EFFECT OF PLANTING DATES AND CUTTING STAGES ON *RAPHANUS SATIVUS* AND *BRASSICA RAPA* IN CONTRIBUTION TO FODDER FLOW PLANNING

BY

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DISSERTATION SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF AGRICULTURAL ADMINISTRATION (PASTURE SCIENCE),

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SEPTEMBER 2014

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DECLARATION

I, Matsobane Alpheus Ngoasheng, hereby declare that this work has not previously been submitted at this or any other university, and that it is my own work with no plagiarism and that all reference materials contained have been duly acknowledged.

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SIGNATURE DATE

ACKNOWLEDGEMENTS

I am deeply grateful to God, for having mercy upon me and blessing me according to his heavenly riches. Special gratitude is send to my supervisor Professor C. S. Dannhauser for his guidance throughout the study. I would like to thank him for recognizing potential in me and offering me sponsorship together with NRF to conduct the research. I would also like to thank Hygrotech Company for providing seeds, ferlilizers, herbicides and a study site. It has been a hard and long road that has been made easier by fellow students; P. N. Ramaselele, P. J. Mabusela, N. S. Mogano, N. E. Choshi, K.P. Sekwadi. Last but not least I would like to thank my family: Mom, Dad (who is late, 31 August 2012), Ephraim, Irene, Katlego, Happy and the special woman in my life Maisha Gole for the support and patience while studying.

ABSTRACT

In the summer rainfall areas of South Africa small scale farmers, as well as commercial farmers experience low animal production due to a lack of good quality roughage. The nutritional value of the rangeland cannot maintain livestock during autumn and winter. Producing winter fodder could be expensive and literature showed that planting fodder radish and turnip might be a cheap relative option (not in sweet veld).

Winter supplementation contributes largely to high input costs in livestock production, which can make this enterprise uneconomically. For this reason alternative winter feeding strategies should be investigated, like the use of *Brassica* and *Raphanus* species for feed supply, of high quality, in winter.

Two Localities [Syferkuil, (University of Limpopo's experimental farm (Limpopo) and Dewageningsdrift, (Hygrotech Experimental farm (Gauteng)] were used for this research project. On the two localities three different factors were tested:

- Three planting dates (February, March and April)
- Three cultivars (Nooitgedacht fodder radish, Forage star turnip (not on Syferkuil) and Mammoth purple top turnip)
- Three cutting frequencies (first cut10 weeks after planting + regrowth; first cut 14 weeks after planting + regrowth and 18 weeks after planting, no regrowth).

Samples (for dry matter production and nutritional value analysis) were collected at both localities as per cutting frequency treatments during the 2007 growing season. The samples were used to evaluate the influence of the mentioned treatments on total dry matter production, nutritional value, leaf production and tuber production of the three cultivars.

At Syferkuil the DM production Nooitgedacht fodder radish was higher (5.23 to 5.9 t/ha) than that of Mammoth purple top turnip (3.24 t/ha) when planted in February. The same trend was seen during the March planting date (4.7 t/ha and 3.6 t/ha respectively for 18 W treatment). During the April planting date the highest production was higher (5.07 t/ha and 5.13 t/ha respectively) than that of the March

planting date. The 10 Weeks + Re-growth cutting treatment resulted in general in the lowest production.
At Dewageningsdrift (Gauteng) Nooitgedacht fodder radish produced the highest of all three cultivars at the 18 Weeks treatment, with the highest when planted in March (7.67 t/ha), 5.5 t/ha when planted in April and 5.3 t/ha when planted in February. For the rest of the treatments the DM production of Nooitgedacht varied between 2.9 t/ha and 4.6 t/ha.

The highest DM production of Forage star turnip was 3.01 t/ha (10 W+R, February planting date), 1.35 t/ha (14 Weeks + Re-growth, March planting date) and 2.34 t/ha (18 Weeks, April planting date).

The highest DM production of Forage star turnip was 2.96 t/ha (18 Weeks, February planting date), 2.59 t/ha (14 Weeks + Re-growth, March planting date) and 4.1 t/ha (18 Weeks, April planting date).

An estimation of the grazing/feeding potential of the different cultivars, at different planting dates and defoliation/cutting treatments, was calculated by using the leave and tuber production (variable criteria) from each treatment. The period from the initial cut to the last regrowth cut was a second variable criterion that was used. The third criterion (non-variable) was the standard norm that the daily intake of a matured livestock unit (MLU) of 450 kg is 10 kg.

According to the results the following example of a combination of treatments can be used to maintain ± 10 MLU/ha for the longest period in the winter in Limpopo:
Plant 1.1 ha Nooigedacht radish in February, utilize from ± 27 April to 22 June,
Plant 2.4 ha Nooigedacht radish in April, utilize from ± 22 June to 27 August,
Plant 0.9 ha Mammoth purple top in April, utilize from ± 20 August to 3 Oct

According to the results the following example of a combination of treatments can be used to maintain ± 10 MLU/ha for the longest period in the winter in Gauteng:
Plant 2.1 ha Forage star turnip in February, utilize from ± 12 April to 13 June,
Plant 1.7 ha Mammoth purple top in February, utilize from ± 7 June to 28 July,
Plant 1.5 ha Forage star turnip in April, utilize from ± 18 July to 29 August, Plant 2.1 ha Forage star turnip in April, utilize from ± 17 August to 4 Oct.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Forage Brassicas are members of *Brassicaceae* family, which includes radish, turnip, Swedes, broccoli, brussel sprouts, cauliflower and cabbage (Philbrick *et al.*, 1979). The focus of the study will be on the two crops being radish (*Raphanus sativus*) and turnip (*Brassica rapa*). They are commonly sown in spring, late summer and autumn for utilization when the pasture quality is often low or when autumn and winter pasture is limited. Forage *Brassica* provide quick and abundant feed with high digestibility, energy and protein (Fair 1989). The crude protein content of *Brassica* leaves ranges from 15 – 25 %. The metabolisable energy content ranges from 11–14 MJ ME/Kg DM (Van Zyl *et al.* 2005). The relatively low cost of establishing forage *Brassica* also makes them an attractive option for quick feed.

Farmers are influenced by the problem of scarce feeds for livestock during winter and dry periods on commercial farms and communal areas (Fair 1989). The impact of unsustainable beef production due to winter and dry periods often entices a lower Gross Domestic Production (GDP) for the country. That is a consequence of high imports of meat, because of leaner meat as a result of scarce nutritional feeding system (Anon, 2004). This then results in higher prices for the consumer from the previously disadvantaged communities to access meat and resulting to health issues (lack of iron in their ration).

The problem of low quality feed during winter and spring is common to many livestock farmers (Fair 1989). Many farmers use Lucerne hay (mostly dairy industry) as their alternative during this period. However, Lucerne and other crops like sorghum have problem of bloat and prussic acid, which are often a limiting factor to these crops (Donaldson 2001 and Fair 1989).

The use of Brassicas as fodder crops has big potential and can provide quick and abundant feed for livestock (Kalmbacher *et al.*, 1982 and Fair 1989). The fact that it can be sown in less fertile soils and under dry land conditions is a huge advantage over other winter fodder crops that need irrigation (Fair 1989). Brassicas can also reduce the incidence of soil borne plant diseases and also reduce nematodes since they contain natural chemicals, called glucosinolates, which break down in the soil to produce compounds that inhibit the growth of soil borne diseases and organisms such as nematodes and fungi (Jung *et al.,* 1979).

The study will bring more alternatives of feeds that are abundant in production for commercial and communal farmers, due to their ability to resist drought. Brassicas can grow fast after establishment and give abundant feed to livestock (as quick as in 10 weeks). With a high digestibility and nutritional value and correct planting time, Brassicas can be a potential fodder crops for livestock in the future.

1.2 PROBLEM STATEMENT

With the low annual rainfall in the biggest part of South Africa, it becomes difficult to feed the masses of this country. Low rainfall is not the only limitation; its distribution (mainly in winter) is also a problem. Because of the fact that the country is semi-arid to arid, this means that most parts in the country receive less 600 mm/annum. Water is a scarce resource in most parts of this country and therefore, it need to be maximized to achieve sustainable agricultural (Donaldson 2001). The scarcity of high quality fodder, especially during winter and spring, is one of the major limiting factors in livestock production in most parts of the country in general and in rural farming in particular. This is further aggravated by the very narrow genetic base in species that could be planted in winter especially. Therefore, alternative fodder crops (*Brassica* spp) could play an important role in livestock feeding, especially because of it's a high nutritional value and is drought resistance.

1.3 MOTIVATION FOR THE STUDY

The dominant variable on any livestock farm is the supply of feed right through the year. Basic feed supplies are often erratic and inadequate, because of poor planning and adverse weather conditions (Stewart *et al.,* 2005). It is in most cases not economic to fill these gaps with concentrates or any bought in feed. With the price ratio of milk/concentrates currently (near 1:1), it is more important than ever to realize that concentrates are supplementary feeds and not staple feed. Dairy and livestock producers often purchase a large portion of their animal feed from off-farm sources. In growing roughage for livestock, farmers think first of traditional feeds such as corn silage and hay crops (Stewart *et al.,* 2005 and Jones 1987). Other non-traditional crops such as certain *Brassica* species, fodder beet, annual legume forages and stockpiled grasses, are not used regularly in South Africa. The problem seems to be a lack of knowledge or the difficulties with establishment and management of some of these crops, like legumes. The *Brassica* species establish easier and is not difficult to manage. Growing these feed crops would allow farmers to extend the grazing season and be more self-sufficient in home-grown feed and fodder, resulting in less off-farm expenditures and potentially greater monetary returns for small and large producers.

Production of *Brassica* crops for forage production can occur in many locations, including soils where conditions may not be suited for production of Lucerne or maize. These locations are often the most difficult or neglected sites where forage production problems such as soil acidity, low nutritional value, poor soil moisture capacity and topographical limitations exist.

1.4 AIM

4.1 Aim

The aim of the study was to evaluate cultivar(s) of turnip and radish at different planting dates and cutting stages as fodder crops during dry periods and the winter season for commercial and rural farming.

4.2 Objectives

4.2.1 To determine dry matter production, tuber size and nutritional contents on different planting dates.
4.2.2 To determine the best cultivar in terms of dry matter production, tuber size and nutritional contents.
4.2.3 To determine the effects of cutting frequency on dry matter production and tuber size for different cultivars.
4.2.4 To determine the effects of planting date on dry matter production and tuber size for different cultivars.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

The importance of fodder production and conservation will vary from one ecological area to another. For example, in the relatively dry extensive farming areas, forage production may only be confined to selected favourable areas such as old crop lands. The fodder may be used as a drought reserve with livestock production being confined almost entirely to veld, for the longest part of the year. Whether livestock is carried on the veld or on artificial pastures (as green grazing), foggage, hay, silage or crop residues, and the fact remains that a sufficient quantity and quality of feed must be available throughout the year.

Rainfall distribution is so seasonal that the growth and production patterns of rain-fed veld grasses and shrubs, as well as panted pastures and fodder crops are restricted to the summer in the summer rainfall areas. In summer rainfall areas green active growing winter fodder can mainly be done under irrigation. Without irrigation seasonal imbalances of fodder production might occur, farmers must rely on summer growing crops in the times of dormancy as foggage (Donaldson 2001). In the higher rainfall areas (650-750mm) with late summer rain, a restricted variety of winter growing crops might be planted which will be discussed later in this chapter. A description of different winter feeding strategies follows.

2.2 WINTER FEEDING STRATEGIES IN SUMMER RAINFALL AREAS

2.2.1 Foggage as winter feed

Traditionally, hay, silage and crop residues have been used to maintain animals such as dry cows and weaners, during winter. Foggage is a term used to refer to herbage that has been allowed to grow during late summer-autumn and which is conserved on the land to be grazed as a standing crop during winter when pasture growth is slow or has stopped (Donaldson 2001). Foggageing may therefore, effect savings in labour and machinery costs when compared to making hay or silage. The difficulty of producing hay in high rainfall areas also makes foggage a very useful alternative source of winter feed (Engelbrecht 2002).

Knowing when to close up a pasture is a pre-requisite for successful production of a good quality and or quantity of foggage. January is usually the best month for closing up in most summer rainfall areas, mainly because of the normally dry autumn period and low autumn temperatures. Closing up a month earlier i.e. December, certainly leads to a higher yield but generally produces a poorer quality of foggage because of older material. The foggage yields from a February closing-up period will be very much lower than the January's foggage, but the quality will be much better. The timing and the amount of the rainfall is therefore a major factor influencing the quality and/or the quantity of foggage production (Donaldson 2001). .

The most efficient method of utilizing Foggage is by some form of rotational grazing. Rotational strip grazing is recommended because it is not only allows for an efficient utilization of the foggage, but also provides a more effective rationing of the feed supply. In strip grazing foggage, a new area is allocated to the animals on a daily to weekly bases. A two-herd rotational grazing can also be used with success when utilizing foggage alternatively (Rethman 1984). Satisfactory animal performances can be obtained by continuously grazing foggage at low to moderate stocking rates. The system is however more wasteful than rotational methods but is less costly in terms of labour and materials. The length of the period before using foggage in the winter is of importance for the successful use of foggage, particularly in early spring rainfall areas. The longer the foggage is left before it is utilized the poorer its quality (Rethman *et al.,* 1991). Ideally foggage closed-up in January, should be grazed from May to the end of July at the least. As the winter advances there is a steady decline in both the quantity and quality of foggage. The necessity to supplement animals on foggage with a protein and or energy lick will depend on the quality of the foggage, the stocking rate, the class of the stock and animal performance required (Engelbrecht 2002 and Donaldson 2001).

Correct management and selection of pasture species for foggage production will produce herbage of relatively high quality capable of supporting growing animals and dry stock with little or no supplementation. Grasses such as cocksfoot, tall fescue, perennial ryegrass, kikuyu, Smuts finger grass and Nile grass fall into this category (Rethman *et al.,* 1991).
Most of these pastures would, if grazed at a young stage early in winter, support producing animals without supplementation. Mass gains of 0,2 to 0,6 kg per head per day have been recorded for young steers grazing cocksfoot and tall fescue foggage, while heifers on foggaged kikuyu have achieved gains of 0,6 kg per head per day. The necessity to supplement foggage would depend on the quality of the herbage, the class of stock being fed and the animal performance required (Engelbrecht 2002 and Rethman 1984).

2.2.2 Hay and hay making

According to Donaldson 2001, haymaking turns green, perishable, forage into a product that can be safely stored and easily transported without danger of spoilage, while keeping losses of dry matter and nutrients to a minimum.

Hay is one of the most important harvested roughages for over-wintering livestock, but expensive to make. A second problem is that most the hay in South Africa is of low quality, which quality can be prevented by efficient methods of hay making, combined with good judgement. In hay making quality should always be the watchword. Most livestock farmers appreciate the value of quality hay in feeding their herds. However, too many of them cut the hay too late and do not pay enough attention to weather and weather reports or handle the hayed crop properly. As a result of these practices, 20 to 30 % of the nutrients in the hay may be lost. The green leaves are the most nutritious part of the hay plant and they constitute from 30 to 40 % of the protein (Donaldson 2001).

Two main factors determine the timing of haymaking: the expected weather of the time of hay making and the stage of maturity of the crop. The aim is always to have both high-quality herbage and suitable haymaking weather to coincide (high probability). In good tropical and subtropical conditions, it can be cut and cured the same day; under humid temperate conditions, several days of good weather are required (Skerman *et al.*, 1990).

The number of cuts per year varies greatly. On natural pasture (veld), only one cut from the autumn or summer flush is usually possible (unless the herbage is greatly improved by fertilizer). Sown pasture and fodder may provide several cuts. Irrigated crops in semi-arid areas have good haymaking possibilities and cutting should be organized to maximize production while maintaining quality through frequent cuts. This is especially important for the major irrigated forage, lucerne, hay that is cut late has considerably lower feeding value than which is cut early. The best time to harvest grasses and perennial legumes for hay is usually soon after early bloom stage. Winter cereal should be cut for hay when the grain is in the soft to medium dough stage (Donaldson 2001 and Rethnam 1991).

Hay can be kept for long periods if properly made and correctly stored; in contrast, it can deteriorate rapidly and even be lost by careless storage. The aim in storing hay is to keep it dry and to protect it from wastage due to rots, pests, stray livestock, fire or wind (Skerman *et al.*, 1990).

2.2.3 Silage

Silage is a green feed preserved in its succulent form and stored in such a way that its high nutritive value is largely retained. Silage is therefore one of the most effective means of conserving feed. The colour of the silage varies from a pale yellowish-green to a dark brown depending upon the nature of the green forage ensiled and particularly upon the amount of heat produced during the fermentation (Donaldson 2001).

Silage making is actually a simple process, provided that the correct procedure is followed. When plants such as maize, sorghums, cereals and cool-season grasses are ensiled at the correct stage, it is quite unnecessary to add additives like molasses or maize grain (Donaldson 2001).

It is important to plan the silo in relation to the harvesting and feeding out machinery available, or envisaged. There are five common "types of silo" in use in South Africa.

1 Tower silos. These are very good for making silage because the height of the ensiled material aids compaction and the exclusion of air. However, tower silos are expensive to construct and the removal of silage for feeding is a difficult operation.

2 Clamp or stack silos. No structure is necessary. The silage is dumped on a convenient surface to a height of at least 2,0 m and sealed within 3 days. Trench or pit silos. These consist of trenches or pits dug into the soil. They have earthen walls or the walls may be lined with brick or concrete.

3 Bunker or walled surface silos. These are constructed above ground and are most suited to pasture silage.

4 Big bale silage. This involves conserving grass as silage in big round bales.

Pasture silage that is made in self fed bunkers is easily self-fed and, provided enough space is allowed per animal, there should be no restriction on intake. The silage face of a self-fed bunker should be trimmed daily and any old dry silage that is left on the floor of the silo should be removed to discourage animals from lying down and thus denying access to the more timid animals. Silage that is not being self-fed can be loaded mechanically or by hand onto forage wagons or trailers. A mechanical grab fitted to a front end loader is often used. It is wasteful and expensive to feed silage by spreading it in the field. Silage should be fed in troughs (Dickinson 1990).

Probably the most effective way of sealing the silo is by using a sheet of black polythene 250 microns thick. Another method of sealing the silo is to cover the silage with old hay which, in turn, is covered with about 15 cm of soil. Opened up fertiliser bags, covered with old tyres, have sometimes been used, but this results in a great deal of wastage since it is difficult to seal all the edges of the fertiliser bags (Donaldson 2001).

2.3 THE BRASSICACEAE FAMILY AS WINTER CROPS

This study was aimed to evaluate effects of management on the tuber crops as winter fodder and a detailed description follows.

The historical development of the *Brassicaceae* has not been clearly delineated, but it is suggested that the family originated in the Mediterranean region and was quickly adapted to much of Asia and Europe (Harlan 1971). The systematics, domestication, breeding, and conservation of plants belonging to the family *Brassicaceae* have been compiled in an excellent monograph by Tsunoda *et al*., 1980. A brassicas is any member of the genus *Brassica,* which contains roughly 100 different species and includes a great many edible or otherwise useful plants, ranging from turnips to cabbages. Most types of brassica require fairly similar conditions in order to grow and thrive. Plants in this genus are widely used as food for humans, feed for livestock, or for other agricultural or industrial purposes. Many are high in fiber, nutrients, or other beneficial substances. The family includes: Turnip, Kale, and Radish which formed popular livestock feed for at least 600 years wherever they could been grown. The important *Brassicaceae* species used as fodder crops are: *Raphanus sativus* (Japanese radish)

Brassica rapa (turnips)
Brassica napus (oilseed rapes like canola)
Brassica oleracea (vegetables like cabbage, cauliflower etc)

For purposes on the study, *R. sativus* and *B. rapa* will be discussed.

2.4 GENERAL DESCRIPTION OF THE *RAPHANUS SATIVUS* AND *BRASSICA RAPA* FODDER SPECIES

2.4.1 Distribution and Adaptation

Turnip, rape and kale are distributed over much of Europe, northern Asia, northern North America and southern Oceania. These crops are grown year-round in cooler and moist climates. Most Brassicas are cold tolerant, and the leaves can withstand light frost. Moisture content of most species is relatively high and arid dryland farming seldom produce acceptable yields (with the exception of *R. sativus*) (Koch *et al.,* 1998). *Brassicas* thrive well on a wide range of soils, although loamy soils are preferred, and even light or peaty soils will produce good yields if rainfall and fertility are adequate (Yun *et al.,* 1999). The Brassicas are well suited to soils with a pH from 5.5 to 6.5, but will not tolerate waterlogged conditions and may require drainage on heavy soils. In drier areas, soils with moderate organic matter content and moisture holding capacity are essential for production of these crops (Yun *et al.,* 1999 and Barnes *et al.,* 1995).

2.4.2 Germination

Rapid germination and seedling establishment of the *Brassicaceae* spp is of considerable importance in obtaining a high plant population necessary for high yields. Seedling establishment of *Brassicaceae* species can be hindered by low soil temperature and inadequate moisture. *Brassicaceae* species seeds can germinate within the temperature range of 5º C to 45º, but is higher within the temperature range of 10º to 35º C (Wilson *et al.,* 1992). Optimum germination is achieved at 35º C and the time required for germination increases as the temperature declines (Tokumasu *et al.,* 1985).

Soil water content is more important for optimum germination than temperature. Rate of germination and growth are significantly reduced with decreasing soil moisture. Although the amount of water required for seed germination varies extensively among species, total germination and the rate of emergence of all *Brassica* species are highest at soil-water potentials higher than 0.1 mega Pascal (MPa). Total germination and germination rate decline with decreasing of soil water potential below -0.1 MPa (Rao *et al.,* 1986). Cool soil temperature and variable soil water availability in the early spring result in erratic ad reduced seedling emergence. Priming the seed with polyethylene glycol will improve stand establishment in cold soils (Rao *et al.,* 1987b).

2.4.3 <u>Turnip (*Brassica rapa L.)*</u>

Plant Description

Brassica rapa generally has large bulbous or tapered roots of which a large part is exposed above soil and is available to grazing animals. With adequate moisture and fertility, turnips can be expected to provide crop yield of 4500 to 7500 kg DM/ha, of which 35% to 50% should be in the storage root (Evans 1979).

Because leaves are higher in nutritional value than roots, new cultivars were developed recently to increase the leaf to root ratio. Maximum root dry matter yield is achieved in autumn and in spring (Rao *et al.,* 1986).

Management Practices

Seeding Rates and Dates

In North America, maximum production was achieved with late August planting (equivalent to February in South Africa). If autumn planting is delayed, dry matter yield will decrease due to limited time available between planting and harvesting, declining ambient and soil temperatures and reduced solar radiation levels (Rao *et al*., 1986 and Harper *et al*., 1980).

Brasssica rapa is resistant to moderate frost and short periods of moisture stress. However, stands may be killed by prolonged subfreezing temperatures or moisture stress (Sheldrick *et al*., 1981). Frozen material can still be consumed by livestock, but once thawed the entire plant spoils quickly (Westover *et al.,* 1933). Seeding date for early autumn planting depends on the soil temperature. To achieve a reliable stand, soil temperatures should be between 15º to 25º C (Tokumasu *et al*., 1985). Rate of seeding vary according to the method of sowing and row spacing. In general, seeding rates range from 2 to 3 kg/ha for *B. rapa* when seeded in rows; the seeding rate should be slightly higher when seed is broadcasted. Seed should not be covered with more than 2 cm of soil. Lower seeding rates for turnip as compared to rape and kale are due to smaller seed size. Root crops are seeded at higher seeding rates so to reduce storage root production and increase top production (Rao *et al*., 1986 and Harper *et al*., 1980).

Fertilizers and Herbicides

Nitrogen and phosphorous are the most important elements in forage production. Generally forage *B. rapa* are fertilized with 75 to 120 kg N and 60 kg P/ha for the growing season. If soils are medium, to low in K, application of 30 to 60kg/ha K is recommended (Jung *et al.,* 1979). *B. rapa* is poor competitors with other plants, especially during their early growth period. If fertilization is delayed under sod-seeding, the previous crop (sod) will have the advantage over these crops. Fertilizer should be applied after seeding in order to give *B. rapa* a competitive advantage over weeds. Because of their winter hardiness, these crops have a competitive advantage over most weeds after frost. Fertilizer requirements under sod seeding, is slightly higher compared with those of conventional seeding because the sod tends to utilize nutrients (Jung *et al*., 1979).

Weeds can compete for light, moisture and nutrients and can decrease the emergence and establishment of *B. rapa*. Tillage operations before seeding and soil incorporation of pre emergence herbicides reduce early season weed competition for conventional seeding (Wilson *et al*., 1992), whereas post emergence herbicides are used to suppress sod under sod-seeding (Faix *et al*., 1979 and Jung *et al*., 1979).

Animal Performance and Use

According to Koch *et al.,* 1987, *B. rapa* are readily grazed by cattle and sheep and provide useful supplementary grazing in the mid-winter or late autumn when warm-season grasses and cereal forages are nonproductive. Due to their nutritive value, turnips are especially useful for feeding animals with high nutritive requirements. Such an application might include fattening lambs, flushing ewes and feeding lactating ewes, dairy cattle and young beef cattle. Lambs gazing turnip gained an average 214 to 249 g/day, whereas lambs fed hay and gained 186 to 195 g/day (Koch 1998).

Major factors affecting the efficient utilization of these crops are grazing pressure, trampling, and soiling of the crop. Grazing small electrically fenced areas (such as strip grazing) will improve utilization of *B. rapa*. The degree to which a crop becomes soiled is influenced by soil type and rainfall. Growing crops under sod-seeding reduces soiling and improves utilization. Rape and kale are less susceptible to soiling due to erect growth as compared with root crops (Yun *et al.,* 1999).

B. rapa is low in dry matter and fiber content. Changing the animal's diet from high fiber (grass) to low fiber may result in abnormal ruminal fermentation which might cause initial low animal gains (Lambert *et al.,* 1987). Lambs grazing brassicas gain slowly due to low fiber content and anti-quality factors inhibit live weight gain (Marten *et al.,* 1982). Supplementation of a dry high fiber feed along with *B. rapa* forage improves the performance of animals fed *B. rapa* forage alone (Lambert *et al*., 1987).

