CHAPTER 2

MULCHING AND SPACING AFFECTS GROWTH OF WILD GINGER

2.1 INTRODUCTION

Thorpe (1989) and Andrews (2002) defined mulching as a covering material that acts as a blanket and also helps to prevent excessive moisture in the soil evaporating during hot weather conditions. Besides being good for moisture retention, according to Reiley & Shry (1979), mulching is necessary for weed control, organic matter supply and moderating the temperature for the roots, and it also improves the appearance of the area. Mulching has been a beneficial practice in agronomic systems, where it often enhances growth and yield of annual and perennial crops. Plastic mulches increase soil temperature and may promote better plant growth. They are used mostly in high-value crops and in crops where laying the plastic mulch can be mechanized (Zimdahl, 1993).

Spacing is the distance between-row and within-row of planted crops (Widders & Price, 1989). Stoffela & Bryan (1988) reported that within-row spacing affected total plant growth to a greater extent than between-row spacing in cucumbers. Plant height increased with higher plant populations, while stem diameter, root and shoot mass generally decreased as plant populations increased. Ellis (1990) showed that wider spacing is recommended for planting in unusually dry climates, because plant roots need to search further for water. If soil is not very fertile, heavy feeders will also benefit from wider spacing. Overcrowded conditions result in competition for moisture and nutrients, which leads to weak, unhealthy plants (Ellis, 1990).

The objective of this study was to investigate the benefits of mulching on wild ginger, and to investigate the effect of spacing on yield and quality of the plant.

2.2 MATERIALS AND METHODS

2.2.1 Location and environmental characteristics

The experiment was conducted at Hatfield Experimental Farm - University of Pretoria, South Africa. The region is a summer rainfall area with an average rainfall of about 600 - 700mm per annum (October - March). The altitude of the experimental farm is 1370m. Frequent occurrence of frost is experienced during winter months.

2.2.2 Planting material

Rhizomes of wild ginger that were used as planting material were obtained by digging out cultivated plants that were established in a field by the CSIR from tissue-cultured material. The rhizomes were immediately treated with copper oxychloride to prevent fungal growth during storage. After the fungal treatment, all materials were wrapped with newspapers and placed in cut-boxes. After that, they were stored in an uncontrolled storage room until planting.

2.2.3 Experimental design and layout

The layout of the experiment was a randomized complete block design (RCBD) with 6 treatments consisting of a factorial combination of 3 levels of spacing and 2 levels of mulching, with each treatment replicated four times. Plants were spaced in rows 50cm apart. The three levels of in-row spacing were 15cm, 30cm and 45cm in combination with mulching or non-mulching.

2.2.4 Treatments and measurements

Rhizomes were categorized into 4 different sizes that passed through 5cm, 4cm, 3cm or 2cm diameter holes. The circumferences of rhizomes were measured with a Measy vernier callipers (Swiss). Rhizomes were separated in relation to their size and each rhizome was kept in a separate netting bag (Netlon produce, Huhtamaki Packaging Worldwide, RSA), with a tag showing its number. Rhizomes used in the experiment were from the 3cm (834 rhizomes) and 4cm categories (326 rhizomes), giving a total of 1160 rhizomes for the experiment. These two sizes were combined randomly and used for planting.

Rhizomes were treated again with copper oxychloride at the time of planting (11 to 12 December, 2001), to prevent them from fungal infection. Rhizomes were planted ± 7cm deep. The soil was a sandy loam. The three different plots per block were mulched on 16th December 2001, and the mulch was ± 4cm deep. The mulch used was wheat straw and it was placed before the rhizomes started to emerge. The second mulch was added on 12th January 2002, because the first was washed away by rains, wind and irrigation water. The mulch, which was added or supplemented, was ± 6cm deep and was secured to the ground by thin steel rods.

2.2.5 Data collection

The data collected was:

- Soil moisture content

The soil moisture was taken using an auger on 29/04/02, 02/05/02, 08/05/02, 21/05/02, 22/05/02 and 23/05/02. Soil samples were taken from mulch and non-mulched plots at soil depths of 10 and 15cm. The soil moisture was expressed as gravimetric water content. The soil samples taken were weighed, then placed in an oven for 24 hours at 100°C. Plants were irrigated twice per week during cool days and three times per week.

