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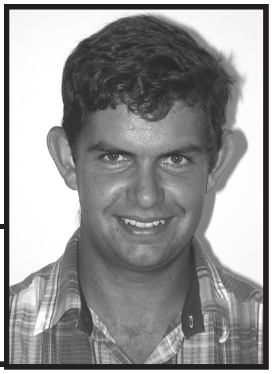
Growth and meat quality of Holstein and Fleckvieh X Holstein bull calves



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Abstract

In South Africa meat from cattle is classified as veal when no molar teeth have erupted yet or the carcass weight is below 100kg. In South Africa this is a small niche market not yet fully exploited. Little research has been done on the quality of veal locally. Furthermore little information is available on the effect of the quality of veal resulting from crossbreeding dairy cows with beef breeds to increase beef production of a dairy herd. This study details slaughter and carcass traits of 14 Holstein and 14 Fleckvieh X Holstein bull calves. Slaughter weight, cold carcass weight and dressing percentage of carcasses were determined. Fat depth was measured at two sites, i.e. 25mm from the midline at the 13th rib and between the 3rd and 4th lumbar vertebrae. The pH of the meat was measured 45 minutes (pH_{45}) and 48 hours post mortem (pH_u). The *Longissimus dorsi* (11-13th rib) muscle was used for meat quality characteristics: drip loss, colour, cooking loss and shear value. The calves were slaughtered at the same live weight and no differences in slaughter age (141 vs. 143 days), carcass weight and dressing percentage (51.3 vs. 51.1 %) were found between Holstein and Fleckvieh X Holstein calves. Fat depth measured at two sites did not differ between breeds. Initial pH of the meat from purebred Holstein calves was lower than meat from Fleckvieh X Holstein calves (6.49 vs. 6.66). No differences were found in the other meat characteristics. The performance of crossbred calves was similar to that of purebred calves in terms of growth. Crossbreeding Holstein cows with Fleckvieh bulls had no detrimental effects on any of the meat quality characteristics measured.

Introduction

Because the milk yield of dairy cows provides the major source of income for dairy farmers they have in the past concentrated on optimising the milk yield of dairy cows. This has led to a reduction in fertility in dairy cows (Van Raden, *et al*., 2003). One way to overcome this is by crossbreeding with another breed to utilize hybrid vigour, on the assumption that the breed selected for crossbreeding provides the required complementary traits and that the genetic distance between the breeds to be used is relatively wide (Pyman, 2006). With most crosses currently tested, the heterosis for survival was approximately 5% above the mid-parent mean (Carrick, et al., 2003). Currently in South Africa, little data is available of which crosses provide the best combination. By using a dual purpose breed such as the Fleckvieh, a Simmentaler derived breed from Ger-

Table 1 *The means (± SE) of growth and carcass characteristics from Holstein and Fleckvieh X Holstein bull calves reared under the same conditions*

Trait	Holstein	Fleckvieh X Holstein	Significance
Number	14	14	
Slaughter age (days)	141 ± 3	143 ± 2	ns
Slaughter weight (kg)	188.9 ± 2.3	187.9 ± 3.4	ns
Cold carcass weight (kg)	96.9 ± 1.3	95.5 ± 1.5	ns
Fat depth 13th rib (mm)	0.36 ± 0.02	0.39 ± 0.03	ns
Fat depth 3rd/4th lumbar (mm)	0.26 ± 0.05	0.36 ± 0.05	ns
pH_{45}	6.49 ± 0.10	6.66 ± 0.12	*
pH_u	5.38 ± 0.10	5.30 ± 0.10	ns
Cooking loss %	30.2 ± 1.1	30.4 ± 1.3	ns
Drip loss %	1.40 ± 0.04	1.48 ± 0.05	ns
Colour L*	41.3 ± 0.5	41.9 ± 0.6	ns
a*	9.52 ± 0.3	9.79 ± 0.4	ns
b*	9.28 ± 0.4	8.83 ± 0.3	ns
Shear value (N)	39.4 ± 4.1	42.9 ± 5.2	ns

* = Significant ($P<0.05$)   n.s. = Not Significant

many, milk yield and milk composition of dairy breeds are not compromised while improving the fertility and beef quality characteristics of dairy breeds. Because the Simmentaler breed is relatively abundant in South Africa many dairy farmers have started crossbreeding Holstein cows with Fleckvieh sires.

Little effort has been put into the rearing of bull calves because that does not always show a profit especially when viewed as a separate enterprise within the dairy industry. But using crossbreeding in a dairy herd a small niche market in producing veal, specifically read veal, could be exploited.

Materials and methods

The study was conducted at the Elsenburg Research Farm of the Western Cape Department of Agriculture. Elsenburg is situated approximately 50 km east of Cape Town in the winter rainfall region of South Africa. Purebred Holstein and Fleckvieh X Holstein bull calves were sourced from a commercial dairy herd within five days after birth. Calves were transported to Elsenburg and put into individual pens. Birth dates and live weight on arrival was recorded for each calf. Colostrum was fed to the calves from calving until five days of age. On arrival they received preheated colostrum collected from cows that had calved in the Elsenburg herd. Calves received colostrum up to eight days of age and thereafter full cream milk at 5% of body weight twice a day until weaning at six weeks of age. A calf starter meal containing 18% crude protein (CP) was provided *ad libitum* from seven days of age until two months of age. From two months of age, a growth meal containing 15% CP was provided *ad libitum* until slaughter at about five months of age. At three months of age, the bull calves were dehorned and castrated using a Burdizzo. The calves were weighted monthly until slaughter weight was reached to produce a carcass of less than 100 kg. Full body live weight was determined 24 hours prior to slaughter. The calves were slaughtered at a commercial abattoir using standard South African slaughter techniques, which included stunning with a pen pistol before being exsanguinated. Carcasses were subsequently hung to bleed out after which they were skinned. Measurements on the carcass included the measurement of the fat depth at two sites, i.e. at the 13th rib 25mm from the midline and between the 3rd and 4th lumbar vertebrae 25mm from the midline on the left side of the carcass.

After 48 hours in cold storage (4°C), the carcasses were weighed to determine cold carcass weight. Instrumental measurements of meat quality were made on the M. longissimus lumborum. A CRISON pH meter (507) was inserted directly into the meat, to measure pH 45min and 48h post mortem. The pH was measured on the right side of each animal in the M. longissimus between the 1st and the 2nd lumbar vertebrae. The M. longissimus dorsi muscle from the left side was dissected from the 1st to the 6th lumbar vertebrae and used for meat quality analyses (Schönfeldt et al., 1993). These meat quality analyses included the following: cooking loss, drip loss, colour and meat tenderness. Tenderness of the meat (the same sample as used for cooking loss) was measured with the Warner-Bratzler shear force test using 1.27cm diameter samples in triplicate (Honikel, 1998). Maximum shear force values (N) required to shear a cylindrical core, perpendicular to the grain (at a crosshead speed of 200.0 mm/min), were recorded for each sample and the mean was calculated for each muscle. The ASREML statistical package (Gilmour et al., 1999) was used to analyze the data.