Chemical Composition and Nutritive Value

B. rapa is lower in dry matter content compared to *Medicago sativus* but produce greater quantities of total dry matter per unit area than most cereals (Oats etc) and forage grasses. The nutritive value of *Brassica* foliar and roots varies among cultivars and plants. Crude protein levels of *B. rapa* normally range from 15% to 20% in the leaves dry matter and from 6% to 15 % in the roots, depending on the size and number of roots per unit area (Rao *et al.,* 1986). The crude protein in leafy stems crops such as rape and kale ranges from 20% to 25% in the leaves and averages about 10% in the stems. Depending on plant parts, *B. rapa* is high in dry matter digestibility, ranging from 75% to 95%, compared with the 70% of good lucern. Digestibility of the root portion is generally five to seven percentage units higher than that of the leaves of root crops due to the roots' high carbohydrate content (Rao *et al.,* 1986, Kalmbacher *et al.,* 1982 and Jung *et al.,* 1979).

The nutritive value of *B. rapa* tends to be higher in the autumn and it is retained for a longer period in the autumn, as compared with the nutritional value of the same plants during spring. Retention of nutritive value for autumn-seeded brassicas could be attributed to lower dry matter accumulation after *B. rapa s* reach their maximum production and to the onset of cooler temperatures (Rao *et al.,* 1986 and Guilard *et al.,* 1984a).

Anti-quality Factors

Although high in nutritional value, turnips might contain anti-quality factors and elevated mineral concentration that may negatively affect animal performance. Concentrations of Ca, Mg, K, Cu, Fe and Mn in the plant are greater in summer-grown species than fall-grown (Guillard *et al.,* 1989a). *B. rapa* forage leaf exceeds the desired range of Ca: P ratio in ruminant diets and the roots has a similar or slightly lower ratio. Magnesium concentration and availability to ruminants is important due to high K, N, and Ca concentration in forages being a factor in the etiology of hypomagnesaemia (low level of Mg in the blood) in ruminants (Wilkinson *et al.,* 1977). Based on the (K+Ca): Mg ratio, hypomagnesaemia may be a concern with fall-grown species, particularly when conditions exist for high K and Ca concentration in herbage (Guillard *et al.,* 1989b). Glucosinolates and s-methyl cysteine sulfoxide in *B. rapa* forages are potential toxins that may adversely affect animal production. Glucosinolates release thiocyanate (SCN-) on hydrolysis, which inhibit thyroid uptake of iodine (Paxman *et al.,* 1974). Concentration of SCN- is greater in roots than in foliage, and higher in plants grown in summer than in fall (Guillard *et al.,* 1989b). Supplementary of

Iodine in the animal's diet will reduce the antithyroid activity of Suprachiasmatic nucleus (SCN).

To avoid potential animal problems, turnip may be fed as only a portion of the total diet. Supplementing with P and I, controlling intake of *B. rapa* species, or adding other forages to the diet should reduce potential problems with mineral imbalances or antigrowth constituents associated with *B. rapa* (Wikse *et al*., 1987).

Diseases and Pests

B. rapa crops are subject to insect damage including cabbage flea beetle or striped flea beetle (*Phyllotreta spp*.), armyworm (*Laphygma frugiperda*), cabbage loopers (*Trichoplusiani*) and aphids (*Brevicoryne brassiceae*). Need for insecticides are greatly reduced with minimum till seeding in seedbeds (Jung *et al*., 1979). When forage *B. rapa* is grown for livestock, care should be taken in selecting insecticides that are approved for grazing animals.

The most serious plant diseases are bacterial black rot (*Xathomonas compestris*) and mildew (*Erysiphe cruciferrarum*). These diseases occur primarily on mature crops. Disease damage is more common in the spring than in the fall. Controlling cabbage root maggot (*Hylemya brassicea*), maintaining crop vigor, and crop rotation are management methods that reduce the risk of these diseases (Jung *et al*., 1979).

2.4.4 Japanese Radish (*Raphanus sativus*)

Plant Description

Japanese radish (*Raphanus sativus*) belongs to the *Brassicaceae* or mustard family. The botanical name *Raphanus* is a Latin form of the Greek for radish. It is said to derive from a phrase meaning 'easily reared'. This is appropriate considering the plant's wide adaptability and its short period from sowing to maturity. Literature from ancient naturalists shows that it was popular in Egypt at the time of the Pharaohs (Anon 2005).

Raphanus sativus is an annual or biennial herb which exists in several different forms: the main distinction is between a small, short-season type of salad radish which is a cool climate plant and a large type which is adapted to a variety of temperature range (Sheldrick *et al.*, 1981). Three botanical varieties are recognised within the species *R. sativus*, namely *radicula, niger, mougri* and *oleifera*. The first two are grown for their tuberous roots, while *oleifera* is grown primarily for the oil in its seeds. Numerous cultivars have been developed within each variety. All varieties intercross freely and also hybridise with wild ones (same family) (Sheldrick *et al*., 1981).

The stems may be simple or branched and the large types reaching as much as 60 cm in height; the basal leaves are long, often pinnately lobed and coarsely toothed, but sometimes are not serrated, while the cauline leaves are simple and linear. The flowers are in long terminal racemes, usually white or lilac with purple veins (Sheldrick *et al*., 1981). The tap root (except in var. *mougri*) is swollen and varies from almost globular, about 5-7 cm in diameter in the forage types to as much as 60 mm long and 15 cm in diameter, cylindrical or conical in shape, in the oriental types, and weighing up to 15 kg (Hendrick 1972). The flesh is normally white, though in some cultivars may be pink to red.

Raphanus sativus is a cool-season, fast-maturing, easy-to-grow crop. It can be grown wherever there is sunlight and moisture, fertile soil, even on the smallest city garden. Early varieties usually grow best during the cool days of early spring, but some later-maturing varieties can be planted for summer use. Additional sowings of spring types can begin in late summer, to mature in the cooler, more moist days of autumn. Winter radishes are sown in midsummer to late summer, much as autumn turnips. They are slower to develop than spring radishes; and they grow considerably larger, remain crisp longer, are usually more pungent and hold in the ground or store longer than spring varieties (Allardice 1993)

Origin and distribution

There are several wild *Raphanus* species, particularly between the eastern Mediterranean and the Caspian Sea, and it is thought that *R. sativus* must have arisen in this region of Europe and Asia. *R. sativus* of the *niger* variety was an important food in Egypt probably as early as 2700 BC, and is thought to have spread to China by about 500 BC and to Japan by AD 700. The origin of the *radicula* variety is much more recent and it was first reported in the 16th century (from Europe). The globular forms of salad radish were developed from this variety in the 19th century. The large-rooted radishes are cultivars of the *niger* and *radicula* varieties (Jung *et al*., 1979).

Cultivation conditions

Temperature

While the winter types of *R. sativus* var. *radicula* are at their best in cool climates with maximum temperatures about 15°C, all types will tolerate tropical conditions and many do well under high temperatures, with maximum of 30-33°C and minimum of 20-22°C. Even the cool climate types require temperatures of 10-13°C for germination and most cultivars are, in some degree, susceptible to frost damage (Harper *et al*., 1980).

Rainfall

A fairly evenly-distributed rainfall of at least 350 mm during the growing season per year is required. With lower rainfall supplementary irrigation is needed (Dickinson 1990). It can also be grown in areas with late summer rainfall if special moisture conservation is done (like for wheat in the Eastern Free State).

Soil

Raphanus sativus is tolerant of a wide range of soils, though heavy clays may lead to malformed roots. As the growing season is short, nutrients must be readily available: a general recommendation is for early application of a 6:10:8 complete (NPK) fertilizer at 100-700 kg/ha (not a fertilizer experiment: used general application guide given in the book). *Raphanus sativus* grow well in almost any soil that is prepared well, is fertilized before planting and has adequate moisture maintained. *R. sativus* do best on the lighter, sandy, well-drained soils. This allows for even root development and ease of washing after harvest (Fair 1989).

Potash (fertilizer containing potasium) has been shown to improve the quality and storage life of the roots, and high potassium fertilizers are used in the Republic of South Africa where the crop is grown for livestock feeding (Fair 1989).

Altitude

In the tropics radish is grown from sea level to at least 1 800 m. In India it is grown as high as 2 700 m in the Himalayas, while var. *oleifera* has been found suitable for high mountain areas (2 500-3 000 m) in the Yunan Province of China. In Hawaii the Chinese half-long is adapted to year round production in lowland areas and is grown from April to August at elevations over 600 m, while Japanese long types are grown throughout the year at all elevations (Rao *et al*., 1986).

Management

Slow growth makes *R. sativus* hot and fiberous in texture (Fair, 1989). It mature rapidly under favorable conditions and should be checked often for approaching maturity. Harvest should begin as soon as roots reach grazable size and should be completed quickly, before heat, pithiness or seeds stalks can begin to develop (Dickinson 1990 and Fair 1989).

Climatic and Soil Management

Raphanus sativus grows best in the spring and autumn and will tolerate light winter frosts. The high temperatures of summer cause the plant to develop small tubers, and roots rapidly become pithy and strongly pungent after reaching maturity. For summer producing quality *R. sativus* during midsummer is not suggested.

A fine, well-prepared seed bed is important for growing *R. sativus*. The application of animal manure or compost approximately 6 weeks before sowing helps build up the water-holding capacity of the soil and balance the nutrient supply (Fair 1989).

Weed control

Because *R. sativus* have such a short growing period and are grown mostly in small areas, weed control is generally not a serious problem. If weeds are a problem, encourage the weed seeds to germinate and control them with a knockdown herbicide prior to planting radishes. It may also be necessary to use inter-row cultivation and hand-weeding during the growth of the crop (Jung *et al*., 1979).

Pests

As a member of the *Brassicaceae* family, *R. sativus* are attacked by the same pests which attack cabbages and cauliflowers. Major pests include cabbage white butterfly, bagrada bug, aphids and diamondback moth. Other pests of *Brassicaceae* will cause damage from time to time. (Jung *et al*., 1979).

Disease

Because *R. sativus* have short growing period, only a few diseases cause economic losses in radishes. The most important is black rot, a disease caused by a soil-borne fungus. Dark irregular patches develop on the radish root and eventually give the entire root a black colour (Jung *et al*., 1979). Long-rooted cultivars can be severely attacked. The round types may escape infection in infested soil but are not resistant. The disease is controlled by good soil drainage and crop rotations of 3–4 years.

Radishes are also attacked by white rust. This disease causes raised white pustules on the leaves, stems and flowers. It is controlled by the destruction of diseased crop residues, rotations of 3–4 years and the separation of young from old crops (Jung *et al*., 1979).

Yield

Yields of oriental radish are reported to be 15-20 t/ha in India, 12 t/ha in Hawaii. It is reported that depending on the rainfall received it can yield from 4 t/ha to as high 14 in irrigated conditions (Fair 1989). Yield is closely related to spacing; eg in experiments reported from China, at 1 million plants/ha, yields of 36-46 t/ha were obtained, but the roots were very small: at 500 000 plants/ha, yields were 35.5 t/ha, but the roots were still small (Anon 2005).

2.5 SUMMARY AND PLAN OF ACTION

The present study was aimed to breach an existing gap in information regarding planting dates (looking at Gauteng and Limpopo), alternative fodder during dry periods and the effect that cutting frequency might have on the total dry matter production. *Brassicaceae* species are well used as fodder crop in winter and their importance is well delineated in other parts of the world (especially in UK, US and Australia). The cultivars used in the study, under South African conditions are quoted to do well only in cooler parts of the country. Their planting date should to be in February and anything earlier or later will results in crops going to seed much earlier and less production (According to literature not tested in Gauteng). The three planting dates were tested to find the best time for planting; especially in parts of the country were the temperatures are not that cool. These plants have a high potential to plug the gaps in fodder production, especially since they are said to have high protein content. The cutting frequency treatments will reveal whether these crops can be grazed twice or thrice in a season. It will also reveal whether the crops should be grazed in a young stage or when they have reached their maturity.

CHAPTER 3

MATERIALS AND METHODS

3.1 LOCATION

The experiments were done on two different localities in 2007.

3.1.1 Syferkuil (The University of Limpopo's experimental farm).

The University of Limpopo's experimental farm (Syferkuil) is situated approximately 10 km Northwest of Mankweng (29^0 71' S, 23^0 84' E) (See Figure 3.1). The Long Term Average (LTA) meteorological data on Syferkuil is given in Table 3.1. The experimental farm is characterized by hot low rainfall summers and cool winters without any rain. The long–term annual rainfall on the experimental farm is 468.4 mm. The mean average day temperature varies from 28^0C to 30^0C. The soil at experimental farm is sandy loam soil, of the Hutton form, Glenrosa family, with the pH ranging from 6.0 - 6.2 (Nkgapele 2001).

Table 3.1: The long term meteorological data for Syferkuil (University of Limpopo 's experimental farm)

	Frost (days)	Rain (mm)	Rel Hum. Min (%)	Rel Hum. Max (%)	Temp Min (ºC)	Temp Max (ºC)
Jan	0.0	65.9	38.3	86.2	16.1	27.9
Feb	0.0	73.2	37.1	88.1	15.9	28.1
Mar	0.0	61.2	40.0	89.7	14.3	26.9
Apr	0.0	31.1	33.6	89.8	10.6	25.4
May	0.9	10.2	28.5	87.5	5.7	23.2
Jun	4.4	5.4	30.6	85.9	3.0	21.2
Jul	6.6	1.7	26.2	84.9	2.6	20.9
Aug	1.9	0.9	28.4	81.1	5.2	23.0
Sep	0.1	4.3	29.6	77.3	9.2	26.0
Oct	0.0	29.5	34.3	80.0	12.8	26.8
Nov	0.0	88.9	36.2	81.4	14.7	26.9
Dec	0.0	77.2	39.3	85.7	15.8	27.5
Annual	13.8	449.6				

Average first frost: 5 June
Average last frost: 11 August
Average frost season: 18 days
Average frost days/year: 13 days
Percentage years with frost:100.00

Table 3.2: The Meteorological data for 2007 Syferkuil (University of Limpopo's experimental farm) for 2007.

(Source: ISCW, Agromet Section, Private Bag X 79, Pretoria 0001)

	Frost (days)	Rain (mm)	Rel Hum. Min (%)	Rel Hum. Max (%)	Temp Min (ºC)	Temp Max (ºC)
Jan	0.0	5.7	42.1	92.5	15.3	28.5
Feb	0.0	27.5	35.8	90.4	16.1	30.8
Mar	0.0	27.5	39.9	88.6	14.5	29.6
Apr	0.0	61.3	41.8	94.6	12.3	25.8
May	4.0	0.0	32.3	86.8	5.4	23.4
Jun	0.0	0.0	36.9	88.2	5.8	21.8
Jul	1.0	21.0	35.4	89.0	4.9	20.3
Aug	2.0	0.0	33.4	82.9	5.7	23.8
Sep	0.0	9.0	38.1	79.3	10.6	27.3
Oct	0.0	64.0	49.8	93.0	13.1	24.4
Nov	0.0	116.8	49.5	93.3	14.8	26.4
Dec	0.0	67.5	55.0	94.5	15.3	25.4
Annual	7	400.3				

Figure 3.1: Map showing Syferkuil (University of Limpopo's experimental farm)

3.1.2 The Dewageningsdrift (Hygrotech experimental farm)

The Hygrotech experimental farm is positioned along site the R 573 route to KwaMhlanga, approximately 5 km from Moloto village (See Figure 3.2). The type of soil is sand to sandy loam, with chilling temperatures in winter and warm summer days. The Long Term Average (LTA) meteorological data of the weather station of the Animal Production Institute, Roodeplaat (ARC) was used. This meteorological station is about 20 km from Dewageningsdrift.

Table 3.3: The Long Term Average meteorological data of the weather station of the Animal Production Institute, Roodeplaat (ARC)

	Frost (days)	Rain (mm)	Rel Hum. Min (%)	Rel Hum. Max (%)	Temp Min (ºC)	Temp Max (ºC)
Jan	0.0	140.5	36.9	87.8	17.0	29.7
Feb	0.0	94.7	34.3	88.0	16.6	30.2
Mar	0.0	61.2	34.6	88.0	15.0	29.1
Apr	0.0	28.9	31.8	89.8	11.3	27.0
May	1.3	15.9	25.3	87.3	5.8	24.1
Jun	0.8	9.2	26.2	87.5	3.9	21.7
Jul	3.9	1.9	19.8	82.1	2.3	22.2
Aug	1.0	4.8	19.7	79.2	5.7	24.9
Sep	0.1	6.0	17.4	75.7	9.2	28.2
Oct	0.0	59.9	23.9	79.5	13.5	29.7
Nov	0.0	55.9	30.4	84.8	15.3	29.6
Dec	0.0	83.4	32.4	87.0	16.4	30.1
Annual	7.1	562.3				

Average first frost: 29 May
Average last frost: 25 August
Average frost season: 58 days
Average frost days/year: 7 days
Percentage years with frost: 100.00

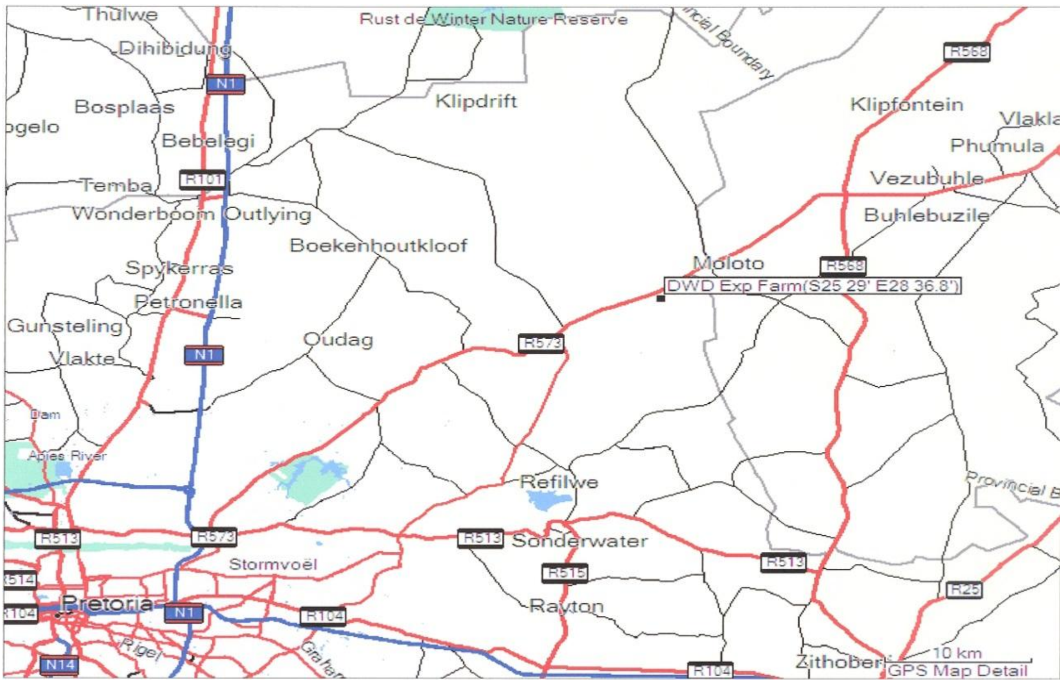

Figure 3.2: Map showing Dewageningsdrift (Hygrotech experimental Farm).

Table 3.4: Meteorological data for 2007 from the Animal Production Instititude, Roodeplaat (ARC).

(Source: ISCW, Agromet Section, Private Bag X 79, Pretoria 0001)

	Frost (days)	Rain (mm)	Rel Hum. Min (%)	Rel Hum. Max (%)	Temp Min (˚C)	Temp Max (˚C)
Jan	0.0	60.7	25.0	85.9	15.9	31.7
Feb	0.0	27.9	18.3	81.0	15.8	33.8
Mar	0.0	7.2	21.0	78.3	14.8	32.1
Apr	0.0	12.5	23.1	85.8	11.5	28.5
May	4.0	0.3	14.7	76.5	4.4	24.9
Jun	2.0	30.1	23.6	85.5	3.3	21.4
Jul	3.0	9.4	18.3	78.4	2.2	22.4
Aug	0.0	0.0	16.4	71.9	4.5	24.8
Sep	0.0	36.3	16.9	69.4	11.3	30.2
Oct	0.0	150.9	38.7	88.1	13.3	25.7
Nov	0.0	55.1	35.3	88.3	15.0	28.5
Dec	0.0	149.3	38.6	88.7	15.5	27.9
Annual	9.0	539.7				

3.2 SEEDBED PREPARATION (Both Localities)

A ripper was used as first action on the land, followed by a disc plough cultivation. To finish off, a disc harrow was used to create a fine seedbed. Before planting the equivalent of 150 kg/ha 2:3:4(18) and 250 kg/ha Rapid Raiser were applied and disc in. Rapid Raiser is an organic fertililzer (OM = 650 kg/m³) made of chicken manure with 30 g/kg N, 30 g/kg K and 60 g/kg Ca. The following micro elements are included in this fertilizer: Sulpher 3.7 g/kg, Magnesium 4.5 g/kg, Zinc 235 mg/kg, Manganese 370 mg/kg, Cooper 30 mg/kg and Iron 1255 mg/kg. Top dressing was applied in two portions four weeks after establishment and again 8 weeks after planting. In each case 125 kg LAN (28%) was applied.

Irrigation of 30 mm/week was applied up to the first cut of the 10 W + R treatment. That was 27 April 2007 for the February planting date, 25 May 2007 for the March planting date and 22 June 2007 for the April planting date on Syferkuil (UL, Limpopo). For Dewgeningsdrift (Gauteng) it was 10 April 2007 for the February planting date, 23 May 2007 for the March planting date and 20 June for the April planting date.

3.3 EXPERIMENTAL DESIGN AND LAYOUT

The experiments on both experimental sites were done in 2007 and three main treatments were used:

- Three planting dates
- Two species and three cultivars (Dewageningsdrift) and two species and two cultivars (Syferkuil due to less favourable conditions).
- Three cutting treatments.

The three planting dates were randomly distributed in six large blocks over the two experimental farms. The statistical analyses for the two localities and different planting dates (large blocks) were done separately.

The layout within each large block (planting date) was a randomized block design (RCBD) with split-plots. A 3x3x3 factorial design, with split plots was used at Dewageningsdrift, which was arranged in the large block. The three blocks represented the three replications. On Syferkuil it was a 2x3x3 factorial design, with split plots.

Dewageningsdrift: Nine plots were used for each planting date (large block): 3 cultivars x 3 replications (small blocks). The three plots (cultivars) in each replication (small block) were randomized and each plot was divided into three sub-plots (randomized) to apply the three cutting treatments.

Syferkuil: Six plots were used for each planting date (large block): 2 cultivars x 3 replications (small blocks). The two plots (cultivars) in each replication (small block) were randomized and each plot was divided into three sub-plots (randomized) to apply the three cutting treatments.

3.3.1 Species and cultivars

Two species and three cultivars were included in the experiment:

Fodder turnip cultivars (*Brassica rapa L.)*

- Mammoth purple top
- Forage star (Not on Syferkuil)

Fodder radish cultivar (*Raphanus sativus*)

- Nooitgedacht

3.3.2 Planting dates

The planting dates were (Syferkuil):

- 15 February
- 16 March

- 16 April

The planting dates were (Dewageningsdrift):

- 01 February
- 14 March
- 13 April

3.3.3 Cutting Treatments

The following cutting treatments were applied to the leaves:

- First cut at 10 weeks after planting and after that re-growth at 14 and 18 weeks
- First cut at 14 weeks after planting and after that re-growth at 18 weeks
- A single cut at 18 weeks after planting

3.4 PLOT DEMENTION and LAYOUT

Each plot (both localities) consisted out of three rows, of 7.5 m long, with intra row spacing of 60 cm. No passages were left between rows to minimize side row effects. The three rows in each plot represented the sub-plots (spilt-plot), in which the different cutting treatments were applied randomly.

Seeds were planted by hand in shallow furrows (± 3cm deep) and no distinct intra row spacing was used. The trial was under dry land, but since there was no satisfactory rain these year, irrigation was applied once a week to field capacity during initial stages only. Weeding was done by using Dutch hoes and was done mainly during higher rainfall months, with less weeding towards the winter.

3.5 DATA COLLECTION

To determine dry matter production of the above ground vegetative material, the data was collected as described in Paragraph 3.3. The material was cut approximately 5 cm above the tubers, oven dried at 55º C, until a constant weight was reached. Establishment and seedling survival was uneven, which resulted in diversity of the intra row spacing. Accurate counting of plants per row was done and taken into consideration when the statistical analysis was done. This resulted in obtaining additional information on effect of intra row spacing on production.

Tubers were pulled out and weighed and dried (as explained for the leaves) to determine the dry matter production. When all the samples were dried, the tubers were grilled to ground to pass through a 2 cm sieve for nutritive value analysis. The samples were send to the feed laboratory of the Kwazulu-Natal Department of Agriculture to analyze for crude protein, calcium, phosphorus, fat, ash content and fiber content.

3.6 DATA ANALYSIS

The three planting dates was compared against each other on the bases of dry matter production, tuber weight and circumference of the tubers. The data obtained from the different planting dates and cultivars was compared against each other.

Data was analysed using the statistical program GenStat® (Payne *et al.*, 2009). Results were compared against each by using an ANOVA and the Fischer's protected LSD and were done separately for each planting date.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 THE UNIVERSITY OF LIMPOPO'S EXPERIMENTAL FARM (SYFERKUIL)

The locality of this experimental farm and description of materials and methods were given in Chapter 3.

The monthly long term average (LTA) meteorological data at The Syferkuil's Experimental Farm (University of Limpopo) for 2007 season is shown in Table 2.2.

Table 3.2: The Meteorological data for 2007 Syferkuil (University of Limpopo experimental farm).
(Source: ISCW, Agromet Section, Private Bag X 79, Pretoria 0001)

	Frost (days)	Rain (mm)	Rel Hum. Min (%)	Rel Hum. Max (%)	Temp Min (°C)	Temp Max (°C)
Jan	0.0	5.7	42.1	92.5	15.3	28.5
Feb	0.0	27.5	35.8	90.4	16.1	30.8
Mar	0.0	27.5	39.9	88.6	14.5	29.6
Apr	0.0	61.3	41.8	94.6	12.3	25.8
May	4.0	0.0	32.3	86.8	5.4	23.4
Jun	0.0	0.0	36.9	88.2	5.8	21.8
Jul	1.0	21.0	35.4	89.0	4.9	20.3
Aug	2.0	0.0	33.4	82.9	5.7	23.8
Sep	0.0	9.0	38.1	79.3	10.6	27.3
Oct	0.0	64.0	49.8	93.0	13.1	24.4
Nov	0.0	116.8	49.5	93.3	14.8	26.4
Dec	0.0	67.5	55.0	94.5	15.3	25.4
Annual	7	400.3				

According to the data in Table 2.2 the total rainfall during January and February 2007 was 33.2 mm compared to the long term average of 145.2 mm. The rainfall for the four months from March to June it was 88.8 mm in total compared to the 103.7 of the LTA over the same period. For July to December it was 278.3 mm, compared to the 213.4 mm of the LTA over the same period. The low rainfall during March to June might have influenced the DM production results as shown later in this Chapter.