Soil samples were taken each time before irrigation and after irrigation to determine the soil water content.

- Soil temperature

Soil temperature was measured continuously from 11/04/02 (when the plants were 3 months old) until 19/06/02. Soil temperature was measured using thermocouples connected to a data logger (USA – Campbell Scientific Inc.). Thermocouples were buried at soil depths of 5cm and 10cm. Data was recorded hourly for 72 days and the values used in plotting graphs were the minimum and maximum daily soil temperatures.

- Rhizome/root yield

Wild ginger rhizomes and roots were harvested on 19/06/02 until 21/06/02.

- Weed biomass

Weeds were harvested by hand on 31/01/02 and on 03/04/02. Fresh weed mass was measured using a Mettler scale (Model PM 6000-F).

- Emergence rate

Emergence rates were recorded from the first day after germination and it was done mostly on Tuesdays.

2.3 RESULTS AND DISCUSSION

2.3.1 Soil temperature

Between 11 April and 13 May, the maximum soil temperature in non-mulched plots was higher than in mulched plots at 5cm soil depth (Fig. 2.1a). The average maximum soil temperature difference between mulched and non-mulched plots was about 5^0C. The highest soil temperature difference between mulched and non-mulched plots was about 7^0C, while the lowest soil temperature difference was about 3^0C. Therefore, mulching played an important role in reducing maximum temperature at this soil depth. In contrast, the minimum soil temperature in mulched plots was higher than in non-mulched plots.

Therefore, mulching acted as a blanket during the night and prevented some of the heat from escaping into the atmosphere. The average minimum soil temperature difference between mulched and non-mulched plots was about 2^0C. The highest soil temperature difference between mulched and non-mulched plots was 4^0C, while the lowest soil temperature difference was 1^0C.

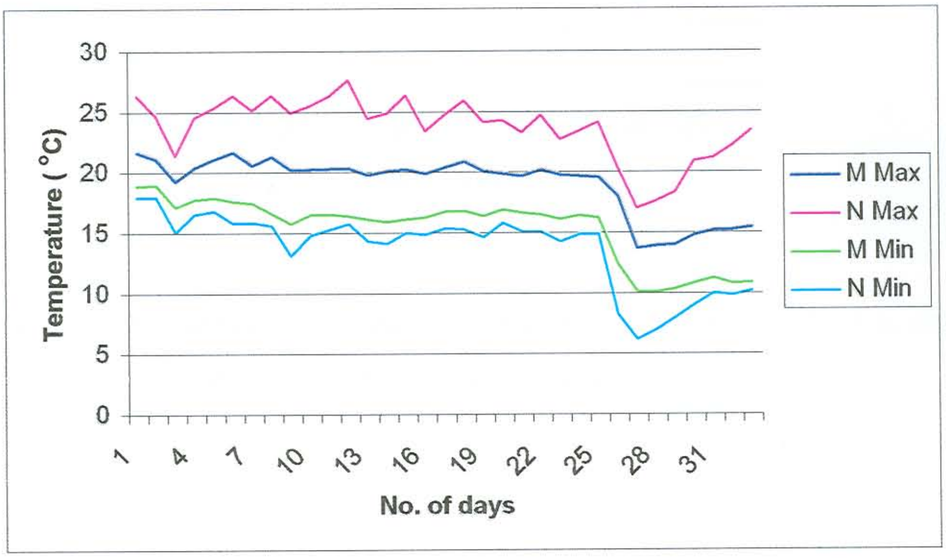

Fig. 2.1a Soil temperature data taken at 5cm soil depth from day 1 to day 33 (11 April to 13 May 2002). M represents mulch and N no mulch

Soil temperature measurements taken at a depth of 10cm followed the same trend as measurements taken at a depth of 5cm (Fig. 2.1b).

Between 14 May and 21 June, the maximum soil temperature in non-mulched plots was higher than in mulched plots at 5cm soil depth (Fig. 2.1c). The average maximum soil temperature difference between mulched and non-mulched plots was about 5^0C. Compared to earlier in the season (Fig. 2.1a), there was a lot of temperature fluctuations in the non-mulched plots compared to the mulched ones (Fig. 2.1c). Therefore, mulching not only reduced day temperatures, but it also had a stabilising effect on the daily maximum temperatures.