Results and discussion

The slaughter weight of calves did not differ (P>0.05) as the target was to produce a carcass of less than 100 kg. Calves of the two breeds reached this target slaughter weight at the same age (Table 1), indicating no difference in the growth rate between the two breeds. Dressing percentage and cold carcass weight did not differ (P>0.05) between the two breeds. The fat depth measured at the two different sites also did not differ (P>0.05) between the two breeds. It seems that the deposition of subcutaneous fat had not started at the age calves were slaughtered (Lawrie, 1998).

Initial pH measured 45 minutes after slaughter in the M. longissimus dorsi muscle of purebred Holstein bull calves was lower (P<0.05) than that of Fleckvieh X Holstein calves. The higher pH45 value of Fleckvieh X Holstein suggested that they might have experienced lower stress levels immediately prior to slaughter. The post-mortem pH is determined by the amount of lactic acid produced from glycogen during anaerobic glycolysis. This is curtailed if glycogen is depleted by fatigue or fear in the animal before slaughter resulting in a lower initial pH (Lawrie, 1998). This contention however could not be validated, since no measures of stress were recorded while the animals were slaughtered at random. Other meat characteristics also did not differ (P>0.05) between breeds.

Conclusion

The growth rate of Fleckvieh X Holstein and Holstein bull calves were similar up to slaughter at about 5 months of age. Post-portem pH levels indicate that purebred calves may be more susceptible to stress than crossbred calves. Crossbreeding Holstein cows with Fleckvieh sires had no detrimental effects on any of the meat quality characteristics measured.

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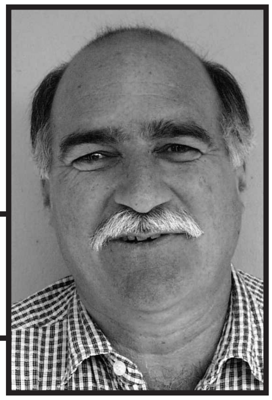
Factors influencing the persistence and production potential of kikuyu (Pennisetum clandestinum) over-sown with different ryegrass and clover species in the southern Cape



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1. Introduction

Kikuyu (*Pennisetum clandestinum*) is a productive pasture species that is well adapted to the main milk producing areas of the southern Cape region in South Africa. The main challenges experienced with kikuyu (a sub-tropical C4 grass) are the seasonality of production and its relatively low nutrient quality (Marais 2001). In this region kikuyu is highly productive during summer and autumn but it has a low production potential in winter and spring. Compared to temperate grass (C3) species, the forage quality of kikuyu is low. Consequently, milk production per cow grazing on kikuyu pastures is lower than for cows grazing on temperate grass pastures (Marais 2001). Cows grazing kikuyu-based pasture must therefore be supplemented with concentrate feeds to increase milk yields. However, nutrient supplementation is costly and also requires a high level of management input to implement successfully.

A major problem experienced in the mild climate of the southern Cape was the invasion of high-cost, irrigated ryegrass-clover pastures by kikuyu. Research during the 1980's focussing on the prevention of kikuyu invading irrigated perennial ryegrass-clover pasture was not successful. The vigorous growth and ability of kikuyu to propagate through seed and rhizomes, makes it impossible to find a cost effective way to keep kikuyu out of the irrigated pastures. During the 1990's the research focused on the possibility of using kikuyu as a summer and autumn pasture as well as a pasture-base during winter and spring by over-sowing it with high quality ryegrass and/or clover species.

The problem was that kikuyu is a very strong competitor for soil nutrients, water and sunlight, the most important components needed for growth by plants. A lack of understanding of the ability of kikuyu to compete for these components was the main reason why the initial attempts to oversow kikuyu with clovers and temperate grass species were unsuccessful (costly, unpredictable and not sustainable). Ongoing research has shown that kikuyu growth and its ability to compete, is suppressed if it is managed in such a way that it is not allowed to over-shadow companion plants in the pasture or to accumulate growth reserves in its stems.

Kikuyu uses some of the growth reserves that accumulate during autumn to over-winter and most (70% to 75%) of the root reserves that accumulated during autumn for the development of new leafs and roots in the following spring. During late spring and summer, kikuyu needs a large quantity of sunlight on its growing points to form new leaves for growth. The above-ground growth of kikuyu consists of about 80% leaves during spring. At this time new stolons and rhizomes are initiated. If water and nutrients are available the plant will grow very aggressively and invade other crops in summer and autumn. During the summer and autumn, as the plant stores its reserves, more space for storage is required thus stimulating rhizome and stolon development. Leaves to stem ratio therefore decreases from 60% in summer to 25% in late autumn (Whyte et al. 1968; Jagger 1999). Forage quality of kikuyu declines as leaf:stem ration decreases.

Jagger (1999) and Weinmann (1940), however, have suggested that it is possible to decrease the competitive dominance of kikuyu during spring by preventing it from building up root reserves during autumn. These findings helped researchers at Outeniqua to find ways to strategically decrease the aggressive growth of kikuyu during spring. Research focused on preventing kikuyu from storing reserves in autumn by the removal of a large amount of stem material during autumn prior to over-sowing the pasture with temperate grass species and clovers, and preventing sunlight from reaching the plant's growing points during spring.

The basis of this research was to graze kikuyu as short as possible during early autumn and then using a mulcher[1] to mulch all above-ground plant material – the kikuyu stems and leaves. By doing this a large amount of the kikuyu's reserve-carrying stem material is destroyed. This mulched material also creates an excellent growth medium for winter and spring growing grasses. The mulch layer together with grasses also prevents sunlight from reaching the growing points of the kikuyu plant during spring, preventing it from forming new leaves and limiting the initiation of rhizomes and stolons. With this management, maximum sunlight will only reach the growing points of kikuyu when the over-sown ryegrass completes its growth cycle (towards the end of spring). The sunlight then stimulates leaf growth and a new kikuyu growing season. The start of this season depends on the ryegrass species or variety selected to over-sow kikuyu. Perennial and Italian ryegrass, with their ability to grow during spring and summer, will overshadow kikuyu longer than the annual Westerwolds ryegrass varieties which have a shorter growing season.

Research at Outeniqua Research Farm has shown that the strategic incorporation of different temperate C3 grass species and clovers into kikuyu can increase the seasonal dry matter (DM) production and quality of kikuyu pasture. However, the persistence and production potential of these pasture species planted into kikuyu and the response of kikuyu to the over-sowing practises depend on the management of a number of important decision making factors. These factors include soil fertility, soil moisture content, temperature, overshadowing, choice of species and varieties, grazing management and methods to plant different species into kikuyu.

2. Soil.

Optimum pasture production depends on correct management of soil fertility. The persistence of ryegrass and

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1 *This machine is similar to a rotavator with the difference that it pulverised all plant material down to the soil surface without disturbing the soil (type: 1.6m Nobili with 32 blades).*

legumes in a kikuyu pasture depend on the physical aspects of the soil, soil fertility and the availability of water to the plant. Deeper, well drained soils will normally be allocated for deep rooted legume plants e.g. lucerne, whereas kikuyu, ryegrass and clover pastures are well suited for shallow soils provided adequate moisture is available.

