	Festul	2	4	62.4	17.4	29.7	79.6
410	4	Duo	Festul	2	4	58.4	19.5	25.9	82.2
411	4	Calibra	PRG	2	4	59.2	16.7	26.3	79.9
412	4	Select	TF	2	4	60.5	16.2	26.9	78.7
413	4	Prodigy	OG	2	4	65.8	17.9	29.5	80.1
414	4	Barfest	Festul	2	4	64.0	16.0	31.1	76.6
415	4	Barolex	TF	2	4	55.0	17.5	25.0	81.2
416	4	Perun	Festul	2	4	58.7	17.2	26.4	80.4
417	4	KYFA1015	Festul	2	4	59.7	17.2	27.9	80.5
418	4	Prairie	OG	2	4	62.2	16.8	30.7	78.1
419	4	Tekapo	OG	2	4	64.0	17.6	30.4	78.9
420	4	BG34	PRG	2	4	66.0	14.6	29.8	76.9
421	4	KYFA1016	Festul	2	4	62.9	15.9	28.2	78.4
422	4	Power	PRG	2	4	69.2	15.2	33.3	79.2
423	4	Granddaddy	PRG	2	4	60.3	16.4	29.5	78.7
424	4	Potomac	OG	2	4	61.4	17.6	29.3	80.5
501	5	Bariane	TF	2	4	58.7	18.0	26.0	80.4
502	5	Persist	OG	2	4	65.7	18.6	29.6	80.1
503	5	Tekapo	OG	2	4	63.4	15.3	30.6	75.5

504	5	Perun	Festul	2	4	61.2	14.4	28.8	76.6
505	5	Barolex	TF	2	4	66.0	14.2	29.7	75.4
506	5	BG34	PRG	2	4	67.3	16.8	30.9	78.7
507	5	Profit	OG	2	4	64.1	15.8	30.9	76.8
508	5	Prairie	OG	2	4	64.5	16.9	28.4	78.6
509	5	Linn	PRG	2	4	61.2	17.5	27.8	79.8
510	5	Benchmark_Plus	OG	2	4	69.3	16.7	31.8	77.4
511	5	Potomac	OG	2	4	68.8	17.1	30.5	77.8
512	5	Power	PRG	2	4	63.8	15.0	31.1	75.8
513	5	SpringGreen	Festul	2	4	62.8	17.6	28.6	80.3
514	5	Jesup_EF	TF	2	4	58.9	17.2	26.6	79.1
515	5	Select	TF	2	4	57.4	17.4	25.1	78.3
516	5	Calibra	PRG	2	4	60.8	17.0	29.0	80.6
517	5	Granddaddy	PRG	2	4	58.2	19.0	25.4	81.8
518	5	KYFA9611	TF	2	4	56.7	17.8	26.2	80.1
519	5	Duo	Festul	2	4	59.0	18.5	26.4	80.6
520	5	Barfest	Festul	2	4	60.5	18.8	26.7	82.4
521	5	Prodigy	OG	2	4	67.2	15.3	32.1	76.4
522	5	KYFA1015	Festul	2	4	66.4	16.3	30.9	78.6
523	5	KYFA1016	Festul	2	4	61.2	16.9	29.0	79.5
524	5	Harvestar	OG	2	4	58.6	18.5	27.4	80.8
601	6	KYFA1015	Festul	2	4	56.9	18.9	25.8	81.6
602	6	Profit	OG	2	4	68.2	16.4	30.0	78.0
603	6	Linn	PRG	2	4	65.6	15.9	31.0	77.0
604	6	Barfest	Festul	2	4	62.0	16.7	28.1	78.9
605	6	Prodigy	OG	2	4	67.2	19.7	29.2	81.6
606	6	Harvestar	OG	2	4	65.1	18.2	30.8	79.1
607	6	Power	PRG	2	4	64.1	18.1	29.2	80.3
608	6	Benchmark_Plus	OG	2	4	59.3	18.7	28.9	81.2
609	6	Jesup_EF	TF	2	4	56.9	20.7	23.8	83.0
610	6	Prairie	OG	2	4	58.6	18.4	27.3	81.5
611	6	BG34	PRG	2	4	57.2	18.0	25.7	80.3
612	6	Select	TF	2	4	58.0	16.3	26.3	77.5
613	6	Duo	Festul	2	4	58.9	17.9	26.3	80.2
614	6	KYFA1016	Festul	2	4	66.8	18.0	33.3	80.6
615	6	Perun	Festul	2	4	55.9	17.6	27.0	82.2
616	6	Granddaddy	PRG	2	4	59.9	16.5	27.9	79.0
617	6	Barolex	TF	2	4	64.4	15.7	27.5	77.6
618	6	Potomac	OG	2	4	67.3	16.1	28.9	76.7
619	6	Tekapo	OG	2	4	71.4	17.6	33.0	77.6
620	6	Calibra	PRG	2	4	61.6	15.7	30.5	78.2
621	6	SpringGreen	Festul	2	4	65.4	16.2	32.0	78.2
622	6	Bariane	TF	2	4	61.8	17.8	28.9	79.4
623	6	Persist	OG	2	4	65.7	19.2	29.0	81.6
624	6	KYFA9611	TF	2	4	56.6	18.2	25.3	80.7