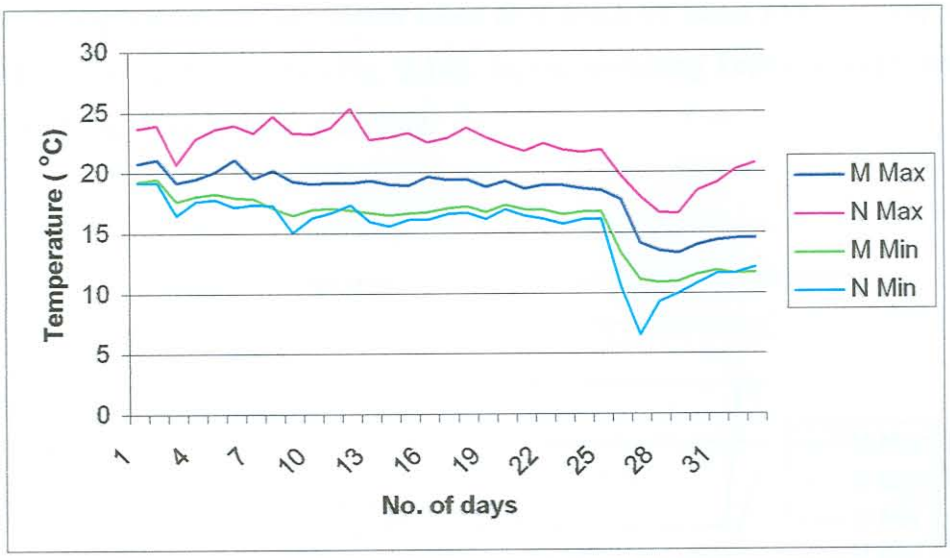

Fig. 2.1b Soil temperature data taken at 10cm soil depth from day 1 to day 33 (11 April to 13 May 2002). M represents mulch and N no mulch

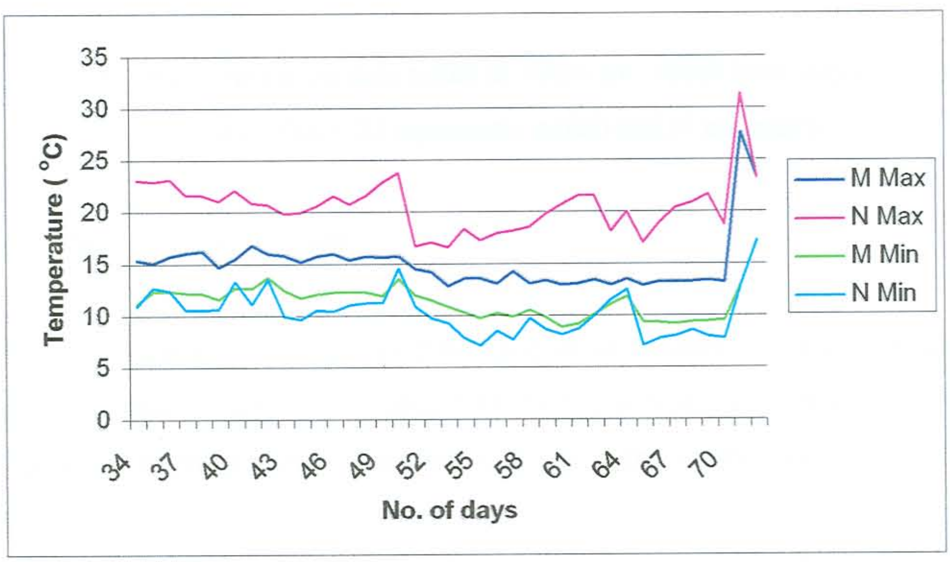

Fig. 2.1c Soil temperature data taken at 5cm soil depth from day 34 to day 71 (14 May to 21 June 2002). M represents mulch and N no mulch

Soil temperature measurements taken at a depth of 10cm followed the same trend as those taken at a depth of 5cm (Fig. 2.1d). Again, mulching kept minimum temperatures at night slightly higher than non-mulching.