2.1 Soil profile map

Before any choice can be made regarding the selection of pasture species, a map showing the different soil types, and based on an evaluation of soil profiles, is required to divide soils with the same features into different camps or management areas. This will make it possible to allocate different pasture species with specific requirements regarding soil physical characteristics i.e. texture, depth, drainage etc. to different soil types. This concept of bringing the plant to the soil is introduced to ensure optimum plant production on different soil types.

2.2 Annual soil sampling

Annual soil sampling is required to obtain and monitor soil nutrient levels. Soil analysis will indicate whether or not additional nutrients are needed to raise soil nutrient status to the required levels, or simply to apply nutrients to ensure maintenance of current levels. Once the maintenance rates have been established, soil sampling can be undertaken every second year. The main advantage of soil analysis will be achieved by repeated testing over a number of years. A picture of trends in soil fertility status of the farm, on a per camp basis, will then be recorded. This can be used to monitor progress in achieving or maintaining nutrient levels. This picture of trends is an extremely important tool for the management of soil fertility in each pasture on the farm.

The importance of correct sampling procedures cannot be over-emphasized. Miles (2003) stated that a poor soil sample is worse than none at all because the results can be misleading. The correct sampling depth for a pasture that requires seedbed preparation (e.g. cultivating the soil before planting lucerne) is 150mm. For maintenance fertiliser or in no till systems, similar to kikuyu or grass-clover over-sown with ryegrass using the planter or mulcher method, a 100mm sample depth is recommended.

Important notes:

- sample at the same time every year on perennial pasture,
- the sample must represent one soil type,
- avoid unusual areas,
- take separate sample on weak areas,
- take 20-40 cores in zigzag pattern – mix thoroughly – take standard sample,
- a record of results over time is important.

2.3 Soil fertility

Kikuyu pastures are fertilised to raise soil fertility to the levels required for optimum growth and secondly to maintain those fertility levels by replacing nutrients lost through grazing and leaching. Kikuyu is sensitive for deficiency in carbon (C), nitrogen (N), magnesium (Mg), phosphorus (P), potassium (K), sulphur (S), iron (Fe), copper (Cu) and manganese (Mn) and less sensitive for calcium (Ca), boron (B), molybdenum (Mo) and sink (Zn).

The recommended soil fertility levels for a mixed kikuyu-ryegrass pasture are:

Organic carbon (C)	>2%
pH (KCl)	5.0-5.5
P (citric acid)	> 30 mg/kg,
K	80-100 mg/kg,
Ca	>400
Mg	>70 (Ca:Mg = 4:1)
S	>11 mg/kg,
Cu	>1.0 mg/kg,
Zn	>1.0 mg/kg
Mn	0-15 mg/kg

A pH above 5.0 (KCl) is important for optimum production and it is recommended that lime is top dressed annually at an application rate of between 500 and 1000 kg/ha. Annual soil samples at a depth of 10cm during February and corrections during March are necessary to prevent nutrient shortages during the winter and spring. Kikuyu-ryegrass pastures should be fertilised with 20kg of P/ha during September regardless of the P status of the soil (Hardy 2002).

2.4 Carbon (C) content (%)

The organic carbon content of the soil is an indication of the soil organic matter content. Soil organic matter is essential for humus development in the soil. Humus is an important plant nutrient which improves soil productivity. Soils without organic matter and humus can be considered as dead. No soil organisms will survive resulting in soil not being suitable for plant growth. Soil carbon content higher than 2% is needed for optimum DM production and persistence of different ryegrass species over-sown into kikuyu.

2.5 Manage high fertilisation cost

The following factors can help to manage the high fertilisation cost of kikuyu-ryegrass pastures:

- Take annual soil samples and keep a record of results.
- The strategic applications of nitrogen (N) during the active growth period of grasses are important. High levels of N applied at the wrong time in an attempt to create out-of-season pasture are uneconomical.
- Fertilise N at recommended amounts according to the pasture species and expected yield.
- The amount of N should be applied in conjunction with pH, macro- and micro element status of soil. Under optimum soil fertility conditions, 50 kg N/ha/month is recommended for optimum DM production.
- Urea as an N fertiliser is ineffective if applied on wet grass pastures in windy conditions.
- Within 10-14 days after nitrogen is applied onto pasture, the N level in plants is high and the dry matter content of the plant material is low. From that point onwards plants will use the nitrogen for growth and the DM content and grazing capacity of the pasture will increase. Therefore the timing of grazing on a newly fertilized pasture is a critical management decision. The influence of this on milk per hectare will positively influence fertilisation cost.
- Irrigation scheduling is essential. Maintaining the soil moisture content is a critical management requirement for optimum plant production. Without irrigation scheduling one can expect that valuable soil nutrients like N, K and Mn will be leached from the soil and shortages will occur resulting in lower DM production.
- Management must focus on the protection and improvement of soil organic material.
- Soil mineral imbalances should be monitored and will negatively influence plant growth and reduce the positive influence of nitrogen on growth:

- High K levels in the soil will decrease uptake of sodium (Na), Mg and Ca by the plant.
- Too much S influences the availability of Cu and molybdenum (Mo).
- A soil S content of 7-8 mg/kg is necessary to maximise the response of pastures to high levels of N fertiliser.

3. Soil moisture content

Low soil moisture levels combined with high temperatures (>30^{0}C) will reduce ryegrass growth. Maintaining moisture content of soils is a critical management requirement for optimum production and botanical composition of grass-clover pastures. Clover growth is reduced as soils dry out and high temperatures prevail. Soil moisture management depends on rooting depth of the pasture species, the growth rate of the plants, soil type and the availability of water. A useful tool available to the farmer for scheduling irrigation is the tensiometer. This instrument, if placed at the correct depth and is correctly maintained, will provide a good indication of moisture availability to the plants. For example, on the Estcourt soil types of the George area, a tensiometer depth of 150 mm and a maximum reading of -25 kPa are recommended for kikuyu-ryegrass pastures. The shallow rooted ryegrasses need an irrigation system that can provide 10-15 mm of water on a frequent basis (2-3 times a week).

4. Temperature

Temperature has a significant effect on the growth of kikuyu and ryegrass pasture. The DM production of kikuyu is the highest at a maximum air temperature of 21^{0}C and minimum air temperature of 9^{0}C (Andrewes & Jagger 1999). The active growth period of kikuyu is during summer and autumn. The production rate of kikuyu is also higher at high temperatures with high moisture content than that of ryegrass. The DM production of kikuyu will decrease by 11kg/ha/day for each 1 ^{0}C that the soil temperature decreases at a depth of 50 mm below 18^{0}C.

Ryegrass has an optimum air temperature of 18^{0}C for growth. This is one reason why ryegrass can successfully be planted into kikuyu pastures during autumn and be dominant during the winter and spring. The kikuyu component will increase as the soil temperature rises above 18^{0}C and kikuyu will be dominant during summer and autumn. Ryegrass will react to N fertilization at temperatures as low as 5^{0}C. This ability of ryegrass to react to nitrogen at low temperatures will stimulate higher grass production during the winter.