The minimum temperatures were in general lower than that of the LTA. A severe frost spell was experienced during the night of the April 26, 2007.

4.1.1 February planting date

4.1.1.1 Dry Matter Production (DM)

The dry matter (DM) production and the chemical analysis for the crops were measured at three different planting dates at Syferkuil. The sampling methods and techniques were discussed in Chapter 3. A discussion of the DM production of the tubers, leaves and the total DM, an estimation of the grazing/feeding potential and the chemical analysis results are discussed in this chapter.

For discussion purposes the following abbreviations will be used:

- 10 W+R = Results for the first cut at 10 weeks plus regrowth on 14 and 18 weeks;
- 14 W+R = Results for the first cut at 14 weeks plus regrowth on 18 weeks and
- 18 W = Results for the first cut at 18 weeks (without regrowth).
- DM production = Dry Matter production
- MPT = *Brassica rapa* (cv Mammoth purple top)
- Nooitgedacht = *Raphanus sativus* (cv Nooitgedacht)

In all DM production tables and figures the interactive effect of cultivars and cutting treatment on results, were compared by using a Fischer's protected LSD, which is shown in each table. The significant differences are shown with different Roman letters in each table. In some instances the statistical analysis indicated that interaction between main treatments did not influence results significantly, however when comparing the results with a Fischer's protected LSD, trends of significance did exist that are shown in different colours in tables. Highest production group = Green; Medium/high production group = Orange; Medium production group = Yellow; Medium/low production group = Light blue, Low production group = Light brown. Only yellow in a table represents non-significance.

- **DM production of Leaves**

The Dry Matter (DM) production of the leaves (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.1.1.

According to Appendix A.1.1 the interaction between cultivar and cutting treatment did not influence leaf production significantly ($P \leq 0.186$). Cultivar and cutting treatment as main treatments also did not influence the results significantly ($P \leq 0.241$ and $P \leq 0.372$ respectively).

According to the results in Table 4.1.1, the average DM productions ranged from 1.23 t/ha to 4.93 t/ha, across cultivars and cutting frequencies. When the interactions between cultivars and cutting treatments were compared with a Fisher's protected LSD of 4.514 in the table, there was no significant differerences. The highest production (4.93 t/ha) was measured with Nooitgedacht at 10 W + R and the lowest (1.23 t/ha) was for Mammoth purple top at 10 W + R.

Table 4.1.1: The effect of cutting treatments on the dry matter production (t/ha) of the leaves of Nooitgedacht and Mammoth purple top at Syferkuil planted in February.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	4.93a	4.43a	3.20a	4.19a
Mammoth Purple Top	1.23a	2.77a	2.03a	2.01a
Average Cutting Treatment	3.08a	3.60a	2.62a	
	LSD (5%)			
Interaction	4.514			
Cultivar	5.685			
Cutting treatment	1.515			

Different Roman letters (a, b, c) *reflects significant difference in means*

Although cultivars (as main treatment) did not influence leaf production significantly ($P \leq 0.241$), Nooitgedacht produced double that of Mammoth purple top (4.19 t/ha vs 2.02 t/ha). Cutting treatment as main treatment did not influence the leaf production significantly ($P \leq 0.186$), although the 14 W+R treatment produced better (3.60 t/ha) than the 10 W+R (3.08 t/ha) and 18 W (2.62 t/ha) treatments respectively.

- **DM production of Tubers**

The Dry Matter (DM) production of the tubers (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.1.2.

According to Appendix A.1.2, cultivar as main treatment influenced tuber production significantly ($P \leq 0.007$), while cutting treatment as main treatment and interaction between cutting treatment and cultivar showed no significant influence ($P \leq 0.915$ and $P \leq 0.337$ respectively).

When comparing the results with a Fisher's protected LSD of 0.391, four different production groups were observed. The total dry matter production of Nooitgedacht cut at 10 W+R and 18

W was in both cases 0.967 t/ha (green in table) that was significantly higher than the productions of all other treatments. Nooitgedacht produced 0.80t/ha at 14 W+R that formed a second production category (orange in table).

The DM production of Mammoth purple top at 14 W+R was 0.467 t/ha (yellow in table), but was not significantly higher than the fourth production group (light blue in table). This fourth group included DM productions of Mammoth purple top at 10 W+R and 18 W (0.267 t/ha and 0.367 t/ha).

Table 4.1.2: The effect of cutting treatments on the dry matter production (t/ha) of the tubers of Nooigedacht and Mammoth purple top at Syferkuil planted in February.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	0.967a	0.800ab	0.967a	0.911a
Mammoth Purple Top	0.267c	0.467bc	0.367c	0.367b
Average Cutting Treatments	0.617a	0.633a	0.667a	
	LSD (5%)			
Interaction	0.391			
Cultivar	0.191			
Cutting treatment	0.276			

Different Roman letters (a, b, c) *reflects significant difference in means*

As main treatment Nooitgedacht (0.911 t/ha), produced significantly higher (P≤0.241) than the Mammoth purple top (0.367 t/ha). The DM produced at 18 W was on average higher (0.667 t/ha) than that at 14 W+R (0.633 t/ha) and the 10.617 t/ha at 10 W+R. but not significantly.

- **Total DM production**

According to Appendix A.1.3 cultivars and cutting treatments (as main treatments) did not influence total DM production significantly (P≤0.184 and P≤0.479 respectively). The interaction between two main treatments was also non-significant (P≤0.212). However if the results, as influenced by the interaction between treatments, were compared with a Fisher's protected LSD of 3.505, three production groups were identified (Table 4.1.3).

The total dry matter production of Nooitgedacht cut at 10 W+R and 14 W+R was 5.9 t/ha and 5.23 t/ha respectively (green in table) and did not differ significantly (LSD = 3.505) from each other. The second group varied between 2.4 t/ha and 4.17 t/ha (yellow in table) and did not differ significantly from the first group. The lowest DM production of 1.5 t/ha was measured with Mammoth purple top at 10 W+R (blue in table) that differed significantly from first group (5.9 t/ha and 5.23 t/ha).

Table 4.1.3: The total DM production (tubers + leaves) of Nooitgedacht and Mammoth purple top at Syferkuil planted in February.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	5.9a	5.23a	4.17ab	5.10a
Mammoth Purple Top	1.5b	3.24ab	2.4ab	2.38a
Average Cutting Treatments	3.7a	4.24a	3.29a	
	LSD (10%)			
Interaction	3.505			
Cultivar	3.987			
Cutting treatment	1.393			

Different Roman letters (a, b, c) *reflects significant difference in means*

As main treatment Nooitgedacht (5.10 t/ha), produced on average higher than Mammoth purple top (2.38 t/ha), although not significantly. The total DM produced at 14 W+R was on average 4.24 t/ha, at 10 W+R it was 3.7 t/ha and at 18 W, it was 3.29 t/ha. These three total DM productions did not differ significantly.

- **Summary DM production (February planting date)**

The total DM production of Nooitgedacht fodder radish was higher (average 5.1 t/ha) than that Mammoth purple top (average 2.38 t/ha), although not significantly. The Nooitgedacht cultivar produced the highest at the 10 W + R together with 14 W + R defoliation treatment, while Mammoth purple top did the best at the 14 W + R defoliation treatment. The leaf production of both cultivars was higher than the tuber production (3.3:1 to 5.5:1 for Nooitgedacht and 4.6:1 to 5.9:1 for Mammoth purple top).

4.1.1.2 Feeding/Grazing Potential

An estimation of the grazing/feeding potential of the different cultivars, at different planting dates and defoliation/cutting treatments, was calculated by using the leaf and tuber production (variable criteria) from each treatment. The period from the initial cut to the last regrowth cut was the second variable criterion [example: at the 10W+R treatment the initial defoliation was 10 weeks after planting, followed by two regrowth cuts at 14 and 18 weeks, thus a period of 8 weeks (56 days)]. The third criterion (non-variable) was the standard norm that the daily intake of a matured livestock unit (MLU) of 450 kg is 10 kg.

An example of the potential feeding/grazing capacity of one of the cultivars at the 10 W+R treatment was as follows:

1. Grazing/feeding potential of leaves: Leaf DM production ÷ defoliation period (ex: **56** days) ÷ daily intake (10 kg/MLU/day) = X MLU/ha/**56** days.
2. Feeding of tubers: Tuber DM production (same area as leaves in 1.) ÷ MLU (calculated in 1.) ÷ daily intake (10 kg/MLU/day) = Y additional days (to feed the X MLU's with tuber material).
3. Thus sufficient roughage for X MLU/ha for 56 + Y days = Z days).

Feeding/grazing potential of material planted in February 2007:

Nooitgedacht 10 W + R

According to Table 4.1.3 the highest total DM production was obtained from Nooitgedacht at 10 W + R (5.9 t/ha). The actual production was 5897 kg/ha. The composition of this material was 4930 kg leaves and 967 kg tubers. The leaf material was harvested by cutting on 27 April (10 weeks after establishment), 25 May (4 weeks of re-growth) and 22 June (another 4 weeks of re-growth). The leaf harvesting period took **56 days** in total and thereafter the 967 kg of tuber material was uprooted.

The potential feeding/grazing capacity was calculated as follows:

- Grazing 4930 kg leaf material for **56 days** at 10 kg/MLU/day means 8.8 MLU/ha/56 days.
- Feeding 967 kg tubers to the 8.8 MLU's at 10 kg/MLU/day gives 11 additional days.
- Thus sufficient roughage for 8.8 MLU/ha for **67 days** (27 April to 22 June).
- The leaf/tuber ratio = 4.93 t/ha of leaves and 0.967 t/ha of tubers = 5.1:1.

Nooitgedacht 14 W + R

The total DM was 5.23 t/ha (5240 kg). This 5230 kg was harvested over a period of 28 days (on 23 May and re-growth on 22 June). The composition of the material was 4430 kg leaves and 800 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 4430 kg leaf material for 28 days at 10 kg/MLU/day means 15.8 MLU/ha/28 days.
- Feeding 800 kg tubers to the 15.8 MLU's gives 5 additional days.
- Thus sufficient roughage for 15.8 MLU/ha for 33 days (25 May to 26 June).
- The leaf/tuber ratio = 4.43 t/ha of leaves and 0.800 t/ha of tubers = 5.5:1.

Nooitgedacht 18 W

The total DM was 4.17 t/ha (4170 kg) when harvested once off on 22 June. The composition of the material was 3200 kg leaves and 967 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing/feeding 3200 kg/ha of leaf material for a period of 30 days (as an example) can support 10.7 MLU/ha.
- Feeding 967 kg/ha tubers to the 10.7 MLU gives 9 additional days.
- Thus sufficient roughage for 10.7 MLU/ha for 39 days (potential feeding/grazing period 22 June to 31 July)
- Leaf/Tuber ratio = 3.20 t/ha leaves and 0.967 t/ha tubers = 3.3:1.

The feeding/grazing potential of Nooitgedacht fodder radish planted in February and cut at different stages is summarized in Table 4.1.4.

Table 4.1.4: The feeding/grazing potential of Nooitgedacht fodder radish planted in February and cut at different stages at Syferkuil.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	27 April	23 May, 22 June	8.8 MLU/ha/67 days	27 April to 22 July.
14 W + R	25 May	22 June	15.8 MLU/ha/33 days	25 May to 26 June
18 W	22 June	--	10.7 MLU/ha/39days	22 June to 31 July

According to the data in Table 4.1.4, Nooitgedacht fodder radish, planted in February, can supply feed/grazing from 27 April until 31 July at a stocking rate 8.8 to 15.8 MLU/ha.

The early availability of fodder was possible with the application of the 10 W + R treatment. The late availability of fodder was possible with the application of the 14 W + R and/or the 18 W treatment.

Mammoth purple top 10 W + R

The total DM was 1.5 t/ha (1500 kg). This 1500 kg was harvested over a period of 56 days (on 27 April, re-growth on 23 May and re-growth on 7 June). The leaf material (1230 kg) was harvested by cutting on 27 April (10 weeks after establishment), 25 May (4 weeks of re-growth) and 22 June (another 4 weeks of re-growth). The leaf harvesting period took in total 56 days and after that the 267 kg of tuber material was uprooted. The composition of this material was 1230 kg leaves and 800 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1230 kg of leaf material for 56 days at 10 kg/MLU/day gives 2.1 MLU/ha/56 days.
- Feeding 800 kg of tubers to the 2.1 MLU's at 10 kg/MLU/day gives 38 additional days.
- Thus sufficient roughage for 2.1 MLU/ha for 94 days (27 April to 29 July).
- The leaf/tuber ratio = 1.23 t/ha of leaves and 0.267 t/ha of tubers = 4.6:1

Mammoth purple top 14 + R

The total DM was 3.24 t/ha (3240 kg). This 3240 kg was harvested over a period of 28 days (on 10 May and re-growth on 7 June). The composition of the material was 2770 kg leaves and 467 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 2770 kg of leaf material for 28 days at 10 kg/MLU/day gives 9.8 MLU/ha/28 days.
- Feeding 467 kg of tubers to 9.8 MLU's at 10 kg/MLU/day gives 5 additional days.
- Thus sufficient roughage for 9.8 MLU/ha for 33 days (25 May to 27 June).
- The leaf/tuber ratio = 2.77 t/ha of leaves and 0.467 t/ha of tubers = 5.9:1.

Mammoth purple top 18 W

The total DM was 2.4 t/ha (2400 kg) when harvested once off on 7 June. The composition of the material was 2030 kg leaves and 367 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 2030 kg/ha of leaf material for a period of 30 days (as an example) can support 6.7 MLU/ha.

- Feeding 367 kg/ha tubers to the 6.7 MLU's at 10 kg/MLU/day gives 5 additional days.
- Thus sufficient roughage for 6.7 MLU/ha for 35 days (potential feeding/grazing period 22 June to 27 July)
- Leaf/Tuber ratio = 2.03 t/ha leaves and 0.367 t/ha tubers = 5.5:1.

The feeding/grazing potential of Mammoth purple top fodder turnip planted in February and cut at different stages as summarized in Table 4.1.5.

Table 4.1.5: The feeding/grazing potential of Mammoth purple top fodder turnip planted in February and cut at different stages at Syferkuil.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	27 April	25 May,22June	2.1 MLU/ha/94 days	27 April to 29 July.
14 W + R	25 May	22 June	9.8 MLU/ha/33 days	25 May to 27 June
18 W	22 June	--	6.7 MLU/ha/35 days	22 June to 27 July

According to the data in Table 4.1.5, Mammoth purple top fodder turnip, planted in February, can supply feed/grazing from 27 April until 29 July at a stocking rate 2.1 to 9.8 MLU/ha.

The early availability of fodder was possible with the application of the 10 W + R treatment. The latest availability of fodder was possible with the application of the second alternative of the 14 W + R treatment (lower stocking rate).

4.1.2 March planting date

4.1.2.1 Dry material production

- **DM production of Leaves**

The Dry Matter (DM) production of the leaves (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.1.6.

According to Appendix A.2.1 the interaction between cultivar and cutting treatment did not influence leaf production significantly ($P \leq 0.525$). Cultivar and cutting treatment as main treatments did not influence the results significantly ($P \leq 0.322$ and $P \leq 0.898$ respectively).

According to the results in Table 4.1.6, the DM productions ranged from 1.50 t/ha to 3.70 t/ha, across cultivars and cutting frequencies that did not differ significantly from each other.

The highest production (3.70t/ha) was measured with Nooitgedacht at 14 W and the lowest (1.50t/ha) for Mammoth purple top at 14 W.

Table 4.1.6: The effect of cutting treatments on the dry matter production (t/ha) of the leaves of Nooigedacht and Mammoth purple top at Syferkuil planted in March.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	2.47a	3.70a	3.20a	3.12a
Mammoth Purple Top	2.47a	1.80a	1.50a	1.92a
Average Cutting Treatments	2.47a	2.75a	2.35a	
	LSD (5 %)			
Interaction	3.229			
Cultivar	3.962			
Cutting treatment	2.035			

Different Roman letters (a, b, c) *reflects significant difference in means*

For this planting date Nooitgedacht (3.12 t/ha) produced on average more than Mammoth purple top (1.92 t/ha) even though they did not differ significantly. The DM produced at 14 W+R was on average higher (2.75 t/ha) than that at 10 W+R (2.47 t/ha) and 2.35 t/ha at 18W, but not significantly higher.

- **DM production of Tubers**

The Dry Matter (DM) production of the tubers (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.1.7.

Table 4.1.7: The effect of cutting treatments on the dry matter production (t/ha) of the tubers of Nooigedacht and Mammoth purple top at Syferkuil planted in March.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	0.37c	0.90bc	1.50ab	0.92a
Mammoth Purple Top	0.40c	1.20abc	2.13a	1.24a
Average Cutting Treatments	0.38c	1.05b	1.82a	
	LSD (5 %)			
Interaction	0.975			
Cultivar	1.221			
Cutting treatment	0.586			

Different Roman letters (a, b, c) *reflects significant difference in means*

According to Appendix A.2.2 the interaction between cultivar and cutting treatment did not influence leaf production significantly ($P \leq 0.525$), as well cultivar, as main treatment ($P \leq 0.374$). Cutting treatment, as main treatment, influence the results significantly ($P \leq 0.002$). Five different production groups were observed, when comparing results with a Fischer's protected LSD of 0.975. The total dry matter production of Mammoth purple top cut at 18 W was 2.13 (green in table) t/ha which was significantly higher than both cultivars at 10 W + R and Nooitgedacht at 14 W + R. The DM production of tubers at the last three mentioned treatments varied between 0.37 t/ha and 0.90 t/ha and are marked pink and blue in table. Nooitgedacht at 18 W (1.5 t/ha, orange in table) and Mammoth purple top (1.2 t/ha, yellow on table) differ significantly from each other, but was not significantly lower than the highest producer, MPT at 18 W.

As main treatment Mammoth purple top (1.24 t/ha), produced on average higher than the Nooitgedacht (0.92 t/ha). The average DM production at 18 W was significantly higher (1.82 t/ha) than that at 14 W+R (1.05 t/ha) and 10 W+R (0.38 t/ha).

- **Total DM production**

According to Appendix A.2.1 cultivars and cutting treatments (as main treatments) did not influence total DM production significantly ($P \leq 0.322$ and $P \leq 0.898$ respectively). The interaction between two main treatments was also non significant ($P \leq 0.525$).

Appendix A.2.3 indicated that no treatments influenced the results significantly, even if compared with a Fisher's protected LSD of 3.505.

Table 4.1.8: The total DM production (tubers + leaves) of Nooigedacht and Mammoth purple top at Syferkuil planted in March.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	2.84a	4.60a	4.70a	4.05a
Mammoth Purple Top	2.87a	3.00a	3.63a	3.17a
Average Cutting Treatments	2.86a	3.8a	4.17a	
	LSD (10%)			
Interaction	3.505			
Cultivar	3.987			
Cutting treatment	1.393			

Different Roman letters (a, b, c) *reflects significant difference in means*

According to Table 4.1.8 the highest production (4.70 t/ha) was obtained from Nooitgedacht at the 18 W cutting treatment and the lowest with the same cultivar at 10W+R (2.84 t/ha).

For this planting date Nooitgedacht (4.05) produced on average higher than Mammoth purple top (3.17 t/ha), although not significantly. The DM produced at 18 W (4.17 t/ha) was on average higher than that at 14 W+R (3.8 t/ha) and 10 W+R (2.86 t/ha), although not significantly.

- **Summary DM production (March planting date)**

The average total DM production of the two cultivars did not differ significantly. Respectively it was 4.05 t/ha for Nooitgedacht and 3.17 t/ha for Mammoth purple top. The Mammoth purple top production compared well with that in the February planting date, but Nooitgedacht was approximately 1.0 t/ha lower than the February planting date. Both cultivars produced the highest at the 18 W cutting treatment. The leaf production of both cultivars was higher than the tuber production (6.2: 1 and 6.7:1) at the 10 W + R treatment, while the leaf/tuber ratio was at the 18 W treatment was 2.1: 1 for Nooitgedacht and 0.7:1 for Mammoth purple top.

4.1.2.2 Feeding/Grazing Potential

Feeding/grazing potential of material planted on 16 March:

Nooitgedacht 10 W+R

The total DM was 2.84 t (2840 kg). This 2840 kg was harvested over a period of 56 days (on 23 May, regrowth on 22 June and re-growth on 20 July). The leaf material (2470 kg) was harvested by cutting on 25 May (10 weeks after establishment), 22 June (4 weeks of re-growth) and 20 July (another 4 weeks of re-growth). The leaf harvesting period took in total 56 days and after that the 370 kg of tuber material was uprooted. The composition of this material was 2470 kg leaves and 370 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 2470 kg of leaf material for 56 days at 10 kg/MLU/day gives 4.4 MLU/ha/56 days.

- Feeding the 370 kg of tubers to the 4.4 MLU's at 10 kg/MLU/day gives 8 additional days.
- Thus sufficient roughage for 4.4 MLU/ha for 64 days (25 May to 28 July).
- The leaf/tuber ratio 2.47 t/ha of leaves and 0.37 t/ha of tubers = 6.7:1.

Nooitgedacht at 14 W + R

The total DM was 4.60 t/ha (4600 kg). This 4600 kg was harvested over a period of 28 days (on 22 June and re-growth on 20 July). The composition of the material was 2770 kg leaves and 900 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 3700 kg of leaf material for 28 days at 10 kg/MLU/day gives 13.2 MLU/ha/28 days.
- Feeding 900 kg of tubers to the 13.2 MLU's at 10 kg/MLU/day gives 7 additional days.
- Thus sufficient roughage for 13.2 MLU/ha for 35 days (22 June to 27 July).
- The leaf/tuber ratio of Nooitgedacht at 14 W + R was 3.70 t/ha of leaves and 0.90 t/ha of tubers. Thus Leaf/Tuber ratio = 4.19:1.

Nooitgedacht 18 W

According to table 4.1.8, the highest total production was obtained from **Nooitgedacht 18 W** that was 4.70 t/ha (4700 kg). The total DM was 4.7 t (4700 kg) when harvested once off on 20 July. The composition was 3200 kg leaves and 1500 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 3200 kg/ha of leaf material for a period of 30 days (as an example) can support 10.7 MLU/ha
- Feeding 1500 kg/ha tubers to the 10.7 MLU's at 10 kg/MLU/ha gives 14 additional days.
- Thus sufficient roughage for 10.7 MLU/ha for 44 days (potential feeding/grazing period 20 July to 2 September)
- Leaf/Tuber ratio = 3.20 t/ha leaves and 1.50 t/ha tubers = 2.1:1.

The feeding/grazing potential of Nooitgedacht fodder radish planted in March and cut at different stages as summarized in Table 4.1.9.

According to the data in Table 4.1.9, Nooitgedacht fodder radish, planted in March, can supply feed/grazing from 25 May until 2 September at a stocking rate 4.4 to 13.2 MLU/ha. To be able to do so part of the crop should be cut/grazed initially late May and managed as the 10W + R treatment. A second part of the established crop should be rested until July and then managed as in the 18 W treatment.

Table 4.1.9: The feeding/grazing potential of Nooitgedacht top fodder radish planted in March and cut at different stages at Syferkuil.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	25 May	22June, 20July	4.4 MLU/ha/64 days	25 May to 28 July
14 W + R	22 June	20 July	13.2 MLU/ha/35 days	22 June to 27 July
18 W	20 July	--	10.7 MLU/ha/44 days	20 July to 2 September

Mammoth purple top 10 W + R

The total DM was 2.87 t/ha (2870 kg). This 2870 kg was harvested over a period of 56 days (on 23 May, re-growth on 18 July and re-growth on 7 June). The leaf material (2470 kg) was harvested by cutting on 12 April (10 weeks after establishment), 10 May (4 weeks of re-growth) and 7 June (another 4 weeks of re-growth). The leaf harvesting period took in total 56 days and after that the 370 kg of tuber material was uprooted. The composition of this material was 2470 kg leaves and 400 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 2470 kg of leaf material for 56 days at 10 kg/MLU/day = 4.4 MLU/ha/56 days.
- Feeding 400 kg of tubers to 4.4 MLU's at10 kg/MLU/day = 9 additional days.
- Thus sufficient roughage for 4.4 MLU/ha for 65 days (23 May to 28 July).
- The leaf/tuber ratio = 2.47 t/ha of leaves and 0.40 t/ha of tubers = 6.2:1.

Mammoth purple top 14 + R

The total DM was 3 t (3000 kg). This 3000 kg was harvested over a period of 28 days (on 20 June and re-growth on 18 July). The composition of the material was 1800 kg leaves and 1200 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1800 kg of leaf material for 28 days at 10 kg/MLU/day = 6.4 MLU/ha/28 days.

- Feeding 1200 kg of tubers to the 6.4 MLU's at 10 kg/MLU/day gives 19 additional days.
- Thus sufficient roughage for 6.4 MLU/ha for 47 days (20 June to 6 August).
- The leaf/tuber ratio = 1.80 t/ha of leaves and 1.20 t/ha of tubers = 1.5:1.

Mammoth purple top 18 W

The total DM was 3.63 t/ha (3630 kg) when harvested once off on 18 July. The composition of the material was 1500 kg leaves and 2130 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1500 kg/ha of leaf material for a period of 30 days (as an example) can support 5.0 MLU/ha
- Feeding 2130 kg/ha tubers to the 5.0 MLU's at 10 kg/MLU/day gives 43 additional days.
- Thus sufficient roughage for 5.0 MLU/ha for 73 days (potential feeding/grazing period 20 July to 2 October)
- Leaf/Tuber ratio = 3.20 t/ha leaves and 1.50 t/ha tubers = 0.7:1.

The feeding/grazing potential of Mammoth purple top fodder turnip planted in March and cut at different stages as summarized in Table 4.1.10.

According to the data in Table 4.1.10, Mammoth purple top fodder turnip, planted in March, can supply feed/grazing from 25 May until 2 October at a stocking rate 4.4 to 6.4 MLU/ha. To be able to do so part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

Table 4.1.10: The feeding/grazing potential of Mammoth purple top fodder turnip planted in March and cut at different stages at Syferkuil.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	25 May	22June, 20July	4.4 MLU/ha/65 days	25 May to 28July.
14 W + R	20 June	18 July	6.4 MLU/ha/47 days	20 June to 6 August
18 W	20 July	--	5.0 MLU/ha/73 days	20 July to 2 October

4.1.3 April planting date

4.1.3.1 Dry matter Production (DM)

- **DM production of Leaves**

The Dry Matter (DM) production of the leaves (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.1.11.