101	1	Duo	Festul	2	5	59.1	18.8	31.1	80.4
102	1	Perun	Festul	2	5	69.7	14.8	33.6	79.6
103	1	Harvestar	OG	2	5	59.8	20.4	29.4	82.3
104	1	Potomac	OG	2	5	59.5	21.4	28.0	81.8
105	1	KYFA1015	Festul	2	5	56.2	13.6	30.9	73.4
106	1	Granddaddy	PRG	2	5	58.2	17.3	29.0	80.8
107	1	BG34	PRG	2	5	59.5	17.7	27.7	79.4
108	1	Barolex	TF	2	5	56.1	17.8	26.9	78.0
109	1	Jesup_EF	TF	2	5	55.3	13.4	30.1	72.7
110	1	SpringGreen	Festul	2	5	59.6	16.4	28.8	79.8
111	1	KYFA1016	Festul	2	5	61.1	16.5	28.1	79.4
112	1	KYFA9611	TF	2	5	59.8	14.0	30.8	74.9
113	1	Calibra	PRG	2	5	56.5	17.3	27.7	80.8
114	1	Profit	OG	2	5	64.1	18.2	31.5	80.3
115	1	Power	PRG	2	5	66.9	14.6	32.3	78.1
116	1	Prodigy	OG	2	5	63.7	19.8	30.9	81.1
117	1	Prairie	OG	2	5	67.1	17.3	30.9	77.4
118	1	Barfest	Festul	2	5	63.6	14.8	30.5	80.3
119	1	Tekapo	OG	2	5	64.6	15.4	30.2	78.1
120	1	Persist	OG	2	5	62.7	16.9	29.8	77.6
121	1	Bariane	TF	2	5	56.3	17.2	29.0	78.4
122	1	Select	TF	2	5	56.9	16.8	27.2	79.9
123	1	Benchmark_Plus	OG	2	5	63.0	17.8	28.4	79.4
124	1	Linn	PRG	2	5	65.5	14.1	35.0	76.3
201	2	KYFA1016	Festul	2	5	60.6	17.8	29.0	79.2
202	2	SpringGreen	Festul	2	5	57.6	17.3	27.3	81.4
203	2	Barolex	TF	2	5	52.0	19.2	24.6	80.9
204	2	Prodigy	OG	2	5	60.0	18.4	30.2	79.9
205	2	Linn	PRG	2	5	64.9	16.7	30.2	78.6
206	2	Duo	Festul	2	5	61.4	15.8	30.1	79.8
207	2	Prairie	OG	2	5	66.4	15.1	31.0	79.6
208	2	Tekapo	OG	2	5	67.2	15.4	31.2	77.5
209	2	Perun	Festul	2	5	58.0	16.7	28.9	79.1
210	2	KYFA1015	Festul	2	5	62.7	14.5	28.4	79.4
211	2	Potomac	OG	2	5	60.0	15.6	32.5	76.0
212	2	Select	TF	2	5	58.1	16.9	26.6	78.8
213	2	Granddaddy	PRG	2	5	58.2	16.8	28.4	80.2
214	2	Bariane	TF	2	5	53.9	19.5	26.1	82.3
215	2	Profit	OG	2	5	66.5	15.9	32.2	78.6
216	2	Benchmark_Plus	OG	2	5	61.3	16.9	30.8	77.5
217	2	Harvestar	OG	2	5	58.3	17.3	32.4	77.3
218	2	Barfest	Festul	2	5	57.3	16.9	27.6	81.3
219	2	Power	PRG	2	5	56.0	18.4	27.1	81.5
220	2	Persist	OG	2	5	60.7	19.8	28.4	81.3
221	2	KYFA9611	TF	2	5	57.0	18.0	27.0	80.3