5. Overshadowing

Light is needed to trigger the growing points of parent clover stolons and -ryegrass tillers to produce new daughter stolons and -tillers. Shading reduces the production of daughter tillers and stolons. The reduction of daughter stolons and -tillers means fewer growing points resulting in lower clover and ryegrass production. Undergrazing is the main cause for the overshadowing of pasture. To prevent undergrazing it is important to implement the correct management practices as discussed under the heading 'grazing management'.

6. Choice of pasture species and varieties

The selection of pasture species and varieties is firstly based on the physical and morphological characteristics of the soil, soil fertility (availability of macro-, micro elements and organic material content), availability of water, climate (atmospheric pressure, rainfall, temperature, wind, humidity) and fodder program requirements. Species best adapted to these conditions in a specific area will be selected by farmers for over-sowing into kikuyu pasture. The aim of over-sowing is to increase and maintain the seasonal and monthly DM production, production rate (kg DM/ha/day) and animal production. It is important that the varieties selected must have the ability to produce adequate, high quality, palatable fodder during the periods when the production and/or quality of kikuyu cannot provide in the need of high producing dairy cattle.

Secondly, the species selected for over-sowing must have the ability to compete within a strategic management system with the vigorous growth of kikuyu. According to the fodder-flow program the aim can be to over-shadow kikuyu during spring and/or early summer.

Perennial ryegrass (Lolium perenne), annual ryegrass (L. multiflorum) varieties Italicum and Westerworldicum, white clover (Trifolium repens) and red clovers (T. pratense) species have been evaluated at Outeniqua Research Farm.

6.1 Perennial ryegrass

The persistence of perennial ryegrass depends on environmental and management factors. Although it persists in cooler countries for up to ten years, it seldom persists for longer than four years in South Africa. Research at Outeniqua has shown that the total DM production of perennial ryegrass decreases annually. For this reason perennial ryegrass is over-sown annually during April/May into kikuyu. This gives perennial ryegrasses the ability to overshadow kikuyu during winter and spring and thus competing with kikuyu during summer and autumn.

6.2 Annual ryegrass

Annual ryegrass consists of *L. multiflorum* var. *westerwoldicum* and *L. multiflorum* var. *italicum,* commonly named Westerwolds and Italian ryegrass respectively. Although Westerwolds and Italian ryegrass are closely related, there are some very important differences.

6.2.1 Italian ryegrass

Italian ryegrass has a vernalisation gene that delays flowering. This vernalisation gene is switched off by a combination of low (winter) temperatures and/or short days followed by increasing day-length (spring) resulting in the initiation of flowering (Nash & Ammann 2006). Italian ryegrass also has the ability to produce new daughter tillers after flowering (Fairy1997; Wallacy & Yan 1998; Nash & Ammann 2006). The degree to which the variety is able to produce daughter tillers will influence the persistence of the variety in spring and summer (Nash & Ammann 2006). Italian ryegrass is therefore not a true annual. Persistence will depend on the cold of winter, if planted before the winter and day length if planted late winter or early spring. Strategically this variety can also be used to seasonally compete and overshadow kikuyu during the growth period of kikuyu.

6.2.2 Westerwolds ryegrass

Westerwolds ryegrasses are true annuals. Westerwolds ryegrass planted in autumn tends to flower earlier than Italian ryegrasses. Westerwolds ryegrasses also do not produce as many daughter tillers after flowering and consequently the plants die and the pasture does not persist after flowering (Nash & Ammann 2006).

Therefore as a true annual, the fact that it has a strong seedling which quickly become a vigorous fast growing grass plant with the only aim to go into seed within 5-6 months, Westerwolds ryegrass can be planted during late summer (February) or early autumn (March) into kikuyu for winter (June, July and August) pasture. Because it can be planted during autumn, it also plays a vital role in the strategic over-sowing of kikuyu. It is the only annual ryegrass which fits into the strategy where the removal of the stem material of kuyu is part of the plan to deplete kikuyu of its growth reserves. Because it's been done when kikuyu is still growing, Westerwolds ryegrass has the ability to establish fast, overshadowing kikuyu and preventing it from creating new leaves and supplementing its root reserves.

Westerwolds and Italian ryegrass cultivars are commonly recommended for their total herbage production. As Goodenough et al. (1987) argued that high levels of herbage production has some merit, but attention should rather be given to how these varieties match the fodder flow requirements in a given enterprise. Westerwolds ryegrass cultivars have a greater yield performance than the Italian ryegrass cultivars during the colder winter months, but the Italian ryegrass cultivars generally out-yield the Westerwolds ryegrass cultivars during mid-spring. Goodenough et al. (1987) also found that spring planted Westerwolds ryegrass cultivars flowered and died within five months of planting, thus limiting the productive life of the pasture. In comparison, spring planted Italian ryegrass cultivars do not flower, tend to form daughter tillers, do not die during summer and consequently provide high quality pasture during the following autumn months.

Different ryegrass species are usually planted into kikuyu during autumn in an attempt to provide animals with adequate fodder of high quality during winter and spring months when the production of Kikuyu is low. The aim is to

- increase the yield of the areas under kikuyu during periods when kikuyu is dormant,
- increase the quality of the kikuyu based pasture
- and enhance the palatability of Kikuyu based pasture.

When different ryegrass species are planted into kikuyu pastures, inter species competition can be expected. The characteristics of different ryegrass species will determine their persistence during spring or if it will eventually set seed, die off, resulting in kikuyu dominating the pasture.

Van der Colf et al. (2008) has found that the greatest effects of inter-species competition occurs during autumn, when ryegrass is over-sown into kikuyu for winter fodder production and during spring, when kikuyu starts to recover from winter dormancy. The rate at which the kikuyu-ryegrass pastures will change from ryegrass dominance to kikuyu dominance during spring will vary between different ryegrass types. Westerwolds ryegrass is usually the first to show a decrease in abundance and production during spring. Westerwolds ryegrass presents less competition to the emerging kikuyu especially in terms of sunlight during spring, allowing kikuyu to be well established with high dry matter production during summer.

In contrast Italian ryegrass continues to dominate pastures well into spring, often displaying higher dry matter production rates during this period than Westerwolds ryegrass-kikuyu pastures. The end result is that kikuyu's summer production is negatively affected by the overshadowing effect of the dense spring Italian ryegrass stand.

Perennial ryegrass is intermediate in terms of the competitive effect that it has on summer production of kikuyu. Although perennial ryegrass plants may still be found in kikuyu pastures even at the end of summer, summer production of such pastures was found to be higher than the Italian ryegrass-kikuyu pastures. It is possible that the differences in growth form of the annual and perennial ryegrass types play a role.

In the same manner kikuyu can have an effect on the successful establishment of ryegrass during autumn. This may be attributed to the "strength" of the kikuyu component during autumn when planting commences. The Westerwolds ryegrass-kikuyu pastures seem to have a stronger and more vigorous kikuyu basis than both Italian and perennial ryegrass-kikuyu pastures. The end result was that emerging Westerwolds ryegrass seedlings had to compete with kikuyu for sunlight, water and nutrients to a greater degree than Italian or perennial ryegrass seedlings.

The understanding of how Italian, Westerwolds and perennial ryegrass interact with kikuyu has a significant effect on the production potential, botanical composition and persistence of these pastures.