Table 4.1.11: The effect of cutting treatments on the dry matter production (t/ha) of the leaves of Nooigedacht and Mammoth purple top at Syferkuil planted in April.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	2.40ab	4.37a	1.37b	2.71a
Mammoth Purple Top	2.63ab	2.73ab	3.40ab	2.92a
Average Cutting Treatments	2.52a	3.55a	2.38a	
	LSD (5%)			
Interaction	2.802			
Cultivar	3.581			
Cutting treatment	1.568			

Different Roman letters (a, b, c) *reflects significant difference in means*

According to Appendix A.3.1 the interaction between cultivar and cutting treatment did not influenced leaf production significantly (P≤0.074). Cultivar and cutting treatment as main treatments did not influence the results significantly (P≤0.823 and P≤0.230 respectively).

Three different production groups were observed when results were compared with a Fisher's protected LSD of 2.802. The total dry matter production of Nooitgedacht cut at 14 W+R was 4.37 t/ha (green in table) which was significantly higher than the production of Nooitgedacht at 18 W (1.37 t/ha, yellow in table). Production of the middle group varied between 2.4 t/ha and 3.4 t/ha (orange in table), but not differ significantly from the high or low production.

As main treatment Mammoth purple top (2.92 t/ha), produced on average higher than Nooitgedacht (2.71 t/ha). The DM production at 14 W+R was on average higher (3.55 t/ha) than that at 10 W+R (2.52 t/ha), but not significantly, however significantly higher than the 2.38 t/ha at 18 W.

- **DM production of Tubers**

The Dry Matter (DM) production of the tubers (t/ha) of different tuber crop cultivars at different cutting treatment are given in Table 4.1.12.

According to Appendix A.3.2 the interaction between cultivar and cutting treatment did not influence leaves production significantly (P≤0.157). There was also no significant difference (P≤0.119) between the productions of tubers of the two cultivars, while cutting treatment had a highly significant (P< 0.001) influence on tuber production.

Table 4.1.12: The effect of cutting treatments on the dry matter production (t/ha) of the tubers of Nooigedacht and Mammoth purple top at Syferkuil planted in April.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	0.333d	0.700c	1.367b	0.800a
Mammoth Purple Top	0.333d	1.100b	1.733a	1.056a
Average Cutting Treatments	0.333c	0.900b	1.55a	
	LSD (5 %)			
Interaction	0.353			
Cultivar	0.417			
Cutting treatment	0.236			

Different Roman letters (a, b, c) *reflects significant difference in means*

Four different production groups were observed when results were compared with a Fisher's protected LSD of 0.353. The total dry matter production of Mammoth purple top cut at 18 W was 1.733 t/ha which was significantly higher than that of all other treatments. Nooitgedacht 18 W (1.367 T/ha) and Mammoth purple top at 14 W+R (1.100 t/ha) formed a second production category (brown in table).

The DM production of Nooitgedacht at 14 W+R (0.700 t/ha, yellow in table) was significantly higher than the fourth production group (light blue in table). This fourth group included results of Nooitgedacht at 10 W+Rand and Mammoth purple top at 10 W+R, both with a production of 0.333 t/ha.

Mammoth purple top (as main treatment), produced on average higher (1.056 t/ha) than Nooitgedacht (0.800 t/ha), but not significantly. The average DM produced at 18 W was on average higher (1.55 t/ha) than that at 14 W+R (0.900 t/ha) and 10 W+R (0.333 t/ha) significantly.

- **Total DM production**

According to Appendix A.3.3 cultivars and cutting treatments (as main treatments) did not influence total DM production significantly (P≤0.665 and P≤0.101 respectively). The interaction between two main treatments was also non-significant (P≤0.067).

According to Table 4.1.13 Mammoth purple top produced the highest (5.13 t/ha) at the 18W cutting treatment, while the lowest production (2.73 t/ha) was obtained from Nooitgedacht at the 10 W+R cutting treatment. These two total DM productions did not differ significantly (LSD = 2.417) from each other. The rest of the treatments resulted in DM productions of between 2.74 t/ha and 5.07 t/ha that did not differ significantly from each other.

Table 4.1.13: The total DM production (tubers + leaves) of Nooigedacht and Mammoth purple top at Syferkuil planted in April.

	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	2.73a	5.07a	2.74a	3.51a
Mammoth Purple Top	2.96a	3.83a	5.13a	3.97a
Average Cutting Treatments	2.85a	4.45a	3.94a	
	LSD (10 %)			
Nooitgedacht	2.417			
Mammoth Purple Top	2.713			
Cutting treatment	1.221			

Different Roman letters (a, b, c) *reflects significant difference in means*

As main treatment Mammoth purple top (3.97 t/ha), produced on average higher than Nooitgedacht (3.51 t/ha), although not significantly. The DM produced at 14 W was on average higher (4.45 t/ha) than that at 18 W+R (3.94 t/ha) and 10 W+R (2.85 t/ha), although not significantly.

- **Summary DM production (April planting date)**

Although the total DM production did not differ significantly between the two cultivars, the leaf production of Nooitgedacht, at 14 W + R, was the highest (4.37 t/ha) and the tuber production of Mammoth purple top was the highest (1.73 t/ha) at W 18. For this relative late planting date the total DM productions of the two cultivars did differ significantly. The higherst productions were 5.07 t/ha, at the 14 W+R treatment for Nooitgedacht and 5.13 at the 18 W treatment on MPT.

4.1.3.2 Feeding/Grazing Potential

Feeding/grazing potential of material planted on 16 April 2007:

Nooitgedacht at 10 W + R

The actual production was 2.73 t/ha. The composition of this material was 2400 kg leaves and 333 kg tubers. The leaf material was harvested by cutting on 22 June (10 weeks after establishment), 20 July (4 weeks of re-growth) and 20 August (another 4 weeks of re-growth). The leaf harvesting period took in total 56 days and after that the 333 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 2400 kg of leaf material for 56 days at 10 kg/MLU/day gives 4.2 MLU/ha/56 days.
- Feeding 333 kg of tubers to the 4.2 MLU's at 10 kg/MLU/day gives 8 additional days.
- Thus sufficient roughage for 4.2 MLU/ha for 64 days (22 June to 27 August).
- The leaf/tuber = 2.40 t/ha of leaves and 0.333 t/ha of tubers = 7.2:1.

Nooitgedachtat 14 W + R

The total DM was 5.07 t/ha (5070 kg). This 5070 kg was harvested over a period of 28 days (on 20 July and re-growth on 20 August). The composition of the material was 4370 kg leaves and 700 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 4370 kg of leaf material for 28 days at 10 kg/MLU/day means 15.6 MLU/ha/28 days.
- Feeding 700 kg of tubers to the 15.6 MLU's at 10 kg/MLU/day gives 4 additional days.
- Thus sufficient roughage for the 15.6 MLU/ha for 32 days (20 July to 22 August).
- The leaf/tuber ratio = 4.37 t/ha of leaves and 0.700 t/ha of tubers = 6.2:1.

Nooitgedacht 18 W

The total DM was 2.74 t/ha (2740 kg) when harvested once off on 20 August. The composition of the material was 1370 kg leaves and 1.367 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1370 kg/ha of leaf material for a period of 30 days (as an example) can support 4.7 MLU/ha
- Feeding 1367 kg/ha tubers to the 4.6 MLU's at 10 kg/MLU/day gives 30 additional days.
- Thus sufficient roughage for 4.6 MLU/ha for 60 days (potential feeding/grazing period 20 August to 18 October)
- Leaf/Tuber ratio = 1.37 t/ha leaves and 1.367 t/ha tubers = 1:1.

The feeding/grazing potential of Nooitgedacht fodder radish planted in April and cut at different stages as summarized in Table 4.1.14.

Table 4.1.14: The feeding/grazing potential of Nooitgedacht fodder radish planted in April and cut at different stages at Syferkuil.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing Period
10 W + R	22 June	20July, 20Aug	4.2 MLU/ha/65 days	22 June to 27 August.
14 W + R	20 July	20 August	15.6 MLU/ha/32 days	20 July to 22 August
18 W	20 August	--	4.6 MLU/ha/60days	20 August to 18 October

According to the data in Table 4.1.14, Nooitgedacht fodder radish, planted in April, can supply feed/grazing from 22 June until 18 October at a stocking rate 4.2 to 15.6 MLU/ha. To be able to do so part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

Mammoth purple top 10 W + R

The total DM was 2.96 t/ha. The composition of this material was 2630 kg leaves and 333 kg tubers. The leaf material was harvested by cutting on 22 June (10 weeks after establishment), 20 July (4 weeks of re-growth) and 20 August (another 4 weeks of re-growth). The leaf harvesting period took in total 56 days and after that the 333 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 2630 kg of leaf material for 56 days at 10 kg/MLU/day = 4.6 MLU/ha/56 days.
- Feeding 333 kg of tubers to 4.6 MLU's at 10 kg/MLU/day = 7 additional days.
- Thus sufficient roughage for 4.6 MLU/ha for 63 days (22 June to 24 August).

- The leaf/tuber ratio = 2.63 t/ha of leaves and 333 t/ha of tubers = 7.9:1.

Mammoth purple top 14 + R

The total DM was 3.83 t/ha (3830 kg). This 3830 kg was harvested over a period of 28 days (on 20 July and re-growth on 20 August). The composition of the material was 2730 kg leaves and 1100 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 2730 kg of leaf material for 28 days at 10 kg/MLU/day means 10 MLU/ha/28 days.
- Feeding 1100 kg of tubers to 10 MLU's at 10 kg/MLU/day = 11 additional days.
- Thus sufficient roughage for 10 MLU/ha for 39 days (20 July to 28 August).
- The leaf/tuber ratio = 2.73 t/ha of leaves and 1.10 t/ha of tubers = 2.5:1.

Mammoth purple top 18 W

According to table 4.1.13, the highest total production was obtained from Mammoth purple top 18 W. The total DM was 5.13 t/ha (5130 kg) when harvested once off on 20 August. The composition of this material was 3400 kg leaves and 1730 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 3400 kg/ha of leaf material for a period of 30 days (as an example) can support 11.3 MLU/ha
- Feeding 1730 kg/ha tubers to 11.3 MLU's 10 kg/MLU/ha gives 15 additional days.
- Thus sufficient roughage for 11.3 MLU/ha for 45 days (potential feeding/grazing period 20 August to 3 October)
- Leaf/Tuber ratio = 3.40 t/ha leaves and 1.73 t/ha tubers = 1.9:1.

The feeding/grazing potential of Mammoth purple top fodder turnip planted in April and cut at different stages as summarized in Table 4.1.15.

According to the data in Table 4.1.15, Mammoth purple top fodder turnip, planted in April, can supply feed/grazing from 22 June until 3 October at a stocking rate 4.6 to 11.3 MLU/ha. To be able to do so part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

Table 4.1.15: The feeding/grazing potential of Mammoth purple top fodder turnip planted in April and cut at different stages at Syferkuil.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	22 June	20 July, 20 Aug	4.6 MLU/ha/63 days	22 June 24 August
14 W + R	20 July	20 August	10 MLU/ha/39 days	20 July to 28 August
18 W	20 Aug	--	11.3 MLU/ha/45days	20 August to 3 October

4.2 DEWAGENINGSDRIFT (HYGROTECH EXPERIMENTAL FARM)

The locality of this experimental farm and description of materials and methods were given in Chapter 3. The monthly long term average (LTA) meteorological data at the Animal Protection Institute, Roodeplaat (ARC) for 2007 season is shown in Table 4.2.1. This meteorology observation station is ± 20 km from Dewageningsdrift.

According to the data in Table 4.3.1 the total rainfall during January and February 2007 was 88.6 mm compared to the long term average of 233.9 mm. The rainfall for the four months from March to June it was 50.1 mm in total, compared to the 115 of the LTA for the same period. For the period July to December it was 402 mm compared to the 223.4 mm of the LTA for the same period. The low rainfall during March to June might have influenced the DM production results as shown later in this Chapter.

The minimum temperatures were in general lower than that of the LTA. A severe frost spell was experienced during the night of the April 26, 2007.

Table 3.4: Meteorological data for 2007 from the Animal Protection Instititude, Roodeplaat (ARC).
(Source: ISCW, Agromet Section, Private Bag X 79, Pretoria 0001)

	Frost (days)	Rain (mm)	Rel Hum. Min (%)	Rel Hum. Max (%)	Temp Min (˚C)	Temp Max (˚C)
Jan	0.0	60.7	25.0	85.9	15.9	31.7
Feb	0.0	27.9	18.3	81.0	15.8	33.8
Mar	0.0	7.2	21.0	78.3	14.8	32.1
Apr	0.0	12.5	23.1	85.8	11.5	28.5
May	4.0	0.3	14.7	76.5	4.4	24.9
Jun	2.0	30.1	23.6	85.5	3.3	21.4
Jul	3.0	9.4	18.3	78.4	2.2	22.4
Aug	0.0	0.0	16.4	71.9	4.5	24.8
Sep	0.0	36.3	16.9	69.4	11.3	30.2
Oct	0.0	150.9	38.7	88.1	13.3	25.7
Nov	0.0	55.1	35.3	88.3	15.0	28.5
Dec	0.0	149.3	38.6	88.7	15.5	27.9
Annual	9.0	539.7				

4.2.1 February planting date

4.2.1.1 The Dry Matter Production (DM)

See general information on interpretation of results and calculation of grazing/feeding potential on page 26.

- **DM production of Leaves**

The Dry Matter (DM) production of the leaves (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.2.1.

According to Appendix B.1.1, the interaction between cultivar and cutting treatment influenced leaf production significantly ($P \leq 0.054$). Cultivar and cutting treatment (as main treatments) did not influence the results significantly ($P \leq 0.209$ and $P \leq 0.550$, respectively).

According to the results in Table 4.2.1, DM productions ranged from 1.0 t/ha to 3.3 t/ha, across cultivars and cutting frequencies. When the interactions between cultivars and cuttings treatments are compared with a Fisher's protected LSD of 1.799, three different production groups existed. Those are shown in different colours in the table. The highest production (3.3 t/ha) was measured with Nooitgedacht at 18W (green in table). The second production group (orange in table) varied between 1.73 t/ha and 2.72 and represents all 3 cultivars (with no specific cutting treatment). The lowest production (1.00 t/ha to 1.10 t/ha) included Forage Star (at 14W+R and 18W), Mammoth Purple Top (at 10W+R and 14W+R) and Nooitgedacht at 10 W+R and is shown in yellow in the table.

Table 4.2.1: The effect of cutting treatments on the dry matter production (t/ha) of the leaves of Nooigedacht, Forage star and Mammoth purple top at Dewageningsdrift planted in February.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	1.00b	2.50ab	3.30a	2.27a
Forage Star	2.72ab	1.07b	1.07b	1.62a
Mammoth purple top	1.10b	1.10b	1.73ab	1.31a
Average Cutting Treatments	1.61a	1.56a	2.04a	
	LSD (5 %)			
Interaction	1.799			
Cultivar	1.322			
Cutting treatment	1.039			

Different Roman letters (a, b, c) *reflects significant difference in means*

For this planting date Nooitgedacht (2.27 t/ha) produced on average higher than Forage star (1.62 t/ha) and Mammoth purple top (1.31 t/ha), although not significantly. The average DM productions at 18 W (main effect)) was on average higher (2.01 t/ha than at 10 W+R (1.61) and at 14 W+R (1.56), although not significantly.

- **DM production of Tubers**

The Dry Matter (DM) production of the tubers (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.2.2.

According to Appendix B.1.2, a significant interaction (P≤0.011) occurred between cultivar x cutting treatment in terms of DM production of the tubers. Cutting treatment (as main treayment) had a highly significant (P≤0.001) influence on the results, while cultivar as main treatment tended to have a significant (P≤0.051) influence.

Table 4.2.2: The effect of cutting treatments on the dry matter production (t/ha) of the tubers of Nooigedacht, Forage star and Mammoth purple top at Dewageningsdrift planted in February.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	0.070d	0.700bc	2.033a	0.934a
Forage Star	0.286cd	0.267cd	0.466cd	0.340b
Mammoth purple top	0.567cd	0.500cd	1.233b	0.767ab
Average Cutting Treatments	0.308b	0.490 b	1.244a	
	LSD (5 %)			
Interaction	0.617			
Cultivar	0.450			
Cutting treatment	0.356			

Different Roman letters (a, b, c) *reflects significant difference in means.*

According to the results in Table 4.2.2, DM productions ranged from 0.070 t/ha to 2.033 t/ha, across cultivars and cutting frequencies. When comparing the interactions between cultivars and cuttings treatments on tuber production, with a Fisher's protected LSD of 0.617, four production groups were identified, shown in different colours in the table. The highest tuber production was 2.033 t/ha with Nooitgedacht, at 18W (green in table). The tuber production of Mammoth purple top at the 18 W was 1.233 t/ha and that of Nooitgedacht at 14 W + R was 0.70 t/ha (orange in the table). The third production group varied between 0.267 t/ha and 0.567 t/ha that included Forage star (all cutting treatments) and Mammoth purple top at 10 W + R and 14 W + R (orange in the table), while the lowest tuber producer (0.07 t/ha) was with Nooitgedacht at 10 W + R (blue in the table).

Nooitgedacht as a main treatment produced (0.934 t/ha) significantly higher than Forage star (0.34 t/ha), but not significantly higher than the 0.767 t/ha of Mammoth purple top (LSD = 0.450). The 18 W cutting treatment resulted in the highest average tuber production (1.244 t/ha). It was significantly higher the other 14 W+R (0.4896 t/ha) and 10 W+R (0.308) with an LSD of 0.356.

- **Total DM production**

According to Appendix B.1.3, cultivars and cutting treatments (as main treatments) did not influence total DM production significantly ($P \leq 0.001$ and $P \leq 0.130$, respectively). The interaction between two main treatments was also non significant ($P \leq 0.031$).

Although Appendix B.1.3, showed that interaction between treatments did not influence results significantly ($P \leq 0.031$), differences were observed when results were compared with a Fisher's protected LSD of 2.592.

Table 4.2.3: The total DM production (tubers + leaves) of the Nooigedacht, Forage star and Mammoth purple top at Dewageningsdrift planted in February.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	1.07b	3.20ab	5.33a	3.20a
Forage Star	3.01ab	1.34b	1.54b	1.96b
Mammoth purple top	1.67b	1.60b	2.96ab	2.08b
Average Cutting Treatments	2.13a	2.05a	3.28a	
	LSD (5 %)			
Interaction	2.592			
Cultivar	0.841			
Cutting treatment	1.497			

Different Roman letters (a, b, c) *reflects significant difference in means.*

Three different production groups were observed. The total dry matter production of Nooitgedacht cut at 18 W (5.33 t/ha, green in table) was significantly higher than all treatments marked yellow in table. The second highest production group (orange in table) varied between 2.96 t/ha, 3.01t/ha and 03.20 t/ha and was not significantly lower than the 5.33 t/ha of Nooitgedacht at 18 W. The lowest production group varied between 1.07 t/ha and 1.67 t/ha and is shown yellow in the table.

Nooitgedacht (3.20 t/ha), as a main treatment, produced significantly higher than Forage star (1.96 t/ha) and Mammoth purple top (2.08 t/ha) when compared with a Fischer's protected LSD of 0.841. The three cutting treatments 10 W+R, 14 W+R and 18 W (as main treatment) did not differ significantly from each other (LSD of 0.356).

- **Summary DM production (February planting date)**

Nooitgedacht fodder radish produced significantly higher (3.2 t/ha at 14 W + R and 5.33 t/ha at 18 W) than Forage star (3.01 t/ha at 10 W + R) and Mammoth purple top (2.96 t/ha at 18 W). To create the longest possible fodder flow program, will be to plant Forage star and utilize it as in the 10 W + R treatment and Nooitgedacht to be utilized as in the 14 W + R and 18 W treatments.

4.2.1.2 Feeding/Grazing Potential

Feeding/grazing potential of material planted on 1 February 2007:

Nooitgedacht at 10 W + R

The total DM of Nooitgedacht at 10 W+R was 1.07 t/ha (1070kg/ha). The composition of the material was 1000 kg leaves and 70 kg tubers. The leaf material was harvested by cutting on 10 April (10 weeks after establishment), 10 May (4 weeks of re-growth) and 7 June (another 4 weeks of re-growth). The leaf harvesting period took 56 days in total and thereafter the 70 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 1000 kg of leaf material for of 56 days at 10 kg/MLU/day gives = 1.7 MLU/ha/56 days.
- Feeding 70 kg of tubers to 1.7 MLU's at 10 kg/MLU/day gives 4 additional days.
- Thus sufficient roughage for 1.7 MLU/ha for 60 days (10 April to 11 June).
- The leaf/tuber ratio = 1 t/ha of leaves and 0.07t/ha of tubers = 14.2:1.

Nooitgedachtat 14 W + R

The total DM was 3.20 t/ha (3200 kg). This 3200 kg was harvested over a period of 28 days (on 10 May and re-growth on 7 June). The composition of the material was 2500 kg leaves and 700 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 2500 kg of leaf material for of 28 days at 10 kg/MLU/day gives = 8.9 MLU/ha/28 days.
- Feeding 700 kg of tubers to the 8.9 MLU's at 10 kg/MLU/day gives 8 additional days.
- Thus sufficient roughage for 8.9 MLU/ha for 36 days (10 May to 15 June).
- The leaf/tuber ratio = 2.50 t/ha of leaves and 0.700 t/ha of tubers = 3.5:1.

Nooitgedacht 18 W

The total DM was 5.33 t/ha (5330 kg) when harvested once off on 7 June. The composition of the material was 3300 kg leaves and 2033 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 3300 kg/ha of leaf material for a period of 30 days (as an example) can support 11.0 MLU/ha.

- Feeding 2033 kg/ha tubers to the 11.0 MLU's at 10 kg/MLU/day gives 18 additional days.
- Thus sufficient roughage for 11.0 MLU/ha for 48 days (potential feeding/grazing period 7 June to 25 July)
- Leaf/Tuber ratio = 3.30 t/ha leaves and 2.033 t/ha tubers = 1.6:1.

The feeding/grazing potential of Nooitgedacht fodder radish planted in February and cut at different stages as summarized in Table 4.2.4.

According to the data in Table 4.2.4, Nooitgedacht fodder radish, planted in February, can supply feed/grazing from 10 April until 25 July at a stocking rate 1.7 to 11 MLU/ha. To obtain this part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

In general a camp system with rotational grazing should be used. It should include a 5 to 7 days grazing and at least a 21 days resting period during each grazing cycle.

Table 4.2.4: The feeding/grazing potential of Nooitgedacht fodder radish planted in February and cut at different stages at Dewageningsdrift.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	10 April	10 May, 7 June	1.7 MLU/ha/56 days	10 April to 11 June.
14 W + R	10 May	7 June	8.9 MLU/ha/36 days	10 May to 15 June
18 W	7 June	--	11.0 MLU/ha/48 days	7 June to 25 July

Forage star 10 W + R

The total DM was 3.06 t/ha (3060 kg). The composition of the material was 2720 kg leaves and 286 kg tubers. The leaf material was harvested by cutting on 10 April (10 weeks after establishment), 10 May (4 weeks of re-growth) and 7 June (another 4 weeks of re-growth). The leaf harvesting period took 56 days in total and thereafter the 286 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 2720 kg of leaf material over a period of 56 days at 10 kg/MLU/day means 4.9 MLU/ha/56 days.
- Feeding 286 kg of tubers to the 4.9 MLU's at 10 kg/MLU/day gives 6 additional days.

- Thus sufficient roughage for 4.9 MLU/ha for 62 days (12 April to 13 June).
- The leaf/tuber ratio = 2.72 t/ha of leaves and 0.286 t/ha of tubers = 9.5:1.

Forage star 14 W + R

The total DM was 1.34 t/ha (1340 kg). This 1340 kg was harvested over a period of 28 days (on 10 May and re-growth on 7 June). The composition of this material was 1070 kg leaves and 800 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1070 kg of leaf material for 28 days at 10 kg/MLU/day gives 3.8 MLU/ha/28 days.
- Feeding 267 kg of tubers to the 3.8 MLU's at 10 kg/MLU/day gives 7 additional days.
- Thus sufficient roughage for 3.8 MLU/ha for 35 days (10 May to 14 June).
- The leaf/tuber ratio = 4.43 t/ha of leaves and 0.800 t/ha of tubers = 4:1.

Forage star 18 W

The total DM was 1.54 t/ha (1540 kg) when harvested once off on 7 June. The composition of the material was 1070 kg leaves and 466 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1070 kg/ha of leaf material for a period of 30 days (as an example) can support 3.6 MLU/ha.
- Feeding 286 kg of tubers to the 3.6 MLU's at 10 kg/MLU/day gives 8 additional days.
- Thus sufficient roughage for 3.6 MLU/ha for 38 days (7 June to 15 July).
- Leaf/Tuber ratio = 1.07 t/ha leaves and 0.466 t/ha tubers = 2.3:1.

The feeding/grazing potential of Forage star fodder turnip planted in February and cut at different stages as summarized in Table 4.2.5.

According to the data in Table 4.2.5, Forage star fodder turnip, planted in February, can supply feed/grazing from 10 April until 15 July at a stocking rate 3.6 to 4.9 MLU/ha. To obtain this part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

Table 4.2.5: The feeding/grazing potential of Forage star fodder turnip planted in February and cut at different stages at Dewageningsdrift.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	10 April	10 May, 7 June	4.9 MLU/ha/62 days	10 April to 13 June.
14 W + R	10 May	7 June	3.8 MLU/ha/35 days	10 May to 14 June
18 W	7 June	--	3.6 MLU/ha/38 days	7 June to 15 July

Mammoth Purple top 10 W + R

The total DM was 1.67 t/ha (1670 kg). The composition of the material was 1100 kg leaves and 567 kg tubers. The leaf material was harvested by cutting on 10 April (10 weeks after establishment), 10 May (4 weeks of re-growth) and 7 June (another 4 weeks of re-growth). The leaf harvesting period took 56 days in total and thereafter the 567 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 1100 kg of leaf material for 56 days at 10 kg/MLU/day gives 2 MLU/ha/56 days.
- Feeding 567 kg of tubers to the 2 MLU's at 10 kg/MLU/day gives 28 additional days.
- Thus sufficient roughage for 2 MLU/ha for 84 days (12 April to 4 July).
- The leaf/tuber ratio = 1.10 t/ha of leaves and 0.567 t/ha of tubers = 1.9:1.