222	2	BG34	PRG	2	5	62.6	17.4	29.6	80.0
223	2	Jesup_EF	TF	2	5	60.8	15.8	27.6	79.7
224	2	Calibra	PRG	2	5	59.4	18.7	27.3	82.2
301	3	KYFA9611	TF	2	5	57.4	18.4	27.2	80.1
302	3	Barfest	Festul	2	5	60.6	17.6	29.6	80.5
303	3	Duo	Festul	2	5	59.4	17.1	29.1	78.6
304	3	Perun	Festul	2	5	51.0	17.7	30.0	80.3
305	3	Barolex	TF	2	5	52.0	16.2	24.8	75.5
306	3	Calibra	PRG	2	5	56.1	21.4	28.3	83.5
307	3	Prairie	OG	2	5	59.6	17.9	27.1	81.1
308	3	Granddaddy	PRG	2	5	54.2	19.4	27.1	80.8
309	3	Persist	OG	2	5	62.7	17.9	28.8	79.8
310	3	Benchmark_Plus	OG	2	5	62.6	17.8	28.9	81.0
311	3	Harvestar	OG	2	5	64.6	18.1	31.7	79.1
312	3	Linn	PRG	2	5	55.1	21.9	25.2	85.9
313	3	Potomac	OG	2	5	58.7	21.7	29.8	84.4
314	3	KYFA1016	Festul	2	5	53.3	19.8	25.1	82.9
315	3	Tekapo	OG	2	5	62.9	17.1	32.7	77.9
316	3	KYFA1015	Festul	2	5	66.4	15.7	34.1	77.8
317	3	Profit	OG	2	5	59.3	19.1	30.1	82.5
318	3	SpringGreen	Festul	2	5	63.0	18.2	31.3	80.8
319	3	BG34	PRG	2	5	51.7	20.4	24.9	83.8
320	3	Prodigy	OG	2	5	58.1	18.2	28.3	79.7
321	3	Bariane	TF	2	5	53.5	20.6	28.4	83.6
322	3	Power	PRG	2	5	55.8	20.0	27.0	83.3
323	3	Select	TF	2	5	56.7	17.0	25.9	79.8
324	3	Jesup_EF	TF	2	5	51.3	16.8	24.6	78.5
401	4	Bariane	TF	2	5	53.9	18.6	25.8	80.0
402	4	Linn	PRG	2	5	57.1	17.6	28.6	79.0
403	4	KYFA9611	TF	2	5	58.2	15.8	28.5	79.5
404	4	Jesup_EF	TF	2	5	56.6	18.1	27.8	79.4
405	4	Persist	OG	2	5	58.0	17.7	31.3	78.9
406	4	Benchmark_Plus	OG	2	5	59.0	18.3	27.2	80.1
407	4	Profit	OG	2	5	58.7	19.1	28.1	79.7
408	4	Harvestar	OG	2	5	56.3	19.1	30.9	80.3
409	4	SpringGreen	Festul	2	5	59.7	18.0	29.0	80.8
410	4	Duo	Festul	2	5	58.7	17.9	28.0	79.5
411	4	Calibra	PRG	2	5	57.0	18.5	24.8	81.4
412	4	Select	TF	2	5	53.7	16.4	25.2	79.0
413	4	Prodigy	OG	2	5	62.0	16.4	29.5	77.2
414	4	Barfest	Festul	2	5	63.3	16.2	30.0	79.9
415	4	Barolex	TF	2	5	55.1	18.0	24.7	80.5
416	4	Perun	Festul	2	5	55.2	18.0	27.8	80.5
417	4	KYFA1015	Festul	2	5	62.3	17.3	28.6	80.7
418	4	Prairie	OG	2	5	66.1	17.6	29.9	77.8