The DM production potential, milk production and economy of kikuyu over-sown with Perennial, Westerwolds or Italian ryegrass is discussed in this publication.

6.4 Kikuyu over-sown with clover

Without a legume component kikuyu pasture is dependant on the application of nitrogen, thus increasing the input cost. The inclusion of a legume component would potentially reduce the N fertilization requirements and increase the quality of the forage produced by the pasture. A study at Outeniqua Research Farm showed that the rotavator method was the preferred method of establishing perennial white and red clovers into kikuyu than the mulcher method. The clover content of the kikuyu-clover pasture ranged from 5.2% to 20.7% with the mulcher method compared to 15% to 60% with the rotavator method (Botha 2003).

Although it is not difficult to establish clovers into kikuyu, a number of factors made the over-sowing of clover into kikuyu unpopular with farmers. The high cost of establishing clovers into kikuyu using expensive implements to preparing a seedbed, maintaining high intensity of grazing and strategic nitrogen applications are but a few.

Overshadowing is the main reason why clover is not persistent in a kikuyu-clover pasture. If clover is shaded the production of daughter stolons is reduced. Clovers need sunlight for the production of daughter stolons. The more stolons, the more growing points, the more growing points the more leaf production and growth (Curtis & O'Brien, 1994). Overshadowing because of undergrazing is the main reason why the 30% to 40% clover fraction needed in a kikuyu-clover pasture, to have a positive effect on nitrogen fixation and the quality of the kikuyu-clover pasture, cannot be maintained.

The inability by farmers to manage kikuyu in such a way that it is always grazed short enough for clovers to persist, starts annually during spring. The growth rate of winter growing ryegrass pastures increases during spring usually resulting in the production of more fodder than can be effectively grazed by the dairy herd. A similar problem occurs during autumn when the growth rate of kikuyu is high but the palatability is low. Animals will then find it difficult to graze the pasture down to the recommended height of 5-10 cm. The result is undergrazed Kikuyu with insufficient sunlight penetrating the canopy which overshadows the clover component and reduces theability of clovers to produce stolons and therefore to persist in the kikuyu-clover pasture. The decline of the clover component reduces organic N availability to the pasture and, since only strategic nitrogen applications during winter are recommended as part of the management tool to sustain clover in kikuyu-clover pasture, the outcome is a decrease in DM production and carrying capacity. Farmers are then forced to apply nitrogen on a regular basis to boost the growth rate of the ryegrass component of the pasture. The result is a diminishing clover component.

7. Grazing management

A good grazing management system is based on the optimum production (kg DM/ha) of adequate high quality, palatable dry matter and the highest possible animal intake (kg DM/cow/day). A well planned fodder flow program and utilisation management system of kikuyu-ryegrass is the basis for a successful grazing management system. It requires that kikuyu should be over-sown with ryegrass according to a specific plan, that grazing only takes place when adequate high quality, palatable pasture is available and that the intensity of utilisation (how short) and frequency of utilisation (grazing intervals) is accurately executed. To obtain these goals the pasture should be grazed at a point where the kikuyu and ryegrass are mature before they are grazed. Kikuyu and ryegrass should be grazed at the 4.5 and 3 leave stage respectively. This can vary between 3 and 6 weeks depending on factors like temperature, light intensity, day length and availability of water which influences leaf appearance. If ryegrass pasture is allowed to get older the third ryegrass leaf will die, resulting not only in pasture waste, but also in unpalatable roughage and in the overshadowing of the growth points of the ryegrass. This will prevent the development of new daughter tillers. Not only will the life of the pasture be shortened but the ryegrass component in a kikuyu-ryegrass pasture will also decline.

Correct grazing intervals and grazing intensity are the only management practices that will ensure optimum utilization of kikuyu-grass pasture. However, the intensity of grazing and grazing intervals should not be measured in time or in pasture height but by the DM availability and the residual DM of a pasture (kg DM/ha). To achieve this goal pasture allocation is one of the most important management factors to prevent over- or undergrazing of Kikuyu-ryegrass pasture. The allocation of inadequate or excessive pasture will result in pasture waste or a loss in milk production.

At Outeniqua Research Farm the quantity of available ryegrass from July to August is measured with the following regression equation: pasture available higher than 30mm (kg DM/ha) = 62 x RPM (Rising Plate Meter) height. The pasture DM intake of Jersey cows weighing 400 kg and fed 6 kg supplement per day is estimated at 8 kg DM per day. If the pasture height before grazing is 20-25 units on the RPM, 1240 kg DM is available per hectare. Pasture allocation of 10 kg DM per cow per day will ensure that cows take in 8 kg DM. This means that 1000 kg or one ha will be allocated to 100 cows per day. The aim is to graze pasture down to 50 mm or a RPM height of 10. Such a system will ensure proper pasture utilisation. It will also ensure that pasture rotation will vary with seasons.

Pasture intake is reduced by the feeding of concentrates. In a study done at Outeniqua Research Farm, Jersey cows grazed mainly on ryegrass-clover were fed 0, 2.4, 4.8, or 7.2 kg of concentrate per day over two lactations and produced 12.8, 15.2, 15.8 and 17 kg of fat corrected milk per day respectively. The feeding of each additional kg of concentrate resulted in production of 1.0, 0.71 and 0.58 kg fat corrected milk (FCM). The poor response to concentrate feeding can be attributed to substitution of pasture by concentrates. The substitution rate (SR) can be calculated as follows: SR = 0.093 X kg of concentrate fed per cow/day. Feeding of high levels of concentrates will result in reduced pasture intake, higher feed cost and under-utilization of pasture (Meeske 2006).

8. Methods of planting different species into Kikuyu

Research at Outeniqua Research Farm has shown that different methods are required to plant different pasture species into kikuyu. Three methods have proven to be effective namely:

8. 1 Perennial or Italian ryegrass pasture

Perennial and Italian ryegrass species are successfully planted into kikuyu using the mulcher-planter method. The kikuyu pasture is grazed to 50 mm, mulched to ground level and afterwards planted with an Aitcheson planter. The seedbed is then rolled once with a Cambridge land roller and irrigated. March and April is recommended for planting Italian and April/May for perennial ryegrass.

8.2 Westerwolds ryegrass

Although Westerwolds can also be planted with a planter it can also be established using a mulcher (1.6 m Nobili with 32 blades). This is cost effective and the only really effective method of planting ryegrass pasture into kikuyu. The kikuyu is grazed down to 50mm and the ryegrass seed broadcasted over the remaining kikuyu pasture. The kikuyu pasture is then mulched to ground level without the blades touching the soil. The mixture of mulched plant material and seed are then rolled once with a Cambridge land roller and irrigated.