Mammoth Purple top 14 W + R

The total DM was 1.60 t/ha (1600 kg). This 1600 kg was harvested over a period of 28 days (on 10 May and re-growth on 7 June). The composition of the material was 1100 kg leaves and 500 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1100 kg of leaf material for 28 days at 10 kg/MLU/day gives 3.9 MLU/ha/28 days.
- Feeding 500 kg of tubers to the 3.9 MLU's at 10 kg/MLU/day gives 13 additional days.
- Thus sufficient roughage for 3.9 MLU/ha for 41 days (10 May to 20 June).
- The leaf/tuber ratio = 1.10 t/ha of leaves and 0.500 t/ha of tubers = 2.2:1.

Mammoth Purple top 18 W

The total DM was 2.96 t/ha (2960 kg) when harvested once off on 7 June. The composition of the material was 1730 kg leaves and 1233 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1730 kg/ha of leaf material for a period of 30 days (as an example) can support 5.8 MLU/ha.
- Feeding 1233 kg/ha tubers to the 5.8 MLU's at 10 kg/MLU/day gives 21 additional days.
- Thus sufficient roughage for 5.8 MLU/ha for 51 days (potential feeding/grazing period 7 June to 28 July)
- Leaf/Tuber ratio = 1.73 t/ha leaves and 1.233 t/ha tubers = 1.4:1.

The feeding/grazing potential of Mammoth purple top fodder turnip planted in February and cut at different stages can be summarized as illustrated in Table 4.2.7.

Table 4.2.6: The feeding/grazing potential of Mammoth purple top fodder turnip planted in February and cut at different stages at Dewageningsdrift.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	10 April	10 May, 7 June	2 MLU/ha/84 days	10 April to 4 July
14 W + R	10 May	7 June	3.9 MLU/ha/41 days	10 May to 20 June
18 W	7 June	--	5.8 MLU/ha/51 days	7 June to 28 July

According to the data in Table 4.2.6, Mammoth purple top fodder turnip, planted in February, can supply feed/grazing from 10 April until 28 July at a stocking rate 2 to 5.8 MLU/ha. To obtain this part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

4.2.2 March planting date

4.2.2.1 Dry Matter production

- **DM production of Leaves**

The Dry Matter (DM) production of the leaves (t/ha) as obtained with different cultivars and at different cutting treatment, are given in Table 4.2.7.

According to Appendix B.2.1, the interaction between cultivar and cutting treatment did not influence leave production significantly ($P \leq 0.350$), but comparing the results with a LSD of 2.226 differences were observed. Cutting treatment as main treatment did not influence the results significantly (P≤ 0.255), while cultivar as main treatment influenced production significantly (P≤0.008).

According to the results in Table 4.2.7, DM productions ranged from 0.80 t/ha to 5.50 t/ha, across cultivars and cutting frequencies. When the interactions between cultivars and cuttings treatments are compared with a Fisher's protected LSD of 2.226, four different production groups existed, that are shown in different colours in the table. The highest production (5.50 t/ha) was measured with Nooitgedacht at 18W (green in table).

Table 4.2.7: The effect of cutting treatments on the dry matter production (t/ha) of the leaves of Nooigedacht, Forage star and Mammoth purple top at Dewageningsdrift planted in March.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	2.97bc	3.43ab	5.50a	3.97a
Forage Star	1.07c	1.20c	0.87c	1.04b
Mammoth purple top	0.80c	1.70bc	1.57bc	1.36b
Average Cutting Treatments	1.61a	2.11a	2.64a	
	LSD (5 %)			
Interaction	2.226			
Cultivar	1.386			
Cutting treatment	1.285			

Different Roman letters (a, b, c) *reflects significant difference in means*

The second highest production (orange in table) was 3.43 t/ha (Nooitgedacht at 14 W + R) that did noy differ significantly from Nooitgedacht at 18W. The third production group varied between 1.57 and 2.97 t/ha (yellow in the table) that included Mammoth purple top (at 14 W + R and 18 W) and Nooitgedacht at 10 W + R. The lowest production (0.80 t/ha to 1.20 t/ha) included Forage Star (all cutting treatments), Mammoth Purple Top (at 10W+R) is shown in light blue in the table.

For this planting date Nooitgedacht produced significantly (P≤0.008) higher than Forage star and Mammoth purple top when compared with a Fisher's protected LSD of 1.386. Cutting treatment as main treatment, did not influenced DM productions significantly (P≤0.255)

- **DM production of Tubers**

The Dry Matter (DM) production of the tubers (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.2.8.

According to Appendix B.2.2, a significant interaction (P≤0.008) occurred between cultivar x cutting treatment in terms of DM production of the tubers. Cutting treatment had a highly significant (P≤0.001) influence on the results, while cultivar as main treatment tends to have a significant (P≤0.004) influence.

According to the results in Table 4.2.8, the DM productions ranged from 0.073 t/ha to 2.167 t/ha, across cultivars and cutting treatments. The effect of interactions between cultivars and cuttings resulted in four different significant groups.

Table 4.2.8: The effect of cutting treatments on the dry matter production (t/ha) of the tubers of Nooigedacht, Forage star and Mammoth purple top at Dewageningsdrift planted in March.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	0.217d	1.167b	2.167a	1.183a
Forage Star	0.100d	0.400cd	0.467cd	0.322b
Mammoth purple top	0.073d	0.893bc	0.633bcd	0.367b
Average Cutting Treatments	0.130c	0.653b	1.089a	
	LSD (5 %)			
Interaction	0.561			
Cultivar	0.358			
Cutting treatment	0.324			

Different Roman letters (a, b, c) *reflects significant difference in means*

Nooitgedacht at 18 W produced significantly mote tuber material than the rest (green in the table). The second highest production, 1.167 t/ha, was with Nooitgedacht at 14 W + R (orange in table. The third production group varied between 0.633 t/ha and 0.893 t/ha (yellow in table) that included Mammoth purple top at14 W + R and 18 W. The lowest production group varied between 0.073 t/ha to 0.400 t/ha and is shown in blue in the table. (All Forage star treatments and all cut]ltivars at 10 W+R).

The average tuber production (main treatment) of Nooitgedacht was the highest (P≤0.008) with 1.183t/ha, followed by Mammoth purple top with 0.367 t/ha and Forage star with 0.322 t/ha. Last two cultivars did not differ significantly in terms of tuber production.

The 18W cutting treatment (main treatment) resulted in the highest tuber production (1.089 t/ha) that was significantly higher (LSD = 0.324) than the other two cutting treatments, 14 W+R, with 0.653 t/ha and 10 W + R with 0.13 t/ha.

➢ **Total DM production.**

According to Appendix B.2.3, cultivars and cutting treatments (as main treatments) influenced the total DM production significantly (P≤0.002 and P≤0.042 respectively). The interaction between the two main treatments did not influence the total DM production significantly (P≤0.158).

Although Appendix B.2.3, showed that interaction between treatments did not influence results significantly (P≤158), differences were observed when results were compared with a Fisher's protected LSD of 2.604.

Table 4.2.9: The total DM production (tubers + leaves) of Nooigedacht, Forage star and Mammoth purple top at Dewageningsdrift planted in March.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	3.18bc	4.6b	7.67a	5.15a
Forage Star	1.17c	1.6c	1.34c	1.37b
Mammoth purple top	0.87c	2.59bc	2.20bc	1.89b
Average Cutting Treatments	1.74b	2.93ab	3.74a	
	LSD (5 %)			
Interaction	2.604			
Cultivar	1.210			
Cutting treatment	1.503			

Different Roman letters (a, b, c) *reflects significant difference in means*

Four different production groups were observed. The total dry matter production of Nooitgedacht cut at 18 W was 7.67 t/ha which is significantly higher than that of all other treatments. Nooitgedacht 14 W+R formed a second production category with 4.6 t/ha.

The total DM production of Nooitgedacht at 10 W+R (3.19 t/ha) and Mammoth purple top at 14 W+R and 18 W (2.59 t/ha and 2.20 t/ha respectively), marked yellow in table, did not differ significantly from each other, but were significantly higher than the fourth production group (blue in table) This fourth group included DM productions of Forage star (across all cut treatments) and Mammoth purple top at 10 W+R and varied between 0.87 t/ha and 1.6 t/ha.

As main treatment Nooitgedacht (5.15 t/ha), produced significantly higher (P≤0.002) than the other two cultivars (1.37t/ha and 1.89 t/ha).

The total DM produced at 18 W (as main treatment) was on average higher than the 1.74 t/ha at 10 W+R (2.93 t/ha), but not significantly higher than the 2.93 t/ha at 14 W+R.

- **Summary DM production (March planting date)**

Nooitgedacht fodder radish produced significantly higher (4.6 t/ha at 14 W + R and 7.67 t/ha at 18 W) than Mammoth purple top (2.59 t/ha at 14 W + R) and Forage star (1.349 t/ha at 14 W + R). For the March planting it seemed that Nooitgedacht will be the best option to use and to apply only the 14 W + R and 18 W treatments.

4.2.2.2 Feeding/Grazing Potential

Feeding/grazing potential of material planted on 14 March 2007:

Nooitgedacht at 10 W + R

The total DM was 3.19 t/ha (3190 kg/ha). The composition of this material was 2970 kg leaves and 217 kg tubers. The leaf material was harvested by cutting on 23 May (10 weeks after establishment), 20 June (4 weeks of re-growth) and 18 July (another 4 weeks of re-growth). The leaf harvesting period took 56 days in total and thereafter the 967 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 2970 kg of leaf material for 56 days at 10 kg/MLU/day gives 5.3 MLU/ha/56 days.
- Feeding 217 kg of tubers to the 5.3 MLU's at 10 kg/MLU/day gives 4 additional days.
- Thus sufficient roughage for 5.3 MLU/ha for 60 days (23 May to 23July).
- The leaf/tuber ratio = 2.97 t/ha of leaves and 0.217 t/ha of tubers = 13.7:1.

Nooitgedacht at 14 W + R

The total DM was 4.6 t/ha (4600 kg). This 4600 kg was harvested over a period of 28 days (on 20 June and re-growth on 18 July). The composition of the material was 3430 kg leaves and 1167 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 3430 kg of leaf material for 28 days at 10 kg/MLU/day gives 12.3 MLU/ha/28 days.

- Feeding 1167 kg of tubers to the 12.3 MLU's at 10 kg/MLU/day gives 9 additional days.
- Thus sufficient roughage for 12.3 MLU/ha for 37 days (23 May to 25 July).
- The leaf/tuber ratio = 3.43 t/ha of leaves and 1.167 t/ha of tubers = 2.9:1.

Nooitgedacht 18 W

The total DM was 7.67 t/ha (7670 kg) when harvested once off on 18 July. The composition of the material was 5500 kg leaves and 2167 kg tubers.

The potential feeding was calculated as follows:

- Grazing 5500 kg/ha of leaf material for a period of 30 days (as an example) can support 18.3 MLU/ha.
- Feeding 2167 kg/ha tubers to the 18.3 MLU's at 10 kg/MLU/day gives 12 additional days.
- Thus sufficient roughage for 18.3 MLU/ha for 42 days (potential feeding/grazing period 18 July to 29 August)
- Leaf/Tuber ratio = 5.50 t/ha leaves and 2.167 t/ha tubers = 2.5:1.

The feeding/grazing potential of Nooitgedacht fodder radish planted in March and cut at different stages as summarized in Table 4.2.10.

According to the data in Table 4.2.10, Nooitgedacht fodder radish, planted in March, can supply feed/grazing from 23 May until 29 August at a stocking rate 5.3 to 18.3 MLU/ha. To obtain this part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

Table 4.2.10: The feeding/grazing potential of Nooitgedacht fodder radish planted in March and cut at different stages at Dewageningsdrift.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	23 May	20 June, 18 July	5.3 MLU/ha/60 days	23 May to 23 July.
14 W + R	20 June	18 July	12.3 MLU/ha/37 days	20 June to 27 July
18 W	18 July	--	18.3 MLU/ha/42days	18 July to 29 August

Forage star 10 W + R

The total DM was 1.17 t/ha (1070 kg). The composition of this material was 1070 kg leaves and 100 kg tubers. The leaf material was harvested by cutting on 23 May (10 weeks after establishment), 20 June (4 weeks of re-growth) and 18 July (another 4 weeks of re-growth). The leaf harvesting period took 56 days in total and thereafter the 100 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 1070 kg of leaf material for of 56 days at 10 kg/MLU/day gives 1.9 MLU/ha/56 days.
- Feeding 100 kg of tubers on the 1.9 MLU's at 10 kg/MLU/day gives 5 additional days.
- Thus sufficient roughage for 1.9 MLU/ha for 61 days (23 May to 23 July).
- The leaf/tuber ratio = 1.07 t/ha of leaves and .100 t/ha of tubers = 10.7:1.

Forage star 14 W + R

The total DM was 1.6 t/ha (1600 kg). This 1600 kg was harvested over a period of 28 days (on 20 June and re-growth on 18 July). The composition of the material was 1200 kg leaves and 400 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1200 kg of leaf material for 28 days at 10 kg/MLU/day gives 4.3 MLU/ha/28 days.
- Feeding 400 kg of tubers to the 4.3 MLU's at 10 kg/MLU/day gives 9 additional days.
- Thus sufficient roughage for 4.3 MLU/ha for 37 days (20 June to 27 July).
- The leaf/tuber ratio = 1.20 t/ha of leaves and 0.400 t/ha of tubers = 3:1.

Forage star 18 W

The total DM was 1.34 t/ha (1340 kg) when harvested once off on 18 July. The composition of the material was 870 kg leaves and 467 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 870 kg/ha of leaf material for a period of 30 days (as an example) can support 2.9 MLU/ha.
- Feeding 467 kg/ha tubers to the 2.9 MLU's at 10 kg/MLU/day gives 16 additional days.

- Thus sufficient roughage for 2.9 MLU/ha for 36 days (potential feeding/grazing period 18 July to 23 August)
- Leaf/Tuber ratio = 0.87 t/ha leaves and 0.467 t/ha tubers = 1.8:1.

The feeding/grazing potential of Nooitgedacht fodder radish planted in March and cut at different stages as summarized in Table 4.2.11.

According to the data in Table 4.2.11, Forage star fodder turnip, planted in March, can supply feed/grazing from 23 May until 23 August at a stocking rate 1.9 to 4.3 MLU/ha. To obtain this part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

Table 4.2.11: The feeding/grazing potential of Forage star fodder turnip planted in March and cut at different stages at Dewageningsdrift.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	23 May	20 June, 18 July	1.9 MLU/ha/61 days	23 May to 23 July.
14 W + R	20 June	7 June	4.3 MLU/ha/37 days	20 June to 27 July
18 W	18 July	--	2.9 MLU/ha/36 days	18 July to 23 August

Mammoth Purple top 10 W + R

The total DM was 0.87 t (870 kg). The composition of this material was 800 kg leaves and 70 kg tubers. The leaf material was harvested by cutting on 23 May (10 weeks after establishment), 20 June (4 weeks of re-growth) and 18 July (another 4 weeks of re-growth). The leaf harvesting period took in total 56 days and after that the 967 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 800 kg of leaf material for 56 days at 10 kg/MLU/day gives 1.4 MLU/ha/56 days.
- Feeding 70 kg of tubers to the 1.4 MLU's at 10 kg/MLU/day gives 5 additional days.
- Thus sufficient roughage for 1.4 MLU/ha for 61 days (23 May to 26 July).
- The leaf/tuber ratio = 0.80 t/ha of leaves and 0.07 t/ha of tubers = 11.4:1.

Mammoth Purple top 14 W + R

The total DM was 2.59 t/ha (2590 kg). This 2590 kg was harvested over a period of 28 days (on 20 June and re-growth on 18 July). The composition of the material was 1700 kg leaves and 893 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1700 kg of leaf material for 28 days at 10 kg/MLU/day gives 6.1 MLU/ha/28 days.
- Feeding 893 kg of tubers to the 6.1 MLU's at 10 kg/MLU/day gives 15 additional days.
- Thus sufficient roughage for 6.1 MLU/ha for 43 days (20 June to 2 August).
- The leaf/tuber ratio = 1.70 t/ha of leaves and 0.893 t/ha of tubers = 1.9:1.

Mammoth Purple top 18 W

The total DM was 2.20 t/ha (2200 kg) when harvested once off on 18 July. The composition of the material was 1570 kg leaves and 633 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1570 kg/ha of leaf material for a period of 30 days (as an example) can support 5.2 MLU/ha.
- Feeding 633 kg/ha tubers to the 5.2 MLU's at 10 kg/MLU/day gives 12 additional days.
- Thus sufficient roughage for 5.2 MLU/ha for 42 days (potential feeding/grazing period 18 July to 29 August)
- Leaf/Tuber ratio = 1.57 t/ha leaves and 0.633 t/ha tubers = 2.5:1.

The feeding/grazing potential of Mammoth purple fodder radish planted in March and cut at different stages as summarized in Table 4.2.12.

Table 4.2.12: The feeding/grazing potential of Mammoth purple top fodder turnip planted in March and cut at different stages at Dewageningsdrift.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	23 May	20 June, 18 July	1.4 MLU/ha/61 days	23 May to 26 July.
14 W + R	20 June	18 July	6.1 MLU/ha/43 days	20 June to 2 August
18 W	18 July	--	5.2 MLU/ha/42 days	18 July to 29 August

According to the data in Table 4.2.12, Mammoth purple top fodder turnip, planted in March, can supply feed/grazing from 23 May until 29 August at a stocking rate 1.4 to 6.1 MLU/ha.

To be able to do so part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

4.2.3 April planting date

4.2.3.1 Dry Matter production

- DM production of Leaves

The Dry Matter (DM) production of the leaves (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.2.13.

Table 4.2.13: The effect of cutting treatments on the dry matter production (t/ha) of the leaves of Nooigedacht, Forage star and Mammoth purple top at Dewageningsdrift planted in April.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	2.57b	2.80b	4.73a	3.37a
Forage Star	0.93c	1.93bc	1.47bc	1.44a
Mammoth purple top	1.50bc	2.07bc	2.70b	2.09a
Average Cutting Treatments	1.61b	1.56b	2.04a	
	LSD (5 %)			
Interaction	1.557			
Cultivar	1.492			
Cutting treatment	0.684			

Different Roman letters (a, b, c) *reflects significant difference in means*

According to Appendix B.3.1, the interaction between cultivar and cutting treatment and cultivar (main treatment) did not influence leaf production significantly (P≤0.093 and P≤0.054 respectively). Cutting treatment (as main treatment) influenced leaf production significantly (P≤ 0.005).

Four different production groups were observed when comparing results with a Fischer's protected LSD of 1.557. The total dry matter production of Nooitgedacht cut at 18 W was 4.73 t/ha which was significantly higher than those of all other treatments. Nooitgedacht at 10 W+R and 14 W+R (2.5 t/ha and 2.80 t/ha respectively) and Mammoth purple top at 18 W (2.70 t/ha) formed the second production group.

The DM production of Forage star at 14 W+R and 18 W (1.93 t/ha and 1047 t/ha) and Mammoth purple top at 10 W+R and14 W+R and 18 W (1.50 t/ha and 2.07 t/ha) (all marked yellow) did not differ significantly from each other, but were significantly higher than the fourth production category (blue in table). This fourth category included the DM production of Forage star at 10 W+R (0.93 t/ha).

As main treatment Nooitgedacht (3.37 t/ha), produced on average, higher (non-significantly) than the other two cultivars (2.09 t/ha and 1.44 t/ha). The average DM produced at 18 W (main effect) was significantly higher (2.04 t/ha) than that at 10 W+R (1.61 t/ha) and the 1.56 t/ha at 14 W+R. The last two mentioned leaf productions did not differ significantly.

- **DM production of Tubers**

The Dry Matter (DM) production of the tubers (t/ha) as obtained with different cultivars and at different cutting treatment are given in Table 4.2.14.

According to Appendix B.3.2, a non-significant interaction (P<0.221) occurred between cultivar x cutting treatment in terms of tuber production. Cutting treatment had a highly significant (P≤0.001) influence on the tuber production, while cultivar as main treatment tend to have no significant (P≤0. 355) influence. The interaction between cultivar x cutting treatment did not influenced tuber production significantly, however comparing it with a LSD of 0.562 the following four different production groups were observed. The total dry matter production of Mammoth purple top cut at 18 W was 1.400 t/ha (green in table) that was significantly higher than those of all other treatments, except Forage star at 18 W (0.867 t/ha) that formed a second production category (orange in table).

Table 4.2.14: The effect of cutting treatments on the dry matter production (t/ha) of the tubers of Nooigedacht, Forage star and Mammoth purple top at Dewageningsdrift planted in April.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	0.300c	0.433bc	0.767bc	0.500a
Forage Star	0.297c	0.267c	0.867ab	0.477a
Mammoth purple top	0.333bc	0.567bc	1.400a	0.767a
Average Cutting Treatments	0.310b	0.422b	1.011a	
	LSD (5 %)			
Interaction	0.562			
Cultivar	0.543			
Cutting treatment	0.241			

Different Roman letters (a, b, c) *reflects significant difference in means*

The DM production of a third group, Nooitgedacht at 14 W+R and 18 W (0.433 t/ha and 0.767 t/ha) and Mammoth purple top at 10 W+R and14 W+R and 18 W (0.333 t/ha and 0.567 t/ha) did not differ significantly from each other, but were significantly higher than the fourth production group (blue in table) This fourth group included tuber productions of Forage star (10 W+R and14 W+R) and Nooitgedacht at 10 W+R and varied between 0.267 t/ha and 0.3 t/ha.

The average tuber production of Mammoth purple top (0.767 t/ha) was higher (not significantly) than the other two cultivars (0.500 t/ha and 0.477 t/ha). The tuber production at 18 W was on average significantly higher (1.011 t/ha) than that at 14 W+R (0.422 t/ha) and the 0.310 t/ha at 10 W+R.

- **Total DM production**

According to Appendix B.3.3, cultivars (as main treatment) and interaction between cultivars and cutting treatments did not influence total DM production significantly (P≤0.085 and P≤0.154 respectively). Cutting treatments as main treatment influenced total DM production significantly (P≤0.001).

Although Appendix B.3.3, showed that interaction between treatments did not influence total DM production significantly (P≤0.154), differences were observed when results were compared with a Fisher's protected LSD of 1.760.

Table 4.2.15: The total DM production (tubers + leaves) of Nooitgedacht, Forage star and Mammoth purple top at Dewageningsdrift planted in April.

Cultivars	Cutting Treatments			Average Cultivars
	10 W + R	14 W + R	18 W	
Nooitgedacht	2.87bcd	3.23bc	5.50a	3.87a
Forage Star	1.23d	2.20cd	2.34bcd	1.92b
Mammoth purple top	1.83bc	2.64bcd	4.1ab	2.86ab
Average Cutting Treatments	1.98c	2.69b	3.98a	
	LSD (5 %)			
Interaction	1.760			
Cultivar	1.732			
Cutting treatment	0.702			

Different Roman letters (a, b, c) *reflects significant difference in means*

Four different production groups were observed. The total dry matter production of Nooitgedacht at 18 W was 5.33 t/ha and that was significantly higher than the total DM production of all other treatments. Mammoth purple top 18 W formed a second production category of 4.1 t/ha (orange in table).

The total DM production of Nooitgedacht at 10 W+R (2.87 t/ha) and 14 W+R (3.23 t/ha), Forage star at 18 W (2.34 t/ha) and Mammoth purple top at 14 W+R (2.64 t/ha) (yellow in table) did not differ significantly from each other, but were significantly higher than the fourth production group (blue in table) This fourth group included DM productions of Forage star (10 W+R and 14 W+R) and Mammoth purple top at 10 W+R.

As main treatment Nooitgedacht (3.87 t/ha), produced significantly higher (LSD = 1.732) than the other two cultivars (2.86 t/ha and 1.92 t/ha), although it was indicated as non-significant ($P \leq 0.085$) in Appendix B.3.3. Cutting treatment (as main effect) influenced the average total DM productions significantly with 3.98 t/ha at 18 W, 2.69 t/ha at 14 W+R and 1.98 t/ha at 10 W+R.

- **Summary DM production (April planting date)**

Nooitgedacht fodder radish produced significantly higher (3.23. t/ha at 14 W + R and 5.5 t/ha at 18 W) than Mammoth purple top (4.1 t/ha at 18 W and Forage star (2.34 t/ha at 18 W). The average leaf:tuber ratio of Nooitgedacht was 7.5:1, Forage star 1.7: 1 and Mammoth purple top 1.9:1. The relative high production of Nooitgedacht was the result of high leaf production at the 18 W treatment. In contrast the tuber production of Mammoth purple top was relatively high for the some treatment.

4.2.3.2 Feeding/Grazing Potential

Feeding/grazing potential of material planted on 13 April 2007:

Nooitgedacht at 10 W + R

The total DM was 2.8 t/ha (2800 kg/ha). The composition of this material was 2570 kg leaves and 300 kg tubers. The leaf material was harvested by cutting on 20 June (10 weeks after establishment), 18 July (4 weeks of re-growth) and 17 August (another 4 weeks of re-growth). The leaf harvesting period took 56 days in total and after that the 300 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 2570 kg of leaf material for 56 days at 10 kg/MLU/day gives 4.6 MLU/ha/56 days.
- Feeding 300 kg of tubers to 4.6 MLU's 10 kg/MLU/day gives 7 additional days.
- Thus sufficient roughage for 4.6 MLU/ha for 63 days (20 June to 22 August).
- The leaf/tuber ratio = 2.57 t/ha of leaves and 0.300 t/ha of tubers = 8.6:1.

Nooitgedachtat 14 W + R

The total DM was 3.23 t/ha (3230 kg). This 3230 kg was harvested over a period of 28 days (on 18 July and re-growth on 17 August). The composition of the material was 2800 kg leaves and 433 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 2800 kg of leaf material for 28 days at 10 kg/MLU/day gives 10 MLU/ha/28 days.
- Feeding 433 kg of tubers to the 10 MLU's at 10 kg/MLU/day gives 4 additional days.
- Thus sufficient roughage for 10 MLU/ha for 32 days (18 July to 19 August).
- The leaf/tuber ratio = 2.80 t/ha of leaves and 0.433 t/ha of tubers = 6.5:1.

Nooitgedacht 18 W

The total DM was 5.50 t/ha (5500 kg) when harvested once off on 17 August. The composition of the material was 4730 kg leaves and 767 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 4730 kg/ha of leaf material for a period of 30 days (as an example) can support 15.8 MLU/ha.
- Feeding 767 kg/ha tubers to the 15.8 MLU's at 10 kg/MLU/day gives 5 additional days.
- Thus sufficient roughage for 35 days for 15.8 MLU's (potential feeding/grazing period 17 August to 21 September)
- Leaf/Tuber ratio = 4.73 t/ha leaves and 0.767 t/ha tubers = 6.2:1.

The feeding/grazing potential of Nooitgedacht fodder radish planted in April and cut at different stages is summarized in Table 4.2.16.