419	4	Tekapo	OG	2	5	62.3	18.0	30.3	80.6
420	4	BG34	PRG	2	5	60.9	16.5	28.3	78.8
421	4	KYFA1016	Festul	2	5	57.6	17.4	28.1	80.3
422	4	Power	PRG	2	5	58.9	17.9	27.9	80.7
423	4	Granddaddy	PRG	2	5	56.6	17.5	27.2	79.8
424	4	Potomac	OG	2	5	59.7	18.0	30.5	79.2
501	5	Bariane	TF	2	5	60.3	16.5	29.0	80.7
502	5	Persist	OG	2	5	64.5	17.7	29.0	78.4
503	5	Tekapo	OG	2	5	64.0	14.9	32.2	76.9
504	5	Perun	Festul	2	5	61.0	15.4	30.9	79.0
505	5	Barolex	TF	2	5	53.6	18.6	26.2	79.8
506	5	BG34	PRG	2	5	57.6	18.4	29.5	83.0
507	5	Profit	OG	2	5	66.3	18.3	31.5	79.2
508	5	Prairie	OG	2	5	65.8	16.7	30.8	76.9
509	5	Linn	PRG	2	5	61.4	16.1	28.0	80.0
510	5	Benchmark_Plus	OG	2	5	62.9	17.1	31.0	77.2
511	5	Potomac	OG	2	5	60.4	19.7	28.6	80.7
512	5	Power	PRG	2	5	54.6	20.7	24.7	84.2
513	5	SpringGreen	Festul	2	5	58.0	18.2	27.8	80.5
514	5	Jesup_EF	TF	2	5	59.0	14.9	26.9	78.1
515	5	Select	TF	2	5	64.9	15.0	30.0	78.3
516	5	Calibra	PRG	2	5	61.1	17.1	29.9	80.7
517	5	Granddaddy	PRG	2	5	60.8	17.8	28.0	79.4
518	5	KYFA9611	TF	2	5	68.5	14.9	31.6	77.8
519	5	Duo	Festul	2	5	65.0	13.6	26.4	79.2
520	5	Barfest	Festul	2	5	63.3	16.2	29.9	79.1
521	5	Prodigy	OG	2	5	63.3	19.4	29.4	80.0
522	5	KYFA1015	Festul	2	5	61.1	17.5	27.5	81.7
523	5	KYFA1016	Festul	2	5	60.1	18.1	26.9	81.5
524	5	Harvestar	OG	2	5	63.6	16.2	29.7	77.0
601	6	KYFA1015	Festul	2	5	59.5	16.5	29.1	79.0
602	6	Profit	OG	2	5	63.6	17.0	30.3	78.7
603	6	Linn	PRG	2	5	59.4	17.5	27.4	80.1
604	6	Barfest	Festul	2	5	60.3	17.8	27.3	80.8
605	6	Prodigy	OG	2	5	61.1	15.8	30.6	77.7
606	6	Harvestar	OG	2	5	62.2	17.2	28.8	78.9
607	6	Power	PRG	2	5	59.0	16.3	28.0	78.8
608	6	Benchmark_Plus	OG	2	5	58.9	18.7	28.4	79.3
609	6	Jesup_EF	TF	2	5	54.1	16.6	26.4	78.8
610	6	Prairie	OG	2	5	67.9	15.0	32.7	75.9
611	6	BG34	PRG	2	5	56.6	19.4	26.7	82.5
612	6	Select	TF	2	5	52.4	20.7	27.2	82.3
613	6	Duo	Festul	2	5	61.8	17.6	30.1	81.1
614	6	KYFA1016	Festul	2	5	63.3	17.5	29.3	82.1
615	6	Perun	Festul	2	5	59.8	16.8	28.7	80.3

616	6	Granddaddy	PRG	2	5	60.0	16.3	28.5	79.0
617	6	Barolex	TF	2	5	56.7	18.0	25.1	80.9
618	6	Potomac	OG	2	5	61.9	17.9	28.7	79.2
619	6	Tekapo	OG	2	5	65.3	15.5	32.2	77.2
620	6	Calibra	PRG	2	5	61.0	17.5	27.9	81.9
621	6	SpringGreen	Festul	2	5	58.7	16.5	29.2	77.9
622	6	Bariane	TF	2	5	60.8	16.7	30.0	79.7
623	6	Persist	OG	2	5	62.8	17.9	30.5	79.3
624	6	KYFA9611	TF	2	5	58.4	15.6	29.3	78.8

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Vita

Eric Douglas Billman was born in Northeast Ohio to parents Doug and Rhonda Billman. He spent his childhood growing up on his family's 200 Jersey cow organic dairy farm, where he was first exposed to the principles of agriculture that led to his interest in agricultural sciences. He participated in 4-H up until high school, where he joined Norwayne High School's FFA Chapter. His experiences in FFA led to his eventual decision to pursue an undergraduate degree in Agronomy and Crop Science from The Ohio State University. He attended The Ohio State University Agricultural Technical Institute (ATI) from 2009-2011 where he received his Associates Degree in Agronomy, graduating summa cum laude. He then moved to Columbus, Ohio to The Ohio State University where he graduated summa cum laude in December, 2012 with his Bachelor's Degree in Crop Science. He was a recipient of the Gamma Sigma Delta award for outstanding upper classmen in the College of Food, Agricultural, and Environmental Sciences. In addition, he was a Golden Opportunity Scholar in 2012 at the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America National meetings held in Cincinnati, Ohio.

While at the University of Kentucky for his M.S. degree, he presented the contents of this thesis at the American Forage and Grassland Council national meetings in January 2015, and Southern Branch American Society of Agronomy meetings in February 2015. He also was a runner up at the University of Kentucky Department of Plant and Soil Sciences Bill Whitt Graduate Student Mini-symposium in January 2015.

Upon completing his M.S. at UK he will be attending Mississippi State University to pursue his doctoral degree in plant breeding.