8.3 Clover or a mixture of ryegrass-clover

The only effective way to establish clover or perennial ryegrass-clover pasture into kikuyu is to cultivate the kikuyu pasture using a rotavator (1.55 m Celli with 36 blades). The kikuyu pasture is grazed to 50 mm, mulched to ground level and afterwards rotavated to a depth of 100 mm. The seedbed is then rolled once with a Cambridge land roller, the seed is broadcast by hand, rolled again and irrigated. It is recommended that clovers or mixtures of ryegrass-clover are planted during April/May when the soil temperature at a depth of 10 cm is 18 ^{0}C and the kikuyu is dormant. From a strategic point of view it is a good option to plant clovers or mixtures of ryegrass-clover into Kikuyu pasture that has been over-sown the previous two years during February or March with Westerwolds or Italian ryegrasses. The negative effect of mulching the kikuyu during the previous two autumns regarding the storing of root reserves and overshadowing during autumn and summer, decreased the ability of kikuyu to compete with the perennial clovers or mixtures of ryegrass-clover during the first year of growth.

Notes:

- The seeds of perennial ryegrass, perennial clovers and Italian ryegrass need to make contact with the soil for the seedling to establish well. The seedlings also don't have the ability to compete with active growing kikuyu. The planting method or time of planting must be chosen in a way to benefit the

over-sown crops, hamper the growth of kikuyu or selected at a time when kikuyu is dormant.
- Clovers need a well prepared seedbed. In a study evaluating a mulcher and rotavator method to plant white and red clover into kikuyu, the rotavator method was a better method to establish perennial white and red clover into kikuyu than the mulcher method. By using the rotavator method the clover content of a kikuyu-clover pasture was higher than the clover content of a kikuyu-clover pasture established by the mulcher method for a period of two years after establishing the pastures.
- It is recommended that a kikuyu pasture should be grazed or the leaf and stem (stolons) material should be removed to a height of 50-100mm before being mulched, regardless of the planting method or species being planted. The reason for this is that a large amount of mulched material will cause a nitrogen negative period in which it will be difficult for the Westerwold ryegrass seedlings to germinate and grow fast enough for the roots to reach the soil. It will also cause clotting of the planters coulters, effecting planting depth and the overshadowing of emerging seedlings.

Table 1 shows the botanical composition, seeding rate and over-sowing methods of different pasture species, varieties and cultivars evaluated in kikuyu over-sown system trials at Outeniqua Research Farm.

9. Conclusions

A number of factors are important for ryegrass or clover growth and persistence in a mixed kikuyu-ryegrass or kikuyu-ryegrass-clover pasture. It is important that all the factors discussed above need to be addressed in order to achieve optimum DM production, quality and palatability. The goal should be to seasonally increase the ryegrass content using different ryegrass species without reducing annual pasture dry matter yield. Higher ryegrass content will improve milk yields for the same levels of dry matter available in the pasture. The pasture production, the amount of pasture utilized by our animals and the actual cost in relation to our production cost will be the only guidelines that will tell us if we can produce our milk competitively on an international market.

Table 1 The botanical composition, seeding rate and over-sowing methods of different pasture species, varieties and cultivars evaluated in Kikuyu over-sown system trials at Outeniqua Research Farm.

Botanical compositions of pasture treatments	Seeding rate kg ha^{-1}	Over-sowing methods
Kikuyu	Existing stand	Pure Kikuyu pasture
Kikuyu Westerwold ryegrass	Existing stand 25	Grazed to 50 mm Broadcast seed Mulcher Cambridge roller
Kikuyu Italian ryegrass	Existing stand 25	Grazed to 50 mm Mulcher Aicheson planter Cambridge roller
Kikuyu Perennial ryegrass	Existing stand 25	Grazed to 50 mm Mulcher Aicheson planter Cambridge roller
Kikuyu white clover cv. Haifa White clover cv. Waverley Red clover cv. Kenland Red clover cv. Cherokee	Existing stand 2.5 2.5 3 3	Grazed to 50 mm Mulcher Rotavator Cambridge roller Broadcast seed Cambridge roller
Kikuyu Perennial ryegrass cv. Yatsyn Perennial ryegrass cv. Dobson White clover cv. Haifa White clover cv. Waverley Red clover cv. Kenland Red clover cv. Cherokee	Existing stand 5 5 2 2 2 2	Grazed to 50 mm Mulcher Rotavator Cambridge roller Broadcast seed Cambridge roller

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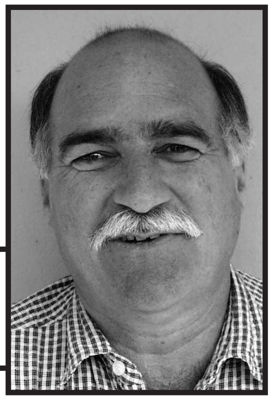
Effect of planting date on the dry matter production of forage sorghum hybrid and hybrid millet cultivars



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Abstract

Forage sorghum hybrids (*Sorghum bicolor (L.)* Moench x *Sorghum sudanense*) and hybrid millets (*Pennisetum glaucum*) are high producing and palatable summer grasses fit for milk and beef production. New cultivars are annually placed on the market of which the production potential needs to be determined. The aim of this study was to determine the dry matter production of different cultivars of both species when planted at different planting dates. Identical cultivars were planted in a small trial on 22 September, 20 October, 21 November and 20 December 2006. Prior to planting, the plots were tilled with a harrow disc followed by a kongskilde. Seed were broadcasted and the plots were rolled with a land roller. Weeds were not controlled. Plants were harvested when 60 % reached the height of 1 meter. Plant samples were dried for 72 hours at 60ºC to determine the dry matter (DM) content (%), DM production (kg DM.ha^{-1}) and growth rate (kg DM ha^{-1}.day^{-1}). During the September planting Betta Grazer (6409 kg DM ha^{-1}), Nutrifeed (5142 kg DM ha^{-1}), Pac 8288 (5582 kg DM ha^{-1}) and Greengrazer (4843 kg DM ha^{-1}) produced the highest total amount of DM per hectare. During the October planting Betta Grazer (6131 kg DM ha^{-1}), Nutrifeed (5805 kg DM ha^{-1}) and Pac 8288 (6052 kg DM ha^{-1}) produced a higher amount of DM ha^{-1} than most of the cultivars and only Super King (5125 kg DM ha^{-1}) could produce a similar amount of total DM per ha. Nutrifeed produced the highest total amount of DM (5913 kg DM ha^{-1}) per hectare during the November planting. During the December planting Hy Pearl Millet (4213 kg DM ha^{-1}), Betta Grazer (3856 kg DM ha^{-1}) and Nutrifeed (4574 kg DM ha^{-1}) produced the highest amounts of total DM per hectare. Betta Grazer planted during September produced a higher amount of total DM (6409 kg DM ha^{-1}) than most of the other cultivars planted at all the different planting dates. Pac 8288 planted during September or October, Nutrifeed planted during October or November and Betta Grazer planted during October could produce a similar amount of DM than Betta Grazer planted during September. Cultivar had a significant influence on DM production. Betta Grazer, Nutrifeed, Pac 8288, Greengrazer, Hy Pearl Millet and Super King were the most prominent cultivars and produced a higher total DM production than most of the other cultivars if compared to planting date and the frequency of cutting.

Introduction

The use of forage sorghum hybrids (*Sorghum bicolor (L.) Moench x Sorghum sudanense*) (Viaene and Abawi 1998) and hybrid millets (*Pennisetum glaucum*) as summer and autumn pasture has become very popular during recent years. This is because forage sorghums hybrids and hybrid millets have low water requirement, high dry matter (DM) productions and rapid growth over a short season (Renato et al. 2001; Butler et al. 2003). Unfortunately no information is available on when to establish these pastures and whether some cultivars can be planted earlier than others. It is important during establishment to choose the most effective planting date to ensure optimal growth. The wrong planting date could lead to insufficient germination and uneven growth.