Table 4.2.16: The feeding/grazing potential of Nooitgedacht fodder radish planted in April and cut at different stages at Dewageningsdrift.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	20 June	18 July, 17 Aug	4.6 MLU/ha/63 days	20 June to 22 August
14 W + R	18 July	17 August	10 MLU/ha/32 days	18 July to 19 August
18 W	17 August	--	15.8 MLU/ha/35 days	17 August to 21 Sept.

According to the data in Table 4.2.16, Nooitgedacht fodder radish, planted in April, can supply feed/grazing from 20 June until 21 September at a stocking rate 4.6 to 15.8 MLU/ha. Obtain this part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and be managed as in the 18 W treatment.

Forage star 10 W + R

The total DM was 1.23 t/ha (1230 kg). The actual production was 1.230. The composition of this material was 930 kg leaves and 297 kg tubers. The leaf material was harvested by cutting on 20 June (10 weeks after establishment), 18 July (4 weeks of re-growth) and 17 August (another 4 weeks of re-growth). The leaf harvesting period took 56 days in total and thereafter the 333 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 930 kg of leaf material for 56 days at 10 kg/MLU/day gives 1.7 MLU/ha/56 days.
- Feeding 297 kg of tubers to the 1.7 MLU's at 10 kg/MLU/day gives 17 additional days.
- Thus sufficient roughage for 1.7 MLU/ha for 73 days (20 June to 1 September).
- The leaf/tuber ratio = 0.93 t/ha of leaves and 0.297 t/ha of tubers = 3.1:1.

Forage star 14 W + R

The total DM was 2.20 t/ha (2200 kg). This 2200 kg was harvested over a period of 28 days (on 18 July and re-growth on 17 August). The composition of the material was 1930 kg leaves and 267 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1930 kg of leaf material for 28 days at 10 kg/MLU/day gives 6.9 MLU/ha/28 days.
- Feeding 267 kg of tubers to the 6.9 MLU's at 10 kg/MLU/day gives 4 additional days.
- Thus sufficient roughage for 6.9 MLU/ha for 32 days (18 July to 19 August).

- The leaf/tuber ratio = 1.93 t/ha of leaves and 0.267 t/ha of tubers = 7.2:1.

Forage star 18 W

The total DM was 2.32 t/ha (2320 kg) when harvested once off on 17 August. The composition of the material was 1470 kg leaves and 867 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 1470 kg/ha of leaf material for a period of 30 days (as an example) can support 4.9 MLU/ha.
- Feeding 867 kg/ha tubers to the 4.9 MLU's at 10 kg/MLU/day gives 18 additional days.
- Thus sufficient roughage for 4.9 MLU/ha for 48 days (potential feeding/grazing period 17 August to 4 October)
- Leaf/Tuber ratio = 1.47 t/ha leaves and 0.867 t/ha tubers = 1.7:1.

The feeding/grazing potential of Forage star fodder turnip planted in April and cut at different stages as summarized in Table 4.2.17.

Table 4.2.17: The feeding/grazing potential of Forage star fodder turnip planted in April and cut at different stages at Dewageningsdrift.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	20 June	18 July, 17 August	1.7 MLU/ha/73 days	20 June to 1 September
14 W + R	18 July	18 July	6.9 MLU/ha/32 days	18 July to 19 August
18 W	17 August	--	4.9 MLU/ha/48 days	17 August to 4 October

According to the data in Table 4.2.17, Forage star fodder turnip, planted in April, can supply feed/grazing from 20 June to 4 October at a stocking rate 1.7 to 6.9 MLU/ha. To obtain this part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

Mammoth Purple top 10 W + R

The total DM was 1.83 t/ha (1830 kg). The composition of this material was 1500 kg leaves and 0.333 kg tubers. The leaf material was harvested by cutting on 20 June (10 weeks after establishment), 18 July (4 weeks of re-growth) and 17 August (another 4 weeks of re-growth). The leaf harvesting period took 56 days in total and thereafter the 333 kg of tuber material was uprooted.

The potential feeding capacity was calculated as follows:

- Grazing 1500 kg of leaf material for 56 days at 10 kg/MLU/day gives 2.7 MLU/ha/56 days.
- Feeding 333 kg of tubers to the 2.7 MLU's at 10 kg/MLU/day gives 12 additional days.
- Thus sufficient roughage for 2.7 MLU/ha for 68 days (20 June to 27 August).
- The leaf/tuber ratio = 1.50 t/ha of leaves and 0.333 t/ha of tubers = 4.5:1.

Mammoth Purple top 14 W + R

The total DM was 2.64 t/ha (2640 kg). This 2640 kg was harvested over a period of 28 days (on 18 July and re-growth on 17 August). The composition was 2070 kg leaves and 567 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 2070 kg of leaf material for 28 days at 10 kg/MLU/day gives 7.4 MLU/ha/28 days.
- Feeding 567 kg of tubers to 7.4 MLU's at 10 kg/MLU/day gives 8 additional days.
- Thus sufficient roughage for 7.4 MLU/ha for 36 days (18 July to 23 August).
- The leaf/tuber ratio = 2.07 t/ha of leaves and 0.567 t/ha of tubers = 3.7:1.

Mammoth Purple top 18 W

The total DM was 4.1 t/ha (4100 kg) when harvested once off on 17 August. The composition of the material was 2700 kg leaves and 1400 kg tubers.

The potential feeding capacity was calculated as follows:

- Grazing 2700 kg/ha of leaf material for a period of 30 days (as an example) can support 9.0 MLU/ha.
- Feeding 1400 kg/ha tubers to the 9.0 MLU's at 10 kg/MLU/day gives 16 additional days.
- Thus sufficient roughage for 9.0 MLU/ha for 46 days (potential feeding/grazing period 17 August to 30 September)
- Leaf/Tuber ratio = 2.70 t/ha leaves and 1.40 t/ha tubers = 1.9:1.

The feeding/grazing potential of Mammoth purple top fodder turnip planted in April and cut at different stages as summarized in Table 4.2.18.

According to the data in Table 4.2.18, Mammoth purple top fodder turnip, planted in April, can supply feed/grazing from 20 June to 2 October at a stocking rate 2.7 to 9 MLU/ha. To obtain this part of the crop should be cut/grazed initially early April and managed as the 10W + R treatment. A second part of the established crop should be rested until June and then managed as in the 18 W treatment.

Table 4.2.18: The feeding/grazing potential of Mammoth purple top fodder radish planted in April and cut at different stages at Dewageningsdrift.

Cutting treatment	Initial cut	Regrowth cut Dates	Feeding/grazing potential	Feeding/grazing period
10 W + R	20 June	18 July, 17 Aug	2.7 MLU/ha/68 days	20 June to 27 August
14 W + R	18 July	17 August	7.4 MLU/ha/36 days	18 July to 23 August
18 W	17 Aug	--	9.0 MLU/ha/46 days	17 August to 2 October

4.3 NUTRITIONAL VALUE OF FODDER RADISH AND FODDER TURNIP (DEWAGENINGSDRIFT)

4.3.1 Chemical analysis

Neutral detergent fiber (NDF), acid detergent fiber (ADF) and the crude protein (CP) are parameters for considering forage quality, (Van Soest 1965) and (Fick *et al.* 1989). Therefore, the following chemical analysis was considered most suitable for the Brassicas of the study area. The chemical analysis was done according to the method by the accredited Feed laboratory of the KwaZulu Natal Department of Agriculture and Environmental Affairs. When reading these results, it should be remembered that it is hand cut samples which might influence the values.

Acid Detergent Fiber (ADF)

ADF represents the cell wall (fibrous) components of the plant material that includes cellulose, hemicellulose, lignin, cutin, silica and tannins (Tainton 1999). The term ADF is used because these components are partly soluble in acid. Acid detergent fiber percentages of between 31 and 40% are classified as good to very good in quality. When it ranges between 41 to 42% it can be described as medium quality and when higher than 42% as low in quality (Blezinger 2002).

Neutral Detergent Fiber (NDF)

Neutral Detergent Fiber represents the cell content of the plant material that includes carbohydrates, starch, organic acids, pectin and protein (Tainton 1999). These components are grouped as NDF because they are soluble in neutral detergents, such as water. Blezinger (1999) described forage with a NDF % of below 46 % as very good, 47 % to 60% as medium to good and above 61% as low.

Crude protein (CP)

Crude protein is the measure of nitrogen content in food. Because proteins consist of about 16% nitrogen by molecular weight, crude protein is computed by multiplying the nitrogen content of a food by 6.25 which is only an estimate of protein content, hence the term crude protein. Because food can contain nitrogen containing substances other than amino acids, measuring nitrogen content is not an accurate method of measuring true protein. It is possible to have a food with more than 100% crude protein.

For example, urea contains 45% N and is a common feed additive in ruminant diets, has no true protein (no amino acids) but it does have 28.1% crude protein (45% N by weight x 6.25 = 28.1% crude protein).

Ruminants can utilize most of the crude protein, while non-ruminants can only utilize the true protein portion of the crude protein. If CP content of the pasture is above 13% the animals can maintain their weight and above 18% they will gain weight. However, if the CP content falls below 6-8% appetite is depressed and the pasture intake by the animal will be less the (Dannhauser 1991).

4.3.2 Nutritional value of the tuberous fodder crops, Dewageningsdrift, Gauteng.

Samples taken from the April planting date (10 W + R, 14 W + R and 18 W) on Dewageningsdrit were used for analysis.

Table 4.3.1: Nutritional status of the leaves of *Raphanus sativus* (cv Nooitgedacht).

Cutting treatment	Crude Protein	ADF	NDF
10 W	30.94	18.87	26.24
14 W	30.42	19.44	26.81
18 W	28.36	18.97	23.24

According to Table 4.3.1, the CP content varied between 28.36 % and 30.94 % and that is according to Dannhauser (2002) high enough for animals to gain weight. The ADF content varied between 18.87 % and 19.44 % which is classified as very good to excellent quality by (Blezinger 2002). The NDF content varied between 23.24 % and 26.81 % which is classified as very good quality by (Blezinger 2002). Cutting treatment did not influence nutritional value in general, the CP, ADF and NDF obtained at all three treatments fall respectively in the same quality groups.

Table 4.3.2: Nutritional status of the leaves of *Brassica rapa* (cv Forage star).

Cutting treatment	Crude Protein	ADF	NDF
10 W	23.83	17.49	23.01
14 W	21.55	19.04	27.64
18 W	21.41	19.01	26.22

According to Table 4.3.2, the CP content varied between 21.41 % and 23.83 % and that is according to Dannhauser (2002) high enough for animals to gain weight. The ADF content varied between 17.49 % and 19.04 % which is classified as very good to excellent quality by (Blezinger 2002). The NDF content varied between 23.01 % and 27.64 % which is classified as very good quality by (Blezinger 2002). Cutting treatment did not influence nutritional value in general, the CP, ADF and NDF obtained at all three treatments fall respectively in the same quality groups.

Table 4.3.3: Nutritional status of the leaves of *Brassica rapa* (cv Mammoth purple top).

Cutting treatment	Crude Protein	ADF	NDF
10 W	27.13	18.34	24.23
14 W	27.20	19.47	24.15
18 W	26.37	19.63	23.98

According to Table 4.3.3, the CP content varied between 26.37 % and 27.20 % and that is according to Dannhauser (2002) high enough for animals to gain weight. The ADF content varied between 18.34 % and 19.63 % which is classified as very good to excellent quality by (Blezinger 2002). The NDF content varied between 23.98 % and 24.23 % which is classified as very good quality by (Blezinger 2002). Cutting treatment did not influence nutritional value in general, the CP, ADF and NDF obtained at all three treatments fall respectively in the same quality groups.

Table 4.3.4: Nutritional status of the tubers of *Raphanus sativus* (cv Nooitgedacht).

Cutting treatment	Crude Protein	ADF	NDF
10 W	17.76	26.80	33.63
14 W	14.59	22.55	28.71
18 W	13.10	19.80	25.86

According to Table 4.3.4, the CP content varied between 13.10 % and 17.76 % and that is according to Dannhauser (2002) high enough for animals to gain weight. The ADF content varied between 19.80 % and 26.80 % which is classified as very good to excellent quality by (Blezinger 2002). The NDF content varied between 25.86 % and 33.63 % which is classified as very good quality by (Blezinger 2002). Cutting treatment did not influence nutritional value in general, the CP, ADF and NDF obtained at all three treatments fall respectively in the same quality groups.

Table 4.3.5: Nutritional status of the tubers of *Brassica rapa* (cv Forage star).

Cutting treatment	Crude Protein	ADF	NDF
10 W	17.79	22.52	30.13
14 W	15.99	23.35	28.56
18 W	12.97	20.34	27.74

According to Table 4.3.5, the CP content varied between 12.97 % and 17.79 % and that is according to Dannhauser (2002) high enough for animals to gain weight. The ADF content varied between 20.34 % and 23.35 % which is classified as very good to excellent quality by (Blezinger 2002). The NDF content varied between 27.34 % and 30.13 % which is classified as very good quality by (Blezinger 2002). Cutting treatment did not influence nutritional value in general, the CP, ADF and NDF obtained at all three treatments fall respectively in the same quality groups.

Table 4.3.6: Nutritional status of the tubers of *Brassica rapa* (cv Mammoth purple top).

Cutting treatment	Crude Protein	ADF	NDF
10 W	13.03	22.58	28.60
14 W	13.44	22.34	29.41
18 W	12.96	21.05	27.86

According to Table 4.3.6, the CP content varied between 12.96 % and 13.44 % and that is according to Dannhauser (2002) high enough for animals to gain weight. The ADF content varied between 21.05 % and 22.58 % which is classified as very good to excellent quality by (Blezinger 2002). The NDF content varied between 27.86 % and 29.41 % which is classified as very good quality by (Blezinger 2002). Cutting treatment did not influence nutritional value in general, the CP, ADF and NDF obtained at all three treatments fall respectively in the same quality groups.

Summary of Nutritional value

According to Tables 4.3.1 to 4.3.3, Nooitgedacht hardly had any differences across all cutting frequencies (10 W + R, 14 W + R and 18 W), though as a cultivar it differed slightly to Mammoth purple top and vastly to Forage star. The both latter cultivars hardly had differences when compared according to cutting frequencies. According to Tables 4.1.4 to 4.1.6, 10 W + R tubers Mammoth purple top had a lower CP as compared to Nooitgedacht and Forage star. This showed that cutting frequency had an effect. The 14 W + R cutting frequency showed little difference between the cultivars with a difference of 1 CP. For 18 W, Nooitgedacht had a higher CP value though is only one above Forage star and Mammoth purple top. The said CP values can be attributed to the cultivar characteristics than the cutting frequency, but the effects can’t be dismissed that easily. In general Nooitgedacht had better CP values than Forage star and Mammoth purple top and cutting frequencies hardly affected the CP values.

CHAPTER 5

CONCLUSIONS

5.1 SYFERKUIL (UL), LIMPOPO

5.1.1 Fertilization

Before planting the equivalent of 150 kg/ha 2:3:4(18) and 250 kg/ha Rapid Raiser were applied and disc in. Rapid Raiser is an organic fertililzer (OM = 650 kg/m³) made of chicken manure with 30 g/kg N, 30 g/kg K and 60 g/kg Ca.

A top dressing was applied in two portions four weeks after establishment and again 8 weeks after planting. In each case 125 kg LAN (28%) was applied. Irrigation of 30 mm/week was applied up to the first cut.

The total fertilization program included:
83.5 kg/ ha N + 16.5 kg/ha P + 12 kg/ha K

5.1.2 Rainfall and irrigation

The total amount of water (rainfall plus irrigation) on the experiment at Syferkuil is shown in Table 5.1 to give an indication of the influence of it on production. The rainfall was measured for the full experimental period, while the irrigation (30 mm/week) was applied since planting date until the first cutting date (at 10 weeks). The first cutting dates were: 27 April 2007 for the February planting date, 25 May 2007 for the March planting date and 22 June 2007 for the April planting date.

Table 5.1: Rainfall and irrigation on the experiment at Syferkuil

Planting date	Cutting treatment	Period of Irrigation	Rainfall (mm)	Irrigation (mm)	Total (mm)
15 Feb	10W+R	15 Feb- 27 April	102.5	300	402.5
	14W+R	15 Feb- 25 May	102.5	300	402.5
	18W	15 Feb – 22 June	102.5	300	402.5
16 Mar	10W+R	16 March-25 May	75.1	300	375.1
	14W+R	16 March-22 June	75.1	300	375.1
	18W	16 March-20 July	96.1	300	396.1
16 April	10W+R	16 April-22 June	30.6	300	330.6
	14W+R	16 April-20 July	30.6	300	330.6
	18W	16 April- 20 Aug	30.6	300	330.6

Only Nooitgedacht fodder radish and Mammoth purple top turnip (MPT) were evaluated at Syferkuil.

5.1.3 Dry matter production: Syferkuil

Planted in February

The total DM production of Nooitgedacht fodder radish was higher (average 5.1 t/ha) than that Mammoth purple top (average 2.38 t/ha), although not significantly. The Nooitgedacht cultivar produced the highest at the 10 W + R and 14 W + R defoliation treatments (5.9 t/ha and 5.23 t/ha respectively).

Mammoth purple top turnip produced the highest at the 14 W + R defoliation treatment (3.24 t/ha). The leaf production of both cultivars was higher than the tuber production (3.3:1 to 5.5:1 for Nooitgedacht and 4.6:1 to 5.9:1 for MPT).

Planted in March

The average total DM production of the two cultivars did not differ significantly, it was 4.05 t/ha for Nooitgedacht fodder radish and 3.17 t/ha for Mammoth purple top turnip. Both cultivars produced the highest at the 18 W cutting treatment (4.7 t/ha and 3.6 t/ha respectively), although the production of Nooitgedacht was not significantly lower (4.6 t/ha) when utilization started 14 weeks after establishment (14 W + R). The leaf production of both cultivars was higher than the tuber production (6.2: 1 and 6.7:1) at the 10 W + R treatment, while the leaf/tuber ratio was at the 18 W treatment was 2.1: 1 for Nooitgedacht and 0.7:1 for MPT.

Planted in April

For this relative late planting date the total DM productions of the two cultivars did differ significantly. The highest productions were 5.07 t/ha, at the 14 W+R treatment for Nooitgedacht and 5.13 t/ha at the 18 W treatment on MPT. The leaf production of Nooitgedacht, at 14 W + R, was the highest (4.37 t/ha) and the tuber production of Mammoth purple top was the highest (1.73 t/ha) at W 18.

5.1.4 Summary: Production at Syferkuil

The DM production Nooitgedacht fodder radish was higher (5.23 to 5.9 t/ha) than that of Mammoth purple top turnip (3.24 t/ha) when planted in February. The same trend was seen during the March planting date (4.7 t/ha and 3.6 t/ha respectively for 18 W treatment). During the April planting date the highest production was higher (5.07 t/ha and 5.13 t/ha respectively) than that of the March planting date. The 10 W + R cutting treatment resulted in general in the lowest production.

5.1.5 Grazing/Feeding potential at Syferkuil

An estimation of the grazing/feeding potential of the different cultivars, at different planting dates and defoliation/cutting treatments, was calculated by using the leave and tuber production (variable criteria) from each treatment. The period from the initial cut to the last regrowth cut was the second variable criterion [example: at the 10W+R treatment the initial defoliation was 10 weeks after planting, followed by two regrowth cuts at 14 and 18 weeks, thus a period of 8 weeks (56 days)]. The third criterion (non-variable) was the standard norm that the daily intake of a matured livestock unit (MLU) of 450 kg is 10 kg.

An example of the potential feeding/grazing capacity of one of the cultivars at the 10W+R treatment was as follows:

- Grazing/feeding the 4930 kg/ha leaf material for 56 days at 10 kg/MLU/day means 8.8 MLU/ha/56 days.
- Feeding the 967 kg tubers/ha (from the same area) to the 8.8 MLU's at 10 kg/MLU/day gives 11 additional days.
- Thus sufficient roughage for 8.8 MLU/ha for 67 days (27 April to 22 June).

Planted in February

The highest calculated utilizing potential for the February planting date was:

Nooitgedacht fodder radish

Utilization from 27 April onwards (10 W + R) it can supply feeding/grazing until end of June to 8.8 MLU/ha for 67 days. When utilization starts on 25 May (14 W + R) it can feed 15.8 MLU/ha/33 days, until 26 June. If utilization starts on 22 June (18 W), 10.7 MLU/ha can be fed for 39 days until the end of July.

Mammoth purple top turnip

Utilization from 25 May onwards (14 W + R) will feed 9.8 MLU /ha for 33 days, until 27 June, which is a relative short period

Planted in March

The highest calculated utilizing potential for the March planting date was:

Nooitgedacht fodder radish

Utilization from 25 May onwards (10 W + R) can supply feeding/grazing until 31 July to 4.4 MLU/ha for 64 days. When utilization starts on 22 June (14 W + R) it can feed 13.2 MLU/ha/35 days, until 26 June (much shorter period, but more animals per ha). If utilization starts on 20 July (18 W), 10.7 MLU/ha can be fed for 44 days until 2 September.

Mammoth purple top turnip

Utilization from 20 July onwards (18 W), will feed 5.0 MLU/ha for 74 days, until 2 October. Alternatively utilization from 25 May onwards (10 W + R), will feed 4.4 MLU/ha for 65 days, until 30 July.

Planted in April

The highest calculated utilizing potential for the April planting date was:

Nooitgedacht, fodder radish

Utilization from 22 June onwards (10 W + R) it can supply feeding/grazing until 26 August to 4.2 MLU/ha for 65 days. When utilization starts on 20 July (14 W + R) it can feed 15.6 MLU/ha/32 days, until 22 August (much shorter period, but more animals per ha). If utilization starts on 20 August (18 W), 4.7 MLU/ha can be fed for 59 days until 18 October.

Mammoth purple top turnip

The highest utilization potential was obtained when defoliation starts on 20 August onwards, until 3 October, when it can feed 11.3 MLU/ha for 45 days. Alternatively, if utilization starts on 22 June it will feed 4.6 MLU/ha for 63 days, until 22 August.

5.2 DEWAGENINGSDRIFT, GAUTENG

5.2.1 Fertilization

The same fertilization program used at Syferkuil (UL) was used at Dewageningsdrift

5.2.2 Rainfall and irrigation

The total amount of water (rainfall plus irrigation) on the experiment at Gewageningsdrift is shown in Table 5.2 to give an indication of the influence of that on production. The rainfall was measured for the full experimental period, while the irrigation (30 mm/week) was applied since planting date until the first cutting date (at 10 weeks). The first cutting dates were: 10 April 2007 for the February planting date, 23 May 2007 for the March planting date and 20 June 2007 for the April planting date.

Table 5.2: Rainfall and irrigation on the experiment at Dewageningsdrift

Planting date	Cutting treatment	Period of Irrigation	Rainfall (mm)	Irrigation (mm)	Total (mm)
1 Feb	10W+R	1 Feb to 10 April	39.2	300	339.2
	14W+R	1 Feb to 10 May	47.6	300	347.6
	18W	1 Feb to 7 June	57.7	300	357.7
14 Mar	10W+R	14 March-23 May	16.4	300	316.4
	14W+R	14 March-20 June	46.5	300	346.5
	18W	14 March-18 July	52.2	300	352.2
13 April	10W+R	13 April-20 June	27.0	300	327.0
	14W+R	13 April-18 July	41.7	300	341.7
	18W	13 April-17 Aug	46.5	300	346.5

Nooitgedacht fodder radish, Forage star and Mammoth purple top turnip (MPT) were evaluated at Dewageningsdrift under the fertilization, irrigation and rainfall conditions mentioned in 5.2.1 and 5.2.2.

5.2.3 Dry matter production: Dewageningsdrift

Planted in February

Nooitgedacht fodder radish produced significantly higher (3.2 t/ha at 14 W + R and 5.33 t/ha at 18 W) compared to Forage star (3.01 t/ha at 10 W + R) and Mammoth purple top (2.96 t/ha at 18 W). To create the longest possible fodder flow program, will be to plant Forage star (in February) and utilize it as in the 10 W + R treatment and Nooitgedacht to be utilized as in the 14 W + R and 18 W treatments.

Planted in March

Nooitgedacht fodder radish produced significantly higher (4.6 t/ha at 14 W + R and 7.67t/ha at 18 W) compared to Mammoth purple top (2.59 t/ha at 14 W + R) and Forage star (1.35 t/ha at 14 W + R). For the March planting date it seemed that Nooitgedacht will be the best option to plant and to apply only the 14 W + R and 18 W treatments.

Planted in April

Nooitgedacht fodder radish produced significantly higher (5.5 t/ha at 18 W) than the highest productions of Mammoth purple top (4.1 t/ha at 18 W) and Forage star (2.34 t/ha at 18 W). The average leaf/tuber ratio of Nooitgedacht was 7.5:1, Forage star 1.7: 1 and Mammoth purple top 1.9:1. The relative high production of Nooitgedacht was the result of high leaf production at the 18 W treatment. In contrast the tuber production of Mammoth purple top was relatively high for the some treatment.

5.2.4 Summary: Production at Dewageningsdrift

Nooitgedacht fodder radish produced the highest of all three cultivars at the 18 W treatment, with the highest when planted in March (7.67 t/ha), 5.5 t/ha when planted in April and 5.3 t/ha when planted in February. For the rest of the treatments the DM production of Nooitgedacht varied between 2.9 t/ha and 4.6 t/ha.

The highest DM production of Forage star turnip was 3.01 t/ha (10 W+R, February planting date), 1.35 t/ha (14 W+R, March planting date) and 2.34 t/ha (18 W, April planting date).

The highest DM production of Forage star turnip was 2.96 t/ha (18 W, February planting date), 2.59 t/ha (14 W+R, March planting date) and 4.1 t/ha (18 W, April planting date).

5.2.5 Grazing/Feeding potential at Dewageningsdrift

The Grazing/Feeding at Dewageningsdrift was calculated as explained in Paragraph 5.1.5

Planted in February

The highest calculated utilizing potential for the February planting date was:

Nooitgedacht, fodder radish

Utilizing Nooitgedacht from 10 May onwards (14 W + R) it can supply feeding/grazing until 11 June to 8.9 MLU/ha for 36 days. When utilization starts on 7 June (18 W) it can feed 11.0 MLU/ha/48 days, until 25 July.

Forage star turnip

Utilizing Forage star from 10 April onwards (10 W + R) it can supply feeding/grazing until 11 June to 8.8 MLU/ha for 62 days.

Mammoth purple top turnip

Utilizing Mammoth purple top from 7 June onwards (18 W) it can supply feeding/grazing until 28 July to 5.8 MLU/ha for 51 days.

Planted: March

The highest calculated utilizing potential for the March planting date was:

Nooitgedacht, fodder radish

Utilizing Nooitgedacht from 23 May onwards (10 W + R) it can supply feeding/grazing until 22 July to 5.3 MLU/ha for 60 days. When utilization starts on 20 June (10 W + R) it can feed 12.3 MLU/ha/37 days, until 17 August. If utilization starts on 18 July (18 W), 18.3 MLU/ha can be fed for 42 days until 29 August.

Forage star turnip

Utilizing Forage star turnip from 20 June onwards (14 W + R) it can supply feeding/grazing until 28 July to 4.2 MLU/ha for 38 days.

Mammoth purple top

Utilizing Mammoth purple top from 18 July onwards (14 W + R) it can supply feeding/grazing until 2 August to 6.1 MLU/ha for 43 days. Utilizing it from 18 July onwards (18 W) it can supply feeding/grazing until 29 August to 5.2 MLU/ha for 42 days

Planted: April

The highest calculated utilizing potential for the April planting date was:

Nooitgedacht, fodder radish

Utilizing Nooitgedacht from 20 June onwards (10 W + R) it can supply feeding/grazing until 22 August to 4.6 MLU/ha for 63 days. When utilization starts on 17 August (18 W) it can feed 15.8 MLU/ha/35 days, until 21 September.

Forage star turnip

Utilizing Forage star turnip from 18 July onwards (14 W + R) it can supply feeding/grazing until 19 August to 6.9 MLU/ha for 32 days.

Mammoth purple top turnip

Utilizing Mammoth purple top from 18 July onwards (14 W+ R) it can supply feeding/grazing until 23 August to 7.4 MLU/ha for 36 days. When utilization starts on 17 August (18 W) it can feed 9.0 MLU/ha/44 days, until 30 September.

5.3 RECOMMENDATION

5.3.1 Syferkuil, Limpopo

The highest DM production and the best calculated grazing/feeding potential, of the three tested cultivars, at Syferkuil (UL, Limpopo), are shown in Table 5.3. Fourteen different options are given that can be used to compile the best fodder flow program for a specific situation. Two different combinations of options are given as examples.

Table 5.3: The DM production, best calculated grazing/feeding potential and possible period of utilization of the three tested cultivars at Syferkuil, Limpopo.

Planting date	Cultivar	Option	DM Prod	Start utilization	End utilization	Potential
February	Nooitgedacht Radish	1	5.9 t/ha	27 April	22 June	8.8 MLU/ha/67 days
		2	5.2 t/ha	25 May	29 July	15.8 MLU/ha/33 days
		3	4.2 t/ha	22 June	31 July	10.7 MLU/ha/39 days
	MPT turnip	4	3.2 t/ha	25 May	27 June	9.8 MLU/ha/33 days
March	Nooitgedacht Radish	5	2.8 t/ha	25 May	28 July	4.4 MLU/ha/64 days
		6	4.6 t/ha	22 June	27 July	13.2 MLU/ha/35 days
		7	4.7 t/ha	20 July	2 Sept	10.7 MLU/ha/44 days
	MPT turnip	8	3.6 t/ha	22 June	6 August	6.4 MLU/ha/47 days
April	Nooitgedacht Radish	9	2.7 t/ha	22 June	27 August	4.2 MLU/ha/65 days
		10	5.1 t/ha	20 July	22 August	15.6 MLU/ha/35 days
		11	2.7 t/ha	20 August	2 Sept	10.7 MLU/ha/44 days
	MPT turnip	12	2.9 t/ha	22 June	24August	4.6 MLU/ha/63 days
		13	3.8 t/ha	20 July	28 August	10 MLU/ha/39 days
		14	5.1 t/ha	20 August	3 October	11.3 MLU/ha/45days

The following combination of options, from Table 5.3, will be able to maintain ± 10 MLU/ha for the longest period in the winter in Limpopo:

Combination 1:

Option 1: Plant 1.1 ha Nooigedacht radish in February, utilize from ± 27 April to 22 June,
Option 9: Plant 2.4 ha Nooigedacht radish in April, utilize from ± 22 June to 27 August,
Option 14: Plant 0.9 ha Mammoth purple top in April, utilize from ± 20 August to 3 Oct.

Combination 2:

Option 1: Plant 1.1 ha Nooigedacht radish in February, utilize from ± 27 April to 22 June,
Option 8: Plant 1.6 ha Mammoth purple top in March, utilize from ± 22 June to 6 August,
Option 13: Plant 1.0 ha Mammoth purple top in April, utilize from ± 20 July to 28 August,
Option 14: Plant 1.0 ha Mammoth purple top in April, utilize from ± 20 August to 3 Oct.

5.3.2 Dewageningsdrift, Gauteng

The highest DM production and the best calculated grazing/feeding potential, of the three tested cultivars, at Dewageningsdrift (Gauteng), are shown in Table 5.4. Twenty different options are given that can be used to compile the best fodder flow program for a specific situation. Three different combinations of options are given as examples.

The following combination of options, from Table 5.4, will be able to maintain ± 10 MLU/ha for the longest period in the winter in Gauteng:

Combination 1:

Option 3: Plant 2.1 ha Forage star turnip in February, utilize from ± 12 April to 13 June,
Option 9: Plant 0.8 ha Nooigedacht radish in March, utilize from ± 20 June to 27 July,
Option 13: Plant 2.0 ha Mammoth purple top in March, utilize from ± 18 July to 29 August,
Option 20: Plant 1.1 ha Mammoth purple top in April, utilize from ± 17 August to 2 Oct.

Combination 2:

Option 3: Plant 2.1 ha Forage star turnip in February, utilize from ± 12 April to 13 June,
Option 7: Plant 1.7 ha Mammoth purple top in February, utilize from ± 7 June to 28 July,
Option 17: Plant 1.5 ha Forage star turnip in April, utilize from ± 18 July to 29 August,
Option 18: Plant 2.1 ha Forage star turnip in April, utilize from ± 17 August to 4 Oct.

Table 5.4: The DM production, best calculated grazing/feeding potential and possible period of utilization of the three tested cultivars at Dewageningsdrift (Gauteng).

Plant date	Cultivar	Option	DM Prod	Start utilization	End utilization	Potential
Feb	Nooitgedacht radish	1	3.2 t/ha	10 May	15 June	8.9 MLU/ha/36 days
		2	5.3 t/ha	7 June	25 July	11 MLU/ha/44 days
	Forage star turnip	3	3.0 t/ha	12 April	13 June	4.9 MLU/ha/62 days
		4	1.3 t/ha	10 May	14 June	3.8 MLU/ha/35 days
		5	1.5 t/ha	7 June	15 July	3.6 MLU/ha/38 days
	MPT turnip	6	1.6 t/ha	10 May	20 June	3.9 MLU/ha/41days
		7	3.0 t/ha	7 June	28 July	5.8 MLU/ha/51 days
March	Nooitgedacht radish	8	3.2 t/ha	23 May	25 July	5.3 MLU/ha/60 days
		9	4.6 t/ha	20 June	27 July	12.3 MLU/ha/37 days
		10	7.7 t/ha	18 July	29 August	18.3 MLU/ha/42 days
	Forage star turnip	11	1.6 t/ha	20 June	27 July	4.3 MLU/ha/37 days
	MPT turnip	12	2.6 t/ha	20 June	2 August	6.1 MLU/ha/43 days
		13	2.2 t/ha	18 July	29 August	5.2 MLU/ha/42 days
April	Nooitgedacht radish	14	2.9 t/ha	20 June	22 August	4.6 MLU/ha/63 days
		15	3.2 t/ha	18 July	19 August	10 MLU/ha/32 days
		16	5.5 t/ha	17 August	21 Sept	15.8 MLU/ha/35 days
	Forage star turnip	17	2.2 t/ha	18 July	19 August	6.9 MLU/ha/32 days
		18	2.3 t/ha	17 August	4 October	4.9 MLU/ha/48 days
	MPT turnip	19	2.6 t/ha	18 July	23 August	7.4 MLU/ha/36 days
		20	4.1 t/ha	17 August	2 October	9.0 MLU/ha/46 days

In general Nooitgedacht forage radish was the best producer and can be use to plan a full fodder flow program for winter. However Mammoth purple top turnip played an important role late in the winter in Limpopo, while Forage star turnip can be used in early and late in the winter in Gauteng.

6. **LITERATURE**

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APPENDIX A.1: Statistical analysis on the influence of different treatments on the production of the Fodder tuber species on Cyferkuil, planted in February

Appendix A.1.1: Variate: Leaves

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	10.793	5.396	0.69	
REP.WPLOT stratum					
CULTIVAR	1	21.364	21.364	2.72	0.241
Residual	2	15.711	7.855	6.07	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	2.904	1.452	1.12	0.372
CULTIVAR x CUT_TMT	2	5.416	2.708	2.09	0.186
Residual	8	10.359	1.295		
Total	17	66.546			

Tables of means
Variate: Leaves
Grand mean 3.10

CULTIVAR	1	3
	4.19	2.01

CUT_TMT	1	2	3
	3.08	3.60	2.62

CULTIVAR x CUT_TMT	1	2	3
1	4.93	4.43	3.20
3	1.23	2.77	2.03

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
e.s.e.	0.934	0.465	1.077
d.f.	2	8	3.44

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
l.s.d.	5.685	1.515	4.514
d.f.	2	8	3.44

Stratum standard errors and coefficients of variation

Variate: Leaves

Stratum	d.f.	s.e.	cv%
REP.WPLOT.SPLOT	8	1.138	36.7

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	4.933	4.963
3	3	1.230	0.148

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	4.433	5.303
3	3	2.767	3.083

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	3.200	3.330
3	3	2.033	1.603

PLDATE	REP	CUT_TMT	CULTIVAR	Leaves	FITTED	RESIDUAL
1	1	1	1	7.500	7.278	0.2222
1	1	2	1	6.800	6.778	0.0222
1	1	3	1	5.300	5.544	-0.2444
1	1	1	3	0.790	0.950	-0.1600
1	1	2	3	2.600	2.487	0.1133
1	1	3	3	1.800	1.753	0.0467
1	2	1	1	3.800	4.211	-0.4111
1	2	2	1	4.300	3.711	0.5889
1	2	3	1	2.300	2.478	-0.1778
1	2	1	3	1.500	1.553	-0.0533
1	2	2	3	4.600	3.090	1.5100
1	2	3	3	0.900	2.357	-0.4567
1	3	1	1	3.500	3.311	0.1889
1	3	2	1	2.200	2.811	-0.6111
1	3	3	1	2.000	1.578	0.4222
1	3	1	3	1.400	1.187	0.2133
1	3	2	3	1.100	2.723	-0.6233
1	3	3	3	3.400	1.990	1.4100

Appendix A.1.2: Variate: Tubers

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.19111	0.09556	10.75	
REP.WPLOT stratum					
CULTIVAR	1	1.33389	1.33389	150.06	0.007
Residual	2	0.01778	0.00889	0.21	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	0.00778	0.00389	0.09	0.915
CULTIVA x CUT_TMT	2	0.10778	0.05389	1.25	0.337
Residual	8	0.34444	0.04306		
Total	17	2.00278			

Tables of means
Variate: Tubers
Grand mean 0.639

CULTIVAR	1	3	
	0.911	0.367	
CUT_TMT	1	2	3
	0.617	0.633	0.667

CULTIVAR x CUT_TMT	1	2	3
1	0.967	0.800	0.967
3	0.267	0.467	0.367

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
e.s.e.	0.0314	0.0847	0.1198
d.f.	2	8	9.34

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
l.s.d.	0.1912	0.2763	0.3907
d.f.	2	8	9.34

Stratum standard errors and coefficients of variation

Variate: Tubers

Stratum	d.f.	s.e.	cv%
REP.WPLOT.SPLOT	8	0.2075	32.5

========= Summary of original data ========

CUT_TMT 1

Nobservd	Mean	Variance

CULTIVAR			
1	3	0.9667	0.013333
3	3	0.2667	0.013333

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.8000	0.07000
3	3	0.4667	0.02333

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.9667	0.10333
3	3	0.3667	0.05333

PLDATE	REP	CUT_TMT	CULTIVAR	Tubers	FITTED	RESIDUAL
1	1	1	1	1.1000	1.1556	-0.0556
	1	2	1	1.0000	0.9889	0.0111
1	1	3	1	1.2000	1.1556	-0.0444
1	1	1	3	0.4000	0.3667	0.0333
1	1	2	3	0.5000	0.5667	-0.0667
1	1	3	3	0.5000	0.4667	0.0333
1	2	1	1	0.9000	0.8556	0.0444
1	2	2	1	0.9000	0.6889	0.2111
1	2	3	1	0.6000	0.8556	-0.2556
1	2	1	3	0.2000	0.2000	0.0000
1	2	2	3	0.6000	0.4000	0.2000
1	2	3	3	0.1000	0.3000	-0.2000
1	3	1	1	0.9000	0.8889	0.0111
1	3	2	1	0.5000	0.7222	-0.2222
1	3	3	1	1.1000	0.8889	0.2111
1	3	1	3	0.2000	0.2333	-0.0333
1	3	2	3	0.3000	0.4333	-0.1333
1	3	3	3	0.5000	0.3333	0.1667

Appendix A.1.3: Variate: Total DM

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	13.541	6.770	0.81	
REP.WPLOT stratum					
CULTIVAR	1	33.374	33.374	3.98	0.184
Residual	2	16.778	8.389	4.98	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	2.722	1.361	0.81	0.479
CULTIVAR x CUT_TMT	2	6.391	3.196	1.90	0.212
Residual	8	13.467	1.683		
Total	17	86.274			

Tables of means

Variate: TotalDM

Grand mean 3.74

CULTIVAR	1	2	3
	5.10a		2.38a

CUT_TMT	1	2	3
	3.70	4.23	3.28

CULTIVAR x CUT_TMT	1	2	3
1	5.90	5.23	4.17
3	1.50	3.23	2.40

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
e.s.e.	0.965	0.530	1.143

Least significant differences of means (10% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
l.s.d.	3.987	1.393	3.505

Stratum standard errors and coefficients of variation

Variate: TotalDM

Stratum	d.f.	s.e.	cv%
REP	2	1.062	28.4
REP.WPLOT	2	1.672	44.7
REP.WPLOT.SPLOT	8	1.297	34.7

Fisher's protected least significant difference test

CUT_TMT

Fisher's protected LSD is not calculated as variance ratio for CUT_TMT is not significant.

Fisher's protected least significant difference test

CULTIVAR.CUT_TMT

Fisher's protected LSD is not calculated as variance ratio for CULTIVAR.CUT_TMT is not significant.

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	5.900	2.343
2	0	*	*
3	3	1.497	0.270

CUT_TMT	2		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	5.233	2.550
2	0	*	*
3	3	3.233	1.904

CUT_TMT	3		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	4.167	2.023
2	0	*	*
3	3	2.400	1.453

Appendix A.2: Statistical analysis on the influence of different treatments on the production of the Fodder tuber species on Cyferkuil, planted in March.

Appendix A.2.1: Variate: Leaves

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	2.501	1.251	0.33	
REP.WPLOT stratum					
CULTIVAR	1	6.480	6.480	1.70	0.322
Residual	2	7.630	3.815	1.63	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	0.508	0.254	0.11	0.898
CULTIVAR x CUT_TMT	2	3.270	1.635	0.70	0.525
Residual	8	18.682	2.335		
Total	17	39.071			

Tables of means

Variate: Leaves

Grand mean 2.52

CULTIVAR	1	3
	3.12	1.92

CUT_TMT	1	2	3
	2.47	2.75	2.35

CULTIVAR x CUT_TMT	1	2	3
1	2.47	3.70	3.20
3	2.47	1.80	150

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
e.s.e.	0.651	0.624	0.971
d.f.	2	8	7.20

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
l.s.d.	3.962	2.035	3.229
d.f.	2	8	7.20

Stratum standard errors and coefficients of variation

Variate: Leaves

Stratum	d.f.	s.e.	cv%

REP.WPLOT.SPLOT	8	1.528	60.6

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	2.467	1.923
3	3	2.467	0.043

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	3.700	8.130
3	3	1.800	0.120

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	3.200	2.920
3	3	1.500	1.270

PLDATE	REP	CUT_TMT	CULTIVAR	LEAVES	FITTED	
RESIDUAL						
2	1	1	1	2.100	1.844	0.2556
2	1	2	1	3.800	3.078	0.7222
2	1	3	1	1.600	2.578	-0.9778
2	1	1	3	2.400	2.278	0.1222
2	1	2	3	2.000	1.611	0.3889
2	1	3	3	0.800	1.311	-0.5111
2	2	1	1	1.300	1.711	-0.4111
2	2	2	1	0.800	2.944	-2.1444
2	2	3	1	5.000	2.444	2.5556
2	2	1	3	2.700	3.044	-0.3444
2	2	2	3	2.000	2.378	-0.3778
2	2	3	3	2.800	2.078	0.7222
2	3	1	1	4.000	3.844	0.1556
2	3	2	1	6.500	5.078	1.4222
2	3	3	1	3.000	4.578	-1.5778
2	3	1	3	2.300	2.078	0.2222
2	3	2	3	1.400	1.411	-0.0111
2	3	3	3	0.900	1.111	-0.2111

Appendix A.2.2: Variate: Tubers

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.1200	0.0600	0.17	
REP.WPLOT stratum					
CULTIVAR	1	0.4672	0.4672	1.29	0.374
Residual	2	0.7244	0.3622	1.87	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	6.1733	3.0867	15.94	0.002
CULTIVAR x CUT_TMT	2	0.2711	0.1356	0.70	05525
Residual	8	1.5489	0.1936		
Total	17	9.3050			

Tables of means

Variate: Tubers

Grand mean 1.08

CULTIVAR	1	3
	0.92	1.24

CUT_TMT	1	2	3
	0.38	1.05	1.82

CULTIVAR x CUT_TMT	1	2	3
1	0.37	0.90	1.50
3	0.40	1.20	2.13

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
e.s.e.	0.201	0.180	0.289
d.f.	2	8	6.66

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
l.s.d.	1.221	0.586	0.975
d.f.	2	8	6.66

Stratum standard errors and coefficients of variation

Variate: Tubers

Stratum	d.f.	s.e.	cv%
REP.WPLOT.SPLOT	8	0.440	40.6

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.367	0.0233
3	3	0.400	0.0700

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.900	0.0700
3	3	1.200	0.0700

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	1.500	0.3900
3	3	2.133	0.5733

PLDATE	REP	CUT_TMT	CULTIVAR	Tubers	FITTED	RESIDUAL
2	1	1	1	0.200	0.278	-0.0778
2	1	2	1	0.600	0.811	-0.2111
2	1	3	1	1.700	1.411	0.2889
2	1	1	3	0.300	0.689	-0.3889
2	1	2	3	1.300	1.489	-0.1889
2	1	3	3	3.000	2.422	0.5778
2	2	1	1	0.500	0.644	-0.1444
2	2	2	1	1.100	1.178	-0.0778
2	2	3	1	2.000	1.178	0.2222
2	2	1	3	0.200	0.122	0.0778
2	2	2	3	0.900	0.922	-0.0222
2	2	3	3	1.800	1.856	-0.0556
2	3	1	1	0.400	0.178	0.2222
2	3	2	1	1.000	0.711	0.2889
2	3	3	1	0.800	1.311	-0.5111
2	3	1	3	0.700	0.389	0.3111
2	3	2	3	1.400	1.189	0.2111
2	3	3	3	1.600	2.122	-0.5222

Appendix A.2.3: Variate: Total DM

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	13.541	6.770	0.81	
REP.WPLOT stratum					
CULTIVAR	1	33.374	33.374	3.98	0.184
Residual	2	16.778	8.389	4.98	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	2.722	1.361	0.81	0.479
CULTIVAR x CUT_TMT	2	6.391	3.196	1.90	0.212
Residual	8	13.467	1.683		
Total	17	86.274			

Tables of means

Variate: TotalDM

Grand mean 3.74

CULTIVAR	1	2	3
	5.10a		2.38a

CUT_TMT	1	2	3
	3.70	4.23	3.28

CULTIVAR x CUT_TMT	1	2	3
1	5.90	5.23	4.17
3	1.50	3.23	2.40

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
e.s.e.	0.965	0.530	1.143

Least significant differences of means (10% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
l.s.d.	3.987	1.393	3.505

Stratum standard errors and coefficients of variation

Variate: TotalDM

Stratum	d.f.	s.e.	cv%
REP	2	1.062	28.4
REP.WPLOT	2	1.672	44.7
REP.WPLOT.SPLOT	8	1.297	34.7

Fisher's protected least significant difference test

CUT_TMT

Fisher's protected LSD is not calculated as variance ratio for CUT_TMT is not significant.

Fisher's protected least significant difference test

CULTIVAR x CUT_TMT

Fisher's protected LSD is not calculated as variance ratio for CULTIVAR.CUT_TMT is not significant.

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	5.900	2.343
2	0	*	*
3	3	1.497	0.270

CUT_TMT	2		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	5.233	2.550
2	0	*	*
3	3	3.233	1.904

CUT_TMT	3		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	4.167	2.023
2	0	*	*
3	3	2.400	1.453

Appendix A.3: Statistical analysis on the influence of different treatments on the production of the Fodder tuber species on Cyferkuil, planted in April.

Appendix A.3.1: Variate: Leaves

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	14.290	7.145	2.29	
REP.WPLOT stratum					
CULTIVAR	1	0.201	0.201	0.06	0.823
Residual	2	6.234	3.117	2.26	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	4.893	2.447	1.78	0.230
CULTIVAR x CUT_TMT	2	10.084	5.042	3.66	0.074
Residual	8	11.022	1.378		
Total	17	46.725			

Tables of means

Variate: Leaves

Grand mean 2.82

CULTIVAR	1	3
	2.71	2.92

CUT_TMT	1	2	3
	2.52	3.55	2.38

CULTIVAR x CUT_TMT	1	2	3
1	2.40	4.37	1.37
3	2.63	2.73	3.40

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
e.s.e.	0.589	0.479	808
d.f.	2	18	5.94

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
l.s.d.	3.581	1.563	2.802
d.f.	2	8	5.94

Stratum standard errors and coefficients of variation

Variate: Leaves

Stratum	d.f.	s.e.	cv%
REP.WPLOT.SPLOT	18	1.174	41.7

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	2.400	2.830
3	3	2.633	0.063

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	4.367	9.843
3	3	2.733	0.763

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	41.367	0.103
3	3	3.400	2.170

PLDATE	REP	CUT_TMT	CULTIVAR	Leaves	FITTED	RESIDUAL
3	1	1	1	3.700	3.289	0.4111
3	1	2	1	5.600	5.256	0.3444
3	1	3	1	1.500	2.256	-0.7556
3	1	1	3	2.400	2.178	0.2222
3	1	2	3	2.500	2.278	0.2222
3	1	3	3	2.500	2.944	-0.4444
3	2	1	1	3.000	3.456	-0.4556
3	2	2	1	6.700	5.422	1.2778
3	2	3	1	1.600	2.422	-0.8222
3	2	1	3	2.600	3.511	-0.9111
3	2	2	3	3.700	3.611	0.0889
3	2	3	3	5.100	4.278	0.8222
3	3	1	1	0.500	0.456	0.0444
3	3	2	1	0.800	2.422	-1.6222
3	3	3	1	1.000	-0.578	1.5778
3	3	1	3	2.900	2.211	0.6889
3	3	2	3	2.000	2.311	-0.3111
3	3	3	3	2.600	2.978	-0.3778

Appendix A.3.2: Variate: Tubers

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.27111	0.13556	3.21	
REP.WPLOT stratum					
CULTIVAR	1	0.29389	0.29389	6.96	0.119
Residual	2	008444	0.04222	1.35	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	4.44778	2.22389	70.85	<.001
CULTIVAR x CUT_TMT	2	0.14778	0.07389	2.35	0.157
Residual	8	0.25111	0.03139		
Total	17	5.49611			

Tables of means

Variate: Tubers

Grand mean 0.928

CULTIVAR	1	3
	0.800	1.056

CUT_TMT	1	2	3`
	0.333	0.900	1.550

CULTIVAR x CUT_TMT	1	2	3
1	0.333	0.700	1.367
3	0.333	1.100	1.733

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
e.s.e.	0.0685	0.0723	0.1080
d.f.	2	8	7.97

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
l.s.d.	0.4168	0.2359	0.3525
d.f.	2	8	7.97

Stratum standard errors and coefficients of variation

Variate: Tubers

Stratum	d.f.	s.e.	cv%

REP.WPLOT.SPLOT	8	0.1772	19.1

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.3333	0.01333
3	3	0.3333	0.00333

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.7000	0.01000
3	3	1.1000	0.04000

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	1.3667	0.17333
3	3	1.7333	0.06333

PLDATE	REP	CUT_TMT	CULTIVAR	Tubers	FITTED	RESIDUAL
3	1	1	1	0.4000	0.4000	0.0000
3	1	2	1	0.7000	0.7667	-0.0667
3	1	3	1	1.5000	1.4333	0.0667
3	1	1	3	0.3000	0.2444	0.0556
3	1	2	3	0.9000	1.0111	-0.1111
3	1	3	3	1.7000	1.6444	0.0556
3	2	1	1	0.4000	0.5000	-0.1000
3	2	2	1	0.8000	0.8667	-0.0667
3	2	3	1	1.7000	1.5333	0.1667
3	2	1	3	0.3000	0.4778	-0.1778
3	2	2	3	1.3000	1.2444	0.0556
3	2	3	3	2.0000	1.8778	0.1222
3	3	1	1	0.2000	0.1000	0.1000
3	3	2	1	0.6000	0.4667	0.1333
3	3	3	1	0.9000	1.1333	-0.2333
3	3	1	3	0.4000	0.2778	0.1222
3	3	2	3	1.1000	1.0444	0.0556
3	3	3	3	1.5000	1.6778	-0.1778

Appendix A.3.3: Variate: Total DM

Analysis of variance

Variate: TotalDM

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	18.388	9.194	2.37	
REP.WPLOT stratum					
CULTIVAR	1	0.980	0.980	0.25	0.665
Residual	2	7.770	3.885	3.01	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	8.001	4.001	3.09	0.101
CULTIVAR x CUT_TMT	2	10.023	5.012	3.88	0.067
Residual	8	10.342	1.293		
Total	17	55.504			

Tables of means

Variate: TotalDM

Grand mean 3.74

CULTIVAR	1	2	3
	3.51a		3.98a

CUT_TMT	1	2	3
	2.85	4.45	3.93

CULTIVAR x CUT_TMT	1	2	3
1	2.73	5.07	2.73
3	2.97	3.83	5.13

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
e.s.e.	0.657	0.464	0.848

Least significant differences of means (10% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	6	3
l.s.d.	2.713	1.221	2.417

Stratum standard errors and coefficients of variation

Variate: TotalDM

Stratum	d.f.	s.e.	cv%
REP	2	1.238	33.1
REP.WPLOT	2	1.138	30.4
REP.WPLOT.SPLOT	8	1.137	30.4

Fisher's protected least significant difference test

CUT_TMT

Fisher's protected LSD is not calculated as variance ratio for CUT_TMT is not significant.