The aim of this study was to determine the effect of planting dates of different cultivars on the DM production of forage sorghum hybrids (Sorghum bicolor (L.) Moench x Sorghum sudanense) and hybrid millets (Pennisetum glaucum)

Material and methods

An experiment using four different planting dates was conducted at Outeniqua Experimental farm with forage sorghum hybrids and hybrid millet cultivars. The farm is situated near George in the Western Cape (altitude of 210 m, 33º 58′ 38″ S and 22º 25′ 16″ E,) (Botha, 2003) with an annual rainfall of 730mm (Anonymous, 1990).

Ten cultivars were selected according to previous sorghum trial results (Gerber, et al. 2006). The cultivars (table 1) were planted on four different planting dates. The planting dates were 22 September 2006, 20 October 2006, 21 November 2006 and 20 December 2006. Table 1 indicates the different types of forage sorghums hybrids and hybrid millet cultivars that were selected.

The cultivars were planted on an Estcourt type of soil. Sixteen paddocks sized 138m² each was each divided into 10 blocks. The size of these blocks was of 11,5 m² each. Soils were sprayed with glyphosate (2 liter ha^{-1}) 2 weeks before planting. Soils were tilled with a disc harrow (1,5m), followed by a kongskilde. Seeds were broadcasted on plots and then rolled with a land roller (2,33m width, 30 rollers, Cambridge type). The seeding rate of forage sorghums hybrids and hybrid millets were 30 kg ha-1 and 15kg ha^{-1} respectively. Irrigation was scheduled according to a tensiometer reading. Irrigation commenced at a tensiometer reading of −25kPa and terminated at −10kPa (Botha 2003). Fertiliser was applied to raise the soil potassium (K) level to 80 mg kg^{-1}, phosphorous (P) to 35mg kg^{-1} and pH (KCl) level to 5.5. Nitrogen (N) and K was applied before planting at a rate of 50kg LAN ha^{-1} and 150kg KCl ha^{-1} respectively. Four weeks after emergence, a top dressing of 200kg ha^{-1} of 4:3:4 (33) was applied and after each cutting 200kg ha^{-1} LAN and 90kg ha^{-1} KCl were given.

Plants were harvested when 60% of plots reached a height of 1 meter. It was cut down with an Agria 5400 cutter (1,27m width) to a height of 100 mm. Sorghums were separated from weeds to determine plot weight. Samples of approximately 300 grams were taken from each plot to be weight and dried for 72 hours at 60ºC. This was used to determine DM production (kg DM ha^{-1}), growth rate (kg DM ha^{-1} day^{-1}) and DM content (%).

The experimental design was a split plot with 4 main plot treatments (planting dates) and 10 split plot treatments (cultivars). To select the treatments, which performed the best, a monthly average was calculated for each variable. An appropriate analysis of variance was conducted. Student 's LSD (least significant difference) at a 5 % significance level was used to compare the treatment means (Ott, 1998). The assumption of normality of the residuals was tested by a Shapiro Wilk test before the analysis of variance could be called reliable and valid. The 'LSTATS' module of SAS program version 8.2 was used to analyse the data (SAS 1999).

Table 1: The types of forage sorghum hybrid and hybrid millet and cultivars evaluated.

Type of sorghum	Cultivar
Conventional:	
• Late	*Jumbo* *Pac 8288*
• Early	*Greengrazer* *Super King*
BMR	*Revolution BMR* *Kow Kandy BMR*
Sweet	*Hunnigreen* *Betta Grazer*
Hybrid millet (Pennisetum)	*Hy Pearl Millet* *Nutrifeed*

Table 2: The DM production (kg DM ha-1) of frequently cut forage sorghum hybrid and hybrid millet cultivars planted during September 2006.

Cultivar	1st cutting 11 Dec	2nd cutting 8 Jan	3rd cutting 6 Feb	4th cutting 12 Mar	5th cutting 25 Apr	Total DM production
Betta Grazer	440^{a}	1615^{a}	1854^{a}	1054^{ab}	1446^{a}	6409^{a}
Hy Pearl Millet*	67^{e}	453^{cd}	940^{cd}	608^{cd}	644^{cd}	2712^{cd}
Nutrifeed*	117^{cde}	803^{bc}	1681^{ab}	1168^{a}	1373^{a}	5142^{ab}
Pac 8288	265^{bc}	1204^{b}	1767^{a}	1171^{a}	1175^{ab}	5582^{ab}
Greengrazer	281^{b}	1143^{b}	1609^{ab}	837^{abc}	973^{bc}	4843^{ab}
Super King	228^{bcd}	1007^{b}	1155^{bc}	790^{bc}	896^{bc}	4076^{bc}
Revolution BMR	46^{e}	382^{d}	322^{e}	180^{e}	151^{e}	1080^{e}
Kow Kandy	12^{e}	226^{d}	74^{e}	23^{e}	35^{e}	369^{e}
Hunnigreen	78^{e}	502^{cd}	371^{de}	134^{e}	162^{e}	1247^{de}
Jumbo	83^{de}	531^{cd}	580^{cde}	351^{de}	327^{de}	1872^{de}
LSD (0.05)	148.2	402.5	586.9	345.8	347.5	1618.5

*abcde Means with no common superscript differ significantly (P<0.05)1 Hybrid millet**

Table 3: The DM production (kg DM ha⁻¹) of frequently cut forage sorghum hybrid and hybrid millet cultivars planted during October 2006.

Cultivar	1st cutting 19 Dec	2nd cutting 18 Jan	3rd cutting 16 Feb	4th cutting 27 Mar	5th cutting 14 May	Total DM production
Betta Grazer	711^{a}	1357^{a}	1330^{a}	2128^{a}	604^{b}	6131^{a}
Hy Pearl Millet*	206^{d}	725^{d}	667^{de}	1145^{c}	401^{bcd}	3145^{de}
Nutrifeed*	379^{cd}	995^{c}	1243^{ab}	1909^{ab}	1279^{a}	5805^{a}
Pac 8288	694^{a}	1257^{ab}	1498^{a}	2044^{a}	559^{bc}	6052^{a}
Greengrazer	462^{bc}	1037^{bc}	919^{bcd}	1525^{bc}	404^{bcd}	4346^{bc}
Super King	631^{ab}	1031^{bc}	1124^{abc}	1796^{ab}	544^{bc}	5125^{ab}
Revolution BMR	303^{cd}	747^{d}	480^{ef}	636^{d}	194^{de}	2359^{e}
Kow Kandy BMR	198^{d}	400^{e}	114^{f}	135^{e}	42^{e}	888^{f}
Hunnigreen	250^{cd}	575^{de}	523^{e}	546^{d}	195^{de}	2090^{e}
Jumbo	446^{bc}	1031^{bc}	758^{cde}	1133^{c}	343^{cd}	3710^{cd}
LSD (0.05)	226.8	243.1	380.1	401.8	256.6	1109

abcde Means with no common superscript differ significantly (P<0.05)1
*Hybrid millet**

Result and Discussion

Table 2 indicates the total DM production (kg DM ha^{-1}) of frequently cut forage sorghum hybrids and hybrid millet cultivars planted during September 2006.