Fisher's protected least significant difference test

CULTIVAR x CUT_TMT

Variances vary and decisions regarding group membership are inconsistent, so there may be gaps in the lines or letters linking means in identical groups.

	Mean	
1 3	2.733	a
1 1	2.733	a
3 1	2.967	ab
3 2	3.833	abc
1 2	5.067	bc
3 3	5.133	ac

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	2.733	1.795
2	0	*	*
3	3	2.967	0.306

CUT_TMT	2		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	5.067	3.232
2	0	*	*
3	3	3.833	1.021

CUT_TMT	3		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	2.733	0.737
2	0	*	*
3	3	5.133	1.704

APPENDIX B.1: Statistical analysis on the influence of different treatments on the production of the Fodder *tuber* species on Dewaginsdrift planted in February

Appendix B.1.1: Variate: Leaves

Analysis of variance

Source of variation	d.f.	(m.v.)	s.s.	m.s.	v.r.	F pr.
REP stratum	2		1.2161	0.6081	0.78	
REP.WPLOT stratum						
CULTIVAR	2		4.2751	2.1376	2.75	0.209
Residual	3	(1)	2.3289	0.7763	0.79	
REP.WPLOT.SPLOT stratum						
CUT_TMT	2		1.2407	0.6204	0.63	0.550
CULTIVAR x CUT_TMT	4		13.1914	3.2978	3.37	0.054
Residual	10	(2)	9.7811	0.9781		
Total	23	(3)	30.2096			

Tables of means
Variate: Leaves
Grand mean 1.73

CULTIVAR	1	2	3
	2.27	1.62	1.31

CUT_TMT	1	2	3
	1.61	1.56	2.04

CULTIVAR x CUT_TMT	1	2	3
1	1.00	2.50	3.30
2	2.72	1.07	1.07
3	1.10	1.10	1.73

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
e.s.e.	0.294	0.330	0.571
d.f.	3	10	12.80

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
l.s.d.	1.322	1.039	1.799
d.f.	3	10	12.80

Stratum standard errors and coefficients of variation

Variate: Leaves

Stratum	d.f.	s.e.	cv%
REP.WPLOT.SPLOT	10	0.989	57.1

========== Summary of original data =========

CUT_TMT 1

CULTIVAR	Nobservd	Mean	Variance
1	3	1.000	0.160
2	2	2.650	7.605
3	3	1.100	0.280

CUT_TMT 2

CULTIVAR	Nobservd	Mean	Variance
1	3	2.500	0.310
2	2	1.000	0.020
3	3	1.100	0.670

CUT_TMT 3

CULTIVAR	Nobservd	Mean	Variance
1	3	3.300	0.070
2	2	1.000	0.180
3	3	1.733	1.223

PLDATE	REP	CUT_TMT	CULTIVAR	Leaves	FITTED	RESIDUAL
1	1	1	1	1.000	0.900	0.1000
1	1	2	1	2.000	2.400	-0.4000
1	1	3	1	3.500	3.200	0.3000
1	1	1	2	*	2.869	*
1	1	2	2	*	1.217	*
1	1	3	2	*	1.217	*
1	1	1	3	1.300	1.489	-0.1889
1	1	2	3	0.900	1.489	-0.5889
1	1	3	3	2.900	2.122	0.7778
1	2	1	1	1.400	1.233	0.1667
1	2	2	1	3.100	2.733	0.3667
1	2	3	1	3.000	3.533	-0.5333
1	2	1	2	0.700	2.067	-1.3672
1	2	2	2	0.900	0.416	0.4836
1	2	3	2	1.300	0.416	0.8836
1	2	1	3	0.500	0.622	-0.1222
1	2	2	3	0.400	0.622	-0.2222
1	2	3	3	1.600	1.256	0.3444
1	3	1	1	0.600	0.867	-0.2667
1	3	2	1	2.400	2.367	0.0333
1	3	3	1	3.400	3.167	0.2333
1	3	1	2	4.600	3.234	1.3662
1	3	2	2	1.100	1.583	-0.4831
1	3	3	2	0.700	1.583	-0.8831
1	3	1	3	1.500	1.189	0.3111
1	3	2	3	2.000	1.189	0.8111
1	3	3	3	0.700	1.822	-1.1222

Appendix B.1.2: Variate: Tubers

Analysis of variance

Source of variation	d.f.	(m.v.)	s.s.	m.s.	v.r.	F pr.
REP stratum	2		0.3480	0.1740	1.94	
REP.WPLOT stratum						
CULTIVAR	2		1.6923	0.8461	9.42	0.051
Residual	3	(1)	0.2695	0.0898	0.78	
REP.WPLOT.SPLOT stratum						
CUT_TMT	2		4.4420	2.2210	19.34	<.001
CULTIVAR x CUT_TMT	4		2.6466	0.6617	5.76	0.011
Residual	10	(2)	1.1486	0.1149		
Total	23	(3)	10.2033			

Tables of means
Variate: Tubers
Grand mean 0.680

CULTIVAR	1	2	3
	0.934	0.340	0.767

CUT_TMT	1	2	3
	0.308	0.489	1.244

CULTIVAR x CUT_TMT	1	2	3
1	0.070	0.700	2.033
2	0.286	0.267	0.466
3	0.567	0.500	1.233

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
e.s.e.	0.0999	0.1130	0.1957
d.f.	3	10	12.82

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
l.s.d.	0.4496	0.3560	0.6166
d.f.	3	10	12.82

Stratum standard errors and coefficients of variation

Variate: Tubers

Stratum	d.f.	s.e.	cv%
REP.WPLOT.SPLOT	10	0.3389	49.8

========== Summary of original data =========

CUT_TMT 1

Nobservd	Mean	Variance

CULTIVAR			
1	3	0.0700	0.0027
2	2	0.2700	0.1058
3	3	0.5667	0.1233

CUT_TMT 2

	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.7000	0.0900
2	2	0.2500	0.0050
3	3	0.5000	0.1600

CUT_TMT 3

	Nobservd	Mean	Variance
CULTIVAR			
1	3	2.0333	0.1433
2	2	0.4500	0.1250
3	3	1.2333	0.2433

PLDATE	REP	CUT_TMT	CULTIVAR	Tubers	FITTED	RESIDUAL
1	1	1	1	0.1000	-0.0644	0.1644
1	1	2	1	0.7000	0.5656	0.1344
1	1	3	1	1.6000	1.8989	-0.2989
1	1	1	2	*	0.3195	*
1	1	2	2	*	0.2996	*
1	1	3	2	*	0.4986	*
1	1	1	3	0.2000	0.7667	-0.5667
1	1	2	3	0.9000	0.7000	0.2000
1	1	3	3	1.8000	1.4333	0.3667
1	2	1	1	0.1000	0.2689	-0.1689
1	2	2	1	1.0000	0.8989	0.1011
1	2	3	1	2.3000	2.2322	0.0678
1	2	1	2	0.5000	0.4468	0.0532
1	2	2	2	0.3000	0.4268	-0.1268
1	2	3	2	0.7000	0.6265	0.0735
1	2	1	3	0.9000	0.5667	0.3333
1	2	2	3	0.5000	0.5000	0.0000
1	2	3	3	0.9000	1.2333	-0.3333
1	3	1	1	0.0100	0.0056	0.0044
1	3	2	1	0.4000	0.6356	-0.2356
1	3	3	1	2.2000	1.9689	0.2311
1	3	1	2	0.0400	0.0934	-0.0534
1	3	2	2	0.2000	0.0735	0.1265
1	3	3	2	0.2000	10.2731	-0.0731
1	3	1	3	0.6000	0.3667	0.2333
1	3	2	3	0.1000	0.3000	-0.2000
1	3	3	3	1.0000	1.0333	-0.0333

Appendix B.1.3: Variate: Total DM

Analysis of variance

Source of variation	d.f.	(m.v.)	s.s.	m.s.	v.r.	F pr.
REP stratum	2		9.692	4.846	15.41	
REP.WPLOT stratum						
CULTIVAR	2		76.864	38.432	122.19	0.001
Residual	3	(1)	0.944	0.315	0.15	
REP.WPLOT.SPLOT stratum						
CUT_TMT	2		10.251	5.125	2.52	0.130
CULTIVAR x CUT_TMT	4		33.686	8.422	4.15	0.031
Residual	10	(2)	20.303	2.030		
Total	23	(3)	143.713			

Tables of means

Variate: Total DM

Grand mean 3.85

CULTIVAR	1	2	3
	3.20	1.96	2.08

CUT_TMT	1	2	3
	2.13	2.05	3.28

CULTIVAR x CUT_TMT	1	2	3
1	1.07	3.20	5.33
2	3.01	1.34	1.54
3	1.677	1.60	2.96

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
e.s.e.	0.187	0.475	0.823

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
l.s.d.	0.841	1.497	2.592

Stratum standard errors and coefficients of variation
Variate: TotalDM

Stratum	d.f.	s.e.	cv%
REP	2	0.734	19.1
REP.WPLOT	3	0.324	8.4
REP.WPLOT.SPLOT	10	1.425	37.0

Fisher's protected least significant difference test

CULTIVAR

	Mean	
2	1.96	b
3	2.08	b
1	3.20	a

Fisher's protected least significant difference test
CUT_TMT

Fisher's protected LSD is not calculated as variance ratio for CUT_TMT is not significant.

Fisher's protected least significant difference test

CULTIVAR x CUT_TMT

	Mean	
1 1	1.07	d
2 2	1.34	cd
2 3	1.54	cd
3 2	1.60	cd
3 1	1.67	bcd
3 3	2.96	abcd
2 1	3.01	abc
1 2	3.20	ab
1 3	5.33	a

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	3.967	0.404
2	2	3.800	2.828
3	3	1.900	0.300

CUT_TMT	2		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	3.20	1.872
2	2	1.96	0.212
3	3	2.05	1.277

CUT_TMT	3		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	5.33	2.291
2	1	3.01	0.424
3	3	2.96	0.819

Appendix B.2: Statistical analysis on the influence of different treatments on the production of the Fodder *tuber* species on Dewaginsdrift planted in March

Appendix B.2.1: Variate: Leaves

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	5.442	2.721	2.42	
REP.WPLOT stratum					
CULTIVAR	2	46.362	23.181	20.66	0.008
Residual	4	4.489	1.122	0.72	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	4.807	2.403	1.54	0.255
CULTIVAR x CUT_TMT	4	7.684	1.921	1.23	0.350
Residual	12	18.782	1.565		
Total	26	87.567			

Tables of means

Variate: Leaves

Grand mean 2.12

CULTIVAR	1	2	3
	3.97	1.04	1.36

CUT_TMT	1	2	3
	1.61	2.11	2.64

CULTIVAR x CUT_TMT	1	2	3
1	2.97	3.43	5.50
2	1.07	1.20	0.87
3	0.80	1.70	1.57

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
e.s.e.	0.353	0.417	0.722
d.f.	4	12	15.98

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
l.s.d.	1.386	1.285	2.226
d.f.	4	12	15.98

Stratum standard errors and coefficients of variation

Variate: Leaves

Stratum	d.f.	s.e.	cv%
REP.WPLOT.SPLOT	12	1.251	59.0

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	2.967	0.203
2	3	1.067	0.023
3	3	0.800	0.070

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	3.433	5.853
2	3	1.200	0.070
3	3	1.700	1.240

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	5.500	5.320
2	3	0.867	0.413
3	3	1.567	1.163

PLDATE	REP	CUT_TMT	CULTIVAR	Leaves	FITTED	RESIDUAL
2	1	1	1	3.400	3.000	0.4000
2	1	2	1	5.300	3.467	1.8333
2	1	3	1	3.300	5.533	-2.2333
2	1	1	2	0.900	0.822	0.0778
2	1	2	2	0.900	0.956	-0.0556
2	1	3	2	0.600	0.622	-0.0222
2	1	1	3	0.600	0.178	0.4222
2	1	2	3	0.500	1.078	-0.5778
2	1	3	3	1.100	0.944	0.1556
2	2	1	1	2.500	1.833	0.6667
2	2	2	1	0.700	2.300	-1.6000
2	2	3	1	5.300	4.367	0.9333
2	2	1	2	1.100	0.956	0.1444
2	2	2	2	1.300	1.089	0.2111
2	2	3	2	0.400	0.756	-0.3556
2	2	1	3	1.100	0.978	0.1222
2	2	2	3	2.700	1.878	0.8222
2	2	3	3	0.800	1.744	-0.9444
2	3	1	1	3.000	4.067	-1.0667
2	3	2	1	4.300	4.533	-0.2333
2	3	3	1	7.900	6.600	1.3000
2	3	1	2	1.200	1.422	-0.2222
2	3	2	2	1.400	1.556	-0.1556
2	3	3	2	1.600	1.222	0.3778
2	3	1	3	0.700	1.244	-0.5444
2	3	2	3	1.900	2.144	-0.2444
2	3	3	3	2.800	2.011	0.7889

Appendix B.2.2: Variate: Tubers

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.75130	0.37565	5.02	
REP.WPLOT stratum					
CULTIVAR	2	4.23130	2.11565	28.28	0.004
Residual	4	0.29926	0.07481	0.75	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	4.14916	2.07458	20.84	<.001
CULTIVAR x CUT_TMT	4	2.25833	0.56458	5.67	0.008
Residual	12	1.19431	0.09953		
Total	26	12.88365			

Tables of means

Variate: Tubers

Grand mean 0.624

CULTIVAR	1	2	3
	1.183	0.322	0.367

CUT_TMT	1	2	3
	0.130	0.653	1.089

CULTIVAR x CUT_TMT	1	2	3
1	0.217	1.167	2.167
2	0.100	0.400	0.467
3	0.073	0.393	0.633

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
e.s.e.	0.0912	0.1052	0.1821
d.f.	4	12	15.95

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
l.s.d.	0.3580	0.3240	0.5612
d.f.	4	12	15.95

Stratum standard errors and coefficients of variation

Variate: Tubers

Stratum	d.f.	s.e.	cv%

REP.WPLOT.SPLOT	12	0.3155	50.6

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.2167	0.0308
2	3	0.1000	0.0000
3	3	0.0733	0.0021

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	1.1667	0.0833
2	3	0.4000	0.0300
3	3	0.3933	0.0961

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	2.1667	0.7033
2	3	0.4667	0.0133
3	3	0.6333	0.1633

PLDATE	REP	CUT_TMT	CULTIVAR	Tubers	FITTED	RESIDUAL
2	1	1	1	0.2000	-0.1667	0.3667
2	1	2	1	1.0000	0.7833	0.2167
2	1	3	1	1.2000	1.7833	-0.5833
2	1	1	2	0.1000	0.0111	0.0889
2	1	2	2	0.2000	0.3111	-0.1111
2	1	3	2	0.4000	0.3778	0.0222
2	1	1	3	0.0200	-0.1267	0.1467
2	1	2	3	0.0800	0.1933	-0.1133
2	1	3	3	0.4000	0.4333	-0.0333
2	2	1	1	0.0500	0.4167	-0.3667
2	2	2	1	1.5000	1.3667	0.1333
2	2	3	1	2.6000	2.3667	0.2333
2	2	1	2	0.1000	0.1111	-0.0111
2	2	2	2	0.5000	0.4111	0.0889
2	2	3	2	0.4000	0.4778	-0.0778
2	2	1	3	0.1000	0.0067	0.0933
2	2	2	3	0.4000	0.3267	0.0733
2	2	3	3	0.4000	0.5667	-0.1667
2	3	1	1	0.4000	0.4000	0.0000
2	3	2	1	1.0000	1.3500	-0.3500
2	3	3	1	2.7000	2.3500	0.3500
2	3	1	2	0.1000	0.1778	-0.0778
2	3	2	2	0.5000	0.4778	0.0222
2	3	3	2	0.6000	0.5444	0.0556
2	3	1	3	0.1000	0.3400	-0.2400
2	3	2	3	0.7000	0.6600	0.0400
2	3	3	3	1.1000	0.9000	0.2000

Appendix B.2.3: Variate: Total DM

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	9.011	4.506	5.27	
REP.WPLOT stratum					
CULTIVAR	2	78.569	39.285	45.96	0.002
Residual	4	3.419	0.855	0.40	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	17.865	8.932	4.17	0.042
CULTIVAR x CUT_TMT	4	17.193	4.298	2.01	0.158
Residual	12	25.708	2.142		
Total	26	151.765			

Tables of means

Variate: Total DM

Grand mean 2.75

CULTIVAR	1	2	3
	5.15	1.37	1.72

CUT_TMT	1	2	3
	1.74	2.76	3.73

CULTIVAR x CUT_TMT	1	2	3
1	3.18	4.60	7.67
2	1.17	1.60	1.33
3	0.87	2.09	2.20

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
e.s.e.	0.308	0.488	0.845

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
l.s.d.	1.210	1.503	2.604

Stratum standard errors and coefficients of variation

Variate: TotalDM

Stratum	d.f.	s.e.	cv%
REP	2	0.708	25.8

REP.WPLOT	4	0.534	19.4
REP.WPLOT.SPLOT	12	1.464	53.3

Fisher's protected least significant difference test

CULTIVAR

	Mean	
2	1.367	a
3	1.722	a
1	5.150	b

Fisher's protected least significant difference test

CUT_TMT

	Mean	
1	1.741	a
2	2.764	ab
3	3.733	b

Fisher's protected least significant difference test

CULTIVAR x CUT_TMT

Fisher's protected LSD is not calculated as variance ratio for CULTIVAR.CUT_TMT is not significant.

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	3.183	0.558
2	3	1.167	0.153
3	3	0.873	0.297

CUT_TMT	2		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	4.600	2.138
2	3	1.600	0.436
3	3	2.093	1.334

CUT_TMT	3		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	7.667	3.057
2	3	1.333	0.757
3	3	2.200	1.480

Appendix B.3: Statistical analysis on the influence of different treatments on the production of the Fodder *tuber* species on Dewaginsdrift planted in April

Appendix B3.1: Variate: Leaves

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.3822	0.1911	0.15	
REP.WPLOT stratum					
CULTIVAR	2	17.2289	8.6144	6.63	0.054
Residual	4	5.1956	1.2989	2.93	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	7.6200	3.8100	8.59	0.005
CULTIVAR x CUT_TMT	4	4.5311	1.1328	2.55	0.093
Residual	12	5.3222	0.4435		
Total	26	40.2800			

Tables of means

Variate: Leaves

Grand mean 2.30

CULTIVAR	1	2	3
	3.37	1.44	2.09

CUT_TMT	1	2	3
	1.67	2.27	2.97

CULTIVAR x CUT_TMT	1	2	3
1	2.57	2.80	4.73
2	0.93	1.93	1.47
3	1.50	2.07	2.70

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
e.s.e.	0.380	0.222	0.493
d.f.	4	12	9.80

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
l.s.d.	1.492	0.684	1.557
d.f.	4	12	9.80

Stratum standard errors and coefficients of variation

Variate: Leaves

Stratum	d.f.	s.e.	cv%
REP.WPLOT.SPLOT	12	0.666	29.0

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	2.567	1.3433
2	3	0.933	0.0233
3	3	1.500	0.5200

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	2.800	0.1300
2	3	1.933	0.5033
3	3	2.067	0.0533

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	4.733	0.1633
2	3	1.467	0.7033
3	3	2.700	2.0100

PLDATE	REP	CUT_TMT	CULTIVAR	Leaves	FITTED	RESIDUAL
3	1	1	1	1.500	2.300	-0.8000
3	1	2	1	2.700	2.533	0.1667
3	1	3	1	5.100	4.467	0.6333
3	1	1	2	0.800	0.822	-0.0222
3	1	2	2	1.300	1.822	-0.5222
3	1	3	2	1.900	1.356	0.5444
3	1	1	3	2.300	2.344	-0.0444
3	1	2	3	2.200	2.911	-0.7111
3	1	3	3	4.300	3.544	0.7556
3	2	1	1	2.400	2.267	0.1333
3	2	2	1	2.500	2.500	0.0000
3	2	3	1	4.300	4.433	-0.1333
3	2	1	2	0.900	1.356	-0.4556
3	2	2	2	2.700	2.356	0.3444
3	2	3	2	2.000	1.889	0.1111
3	2	1	3	0.900	0.978	-0.0778
3	2	2	3	2.200	1.544	0.6556
3	2	3	3	1.600	2.178	-0.5778
3	3	1	1	3.800	3.133	0.6667
3	3	2	1	3.200	3.367	-0.1667
3	3	3	1	4.800	5.300	-0.5000
3	3	1	2	1.100	0.622	0.4778
3	3	2	2	1.800	1.622	0.1778
3	3	3	2	0.500	1.156	-0.6556
3	3	1	3	1.300	1.178	0.1222
3	3	2	3	1.800	1.744	0.0556
3	3	3	3	2.200	2.378	-0.1778

Appendix B.3.2: Variate: Tubers

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.07727	0.03863	0.22	
REP.WPLOT stratum					
CULTIVAR	2	0.46727	0.23363	1.36	0.355
Residual	4	0.68853	0.17213	3.14	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	2.55282	1.27641	23.27	<.001
CULTIVAR x CUT_TMT	4	0.36631	0.09158	1.67	0.221
Residual	12	0.65827	0.05486		
Total	26	4.81047			

Tables of means

Variate: Tubers

Grand mean 0.581

CULTIVAR	1	2	3
	0.500	0.477	0.767

CUT_TMT	1	2	3
	0.310	0.422	1.011

CULTIVAR x CUT_TMT	1	2	3
1	0.300	0.433	0.767
2	0.297	0.267	0.867
3	0.333	0.567	1.400

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
e.s.e.	0.1383	0.0781	0.1770
d.f.	4	12	9.44

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
l.s.d.	0.5430	0.2406	0.5621
d.f.	4	12	9.44

Stratum standard errors and coefficients of variation

Variate: Tubers

Stratum	d.f.	s.e.	cv%
REP.WPLOT.SPLOT	12	0.2342	40.3

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.3000	0.03000
2	3	0.2967	0.03203
3	3	0.3333	0.04333

CUT_TMT	2		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.4333	0.02333
2	3	0.2667	0.00333
3	3	0.5667	0.09333

CUT_TMT	3		
	Nobservd	Mean	Variance
CULTIVAR			
1	3	0.7667	0.06333
2	3	0.8667	0.14333
3	3	1.4000	0.28000

PLDATE	REP	CUT_TMT	CULTIVAR	Tubers	FITTED	RESIDUAL
3	1	1	1	0.2000	0.2333	-0.0333
3	1	2	1	0.3000	0.3667	-0.0667
3	1	3	1	0.8000	0.7000	0.1000
3	1	1	2	0.4000	0.2867	0.1133
3	1	2	2	0.3000	0.2567	0.0433
3	1	3	2	0.7000	0.8567	-0.1567
3	1	1	3	0.5000	0.6333	-0.1333
3	1	2	3	0.9000	0.8667	0.0333
3	1	3	3	1.8000	1.7000	0.1000
3	2	1	1	0.2000	0.3333	-0.1333
3	2	2	1	0.4000	0.4667	-0.0667
3	2	3	1	1.0000	0.8000	0.2000
3	2	1	2	0.0900	0.1167	-0.0267
3	2	2	2	0.2000	0.0867	0.1133
3	2	3	2	0.6000	0.6867	-0.0867
3	2	1	3	0.4000	0.3333	0.0667
3	2	2	3	0.3000	0.5667	-0.2667
3	2	3	3	1.6000	1.4000	0.2000
3	3	1	1	0.5000	0.3333	0.1667
3	3	2	1	0.6000	0.4667	0.1333
3	3	3	1	0.5000	0.8000	-0.3000
3	3	1	2	0.4000	0.4867	-0.0867
3	3	2	2	0.3000	0.4567	-0.1567
3	3	3	2	1.3000	1.0567	0.2433
3	3	1	3	0.1000	0.0333	0.0667
3	3	2	3	0.5000	0.2667	0.2333
3	3	3	3	0.8000	1.1000	-0.3000

Appendix B3.3: Variate: Total DM

Analysis of variance

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
REP stratum	2	0.7955	0.3977	0.23	
REP.WPLOT stratum					
CULTIVAR	2	17.0422	8.5211	4.87	0.085
Residual	4	7.0041	1.7510	3.75	
REP.WPLOT.SPLOT stratum					
CUT_TMT	2	18.5188	9.2594	19.82	<.001
CULTIVAR x CUT_TMT	4	3.7928	0.9482	2.03	0.154
Residual	12	5.6052	0.4671		
Total	26	52.7585			

Tables of means

Variate: Total DM

Grand mean 2.88

CULTIVAR	1	2	3
	3.87	1.92	2.86

CUT_TMT	1	2	3
	1.98	2.69	3.98

CULTIVAR x CUT_TMT	1	2	3
1	2.87	3.23	5.50
2	1.23	2.20	2.33
3	1.83	2.63	4.10

Standard errors of means

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
e.s.e.	0.441	0.228	0.546

Least significant differences of means (5% level)

Table	CULTIVAR	CUT_TMT	CULTIVAR CUT_TMT
rep.	9	9	3
l.s.d.	1.732	0.702	1.760

Stratum standard errors and coefficients of variation

Variate: TotalDM

Stratum	d.f.	s.e.	cv%
REP	2	0.210	7.3
REP.WPLOT	4	0.764	26.5

REP.WPLOT.SPLOT	12	0.683	23.7

Fisher's protected least significant difference test

CULTIVAR

Fisher's protected LSD is not calculated as variance ratio for CULTIVAR is not significant.

Fisher's protected least significant difference test

CUT_TMT

	Mean	
1	1.977	a
2	2.689	b
3	3.978	c

Fisher's protected least significant difference test

CULTIVAR x CUT_TMT

Fisher's protected LSD is not calculated as variance ratio for CULTIVAR.CUT_TMT is not significant.

========== Summary of original data =========

CUT_TMT	1		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	2.867	1.3204
2	3	1.230	0.2563
3	3	1.833	0.8386

CUT_TMT	2		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	3.233	0.4933
2	3	2.200	0.6557
3	3	2.633	0.4163

CUT_TMT	3		
	Nobservd	Mean	s.d.
CULTIVAR			
1	3	5.500	0.3464
2	3	2.333	0.4619
3	3	4.100	1.7349