Betta Grazer produced the highest amount of DM during the first two cuttings (table 2). During the third and fourth cutting, Betta grazer, Nutrifeed, Pac 8288 and Greengrazer produced similar amounts of DM. This resulted in Betta Grazer, Nutrifeed, Pac 8288 and Greengrazer to produce the highest total amount of DM per hectare (kg ha^{-1}).

Table 3 shows the total DM production (kg DM ha^{-1}) of frequently cut forage sorghum hybrids and hybrid millet cultivars planted during October 2006.

Betta Grazer, Nutrifeed, Pac 8288 and Super King had high DM productions throughout the majority of the first four cuttings (table 3). Nutrifeed produced the highest amount of DM during the fifth cutting. This resulted in Betta Grazer, Nutrifeed and Pac 8288 to produce a higher amount of DM ha^{-1} than most of the cultivars and only Super King could produce a similar amount of total DM ha^{-1}.

Table 4 indicates the total DM production (kg DM ha^{-1}) of frequently cut forage sorghum hybrids and hybrid millet cultivars planted during November 2006.

During the first cutting Nutrifeed had a higher DM production than most of the cultivars and only Betta Grazer and Hy Peal Millet had a similar DM production (table 4). The fact that Nutrifeed had a higher DM production during each cutting than most of the other cultivars and only similar to that of Betta Grazer during the third cutting, resulted in Nutrifeed producing the highest total amount of DM per hectare.

Table 5 shows the total DM production (kg DM ha^{-1}) of frequently cut forage sorghum hybrids and hybrid millet cultivars planted during December 2006.

Hy Pearl Millet and Nutrifeed produced similar amounts of DM during each of the three cuttings followed the December planting date (table 5). The similarity of DM produced by Betta Grazer compared to that of Hy Pearl Millet and Nutrifeed during the first and third cut resulted in these three cultivars producing a higher total amount of DM per hectare than most of the cultivars.

Table 6 shows the total DM production (kg DM ha^{-1}) of frequently cut forage sorghum hybrids and hybrid millet cultivars planted on 4 different planting dates.

Betta Grazer planted during September produced a higher amount of total DM than most of the other cultivars (table 6). Only Pac 8288 planted during September or October, Nutrifeed planted during October or November and Betta Grazer planted during October could produce a similar amount of DM than Betta Grazer planted during September.

Conclusion

Cultivar had a significant influence on DM production. Betta Grazer, Nutrifeed, Pac 8288, Greengrazer, Hy Pearl Millet and Super King were the most prominent cultivars and produced a higher total DM production than most of the other cultivars if compared to planting

Table 4: The DM production (kg DM ha^{-1}) of frequently cut forage sorghum hybrid and hybrid millet cultivars planted during November 2006.

Cultivar	1st cutting 11 Jan	2nd cutting 8 Feb	3rd cutting 15 Mar	4th cutting 4 May	5th cutting	Total DM production
Betta Grazer	1314^{abc}	775^{b}	1032^{a}	1172^{bc}	-	4293^{bc}
Hy Pearl Millet*	1456^{ab}	1543^{a}	751^{bc}	1095^{bc}	-	4845^{b}
Nutrifeed*	1597^{a}	1712^{a}	795^{ab}	1809^{a}	-	5913^{a}
Pac 8288	930^{cd}	831^{b}	1009^{ab}	1264^{b}	-	4034^{bc}
Greengrazer	1031^{bcd}	653^{bc}	484^{d}	654de	-	2822^{d}
Super King	958^{cd}	770^{b}	779^{abc}	1031^{bcd}	-	3538^{cd}
Revolution BMR	357^{e}	374^{c}	217^{e}	326^{ef}	-	1274^{e}
Kow Kandy BMR	257^{e}	398^{c}	50^{e}	74^{f}	-	780^{e}
Hunnigreen	264^{e}	385^{c}	194^{e}	400^{ef}	-	1244^{e}
Jumbo	647de	621^{bc}	528^{cd}	804^{cd}	-	2599^{d}
LSD (0.05)	459.0	371.1	259.8	383.9		1055.2

^{abcde} Means with no common superscript differ significantly (P<0.05)1
*Hybrid millet**

Table 5: The DM production (kg DM ha^{-1}) of frequently cut forage sorghum hybrid and hybrid millet cultivars planted during December 2006.

Cultivar	1st cutting 1 Feb	2nd cutting 28 Feb	3rd cutting 17 Apr	4th cutting	5th cutting	Total DM production
Betta Grazer	1397^{a}	924^{b}	1536^{ab}	-	-	3856^{abc}
Hy Pearl Millet*	1051^{ab}	1579^{a}	1583^{a}	-	-	4213^{ab}
Nutrifeed*	1188^{ab}	1686^{a}	1700^{a}	-	-	4574^{a}
Pac 8288	954^{b}	957^{b}	1325^{ab}	-	-	3236^{bc}
Greengrazer	1219^{ab}	818^{b}	804^{cd}	-	-	2841^{c}
Super King	961^{b}	875^{b}	1050^{bc}	-	-	2886^{c}
Revolution BMR	229^{c}	290^{c}	284^{e}	-	-	802^{d}
Kow Kandy BMR	160^{c}	148^{c}	71^{e}	-	-	379^{d}
Hunnigreen	296^{c}	319^{c}	199^{e}	-	-	814^{d}
Jumbo	273^{c}	394^{c}	376de	-	-	1044^{d}
LSD (0.05)	412.0	367.7	494.8			1067.8

^{abcde} Means with no common superscript differ significantly (P<0.05)1
*Hybrid millet**

Table 6: The total DM production (kg DM ha^{-1}) of frequently cut forage sorghum hybrid and hybrid millet cultivars planted on 4 different planting dates.

Cultivars	22 September	20 October	21 November	20 December
Betta Grazer	6409xx	6131x	4293	3856
Hy Pearl Millet*	2712	3145	4845	4213
Nutrifeed*	5142	5805x	5913x	4574
Pac 8288	5582x	6052x	4034	3236
Greengrazer	4843	4346	2822	2841
Super King	4076	5125	3538	2886
Revolution BMR	1080	2359	1274	802
Kow Kandy	369	888	780	379
Hunnigreen	1247	2090	1244	814
Jumbo	1872	3710	2599	1044
1LSD (0.05)	1618.5	1109.0	1055.2	1067.8
2LSD (0.05)	1193.0			

^{1}LSD within planting date
^{2}LSD over planting dates
^{xx}Highest value (P<0.05) LSD = 1193.0
^{x}Differ not from highest value (P>0.05) LSD = 1193.0
*Hybrid millet**

date and the frequency of cutting. Betta Grazer, Nutrifeed and Pac 8288 are recommended for the September and October planting date, Nutrifeed for the November planting date and Nutrifeed, Hy Pearl Millet and Betta Grazer for the December planting date.

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