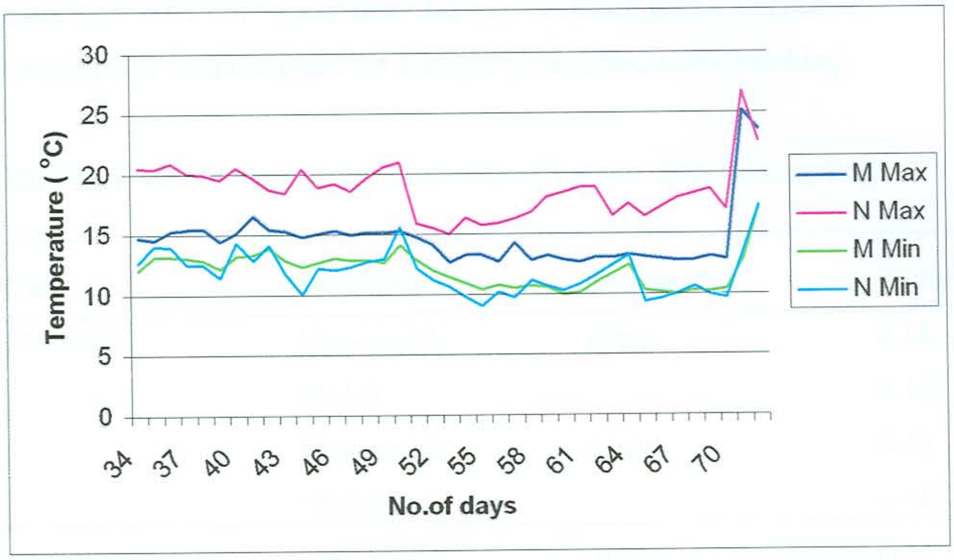

Fig. 2.1d Soil temperature data taken at 10cm soil depth from day 34 to day 71 (14 May to 21 June 2002). M represents mulch and N no mulch

2.3.2 Soil moisture content

At 10cm depth, there was no difference in soil water content between mulched and non-mulched plots on 29/04/02 (Table 2.1). At 15cm depth, mulching retained more soil moisture than non-mulching. There was about 0.03cm^3 extra moisture content retained by mulching.

At 10cm depth, mulching retained 0.01 cm^3 more water than non-mulching on 02/05/02 (Table 2.1). At 15cm depth, mulching had a stronger effect on soil moisture content because it retained 0.03 cm^3 more water than non-mulching. The difference in moisture content was higher with 15cm depth and lower with 10cm depth.

There was a big difference in soil water content within mulched and within non-mulched plots on 21/05/02 (Table 2.2). Mulching retained 0.05 cm^3 more water than non-mulched plots. There was a stronger difference between mulched and non-mulched plots on 22/05/02. Mulched plot retained 0.04 cm^3 more water than non-mulched plot. There was no difference in soil water content within mulched and within non-mulched plots on 23/05/02. Mulched plots kept 0.01 cm^3 water than did non-mulched plots. Therefore, mulching was effective in keeping soil water content for a longer period than non-mulching.

Table 2.1 Gravimetric water content (cm^3) at two days of sampling

Date	Mulching	Soil depth	Water content
29/04/02	Non-mulch	10cm	0.16
	Mulch		0.16
	Non-mulch	15cm	0.13
	Mulch		0.16
02/05/02	Non-mulch	10cm	0.11
	Mulch		0.12
	Non-mulch	15cm	0.12
	Mulch		0.15

2.3.3 Weeding

During the first weeding (31/01/2002), straw mulching significantly reduced the number of weeds compared to bare soil (Table 2.3a). A similar response was found by Ehrhardt (2003) where straw mulch was good in reducing the number of weeds, but weed seeds may come with it. Mulch always increased net return compared to hand-weeding, as the value of the increased yield with mulch more than made up for the increase in production costs (Hemphill & Crabtree, 1988).

Table 2.2 Gravimetric water content (cm^3) taken at soil depth of 15cm at three days in succession

Date	Mulching	Water content
21/05/02	Non-mulch	0.10
	Mulch	0.15
22/05/02	Non-mulch	0.10
	Mulch	0.14
23/05/02	Non-mulch	0.11
	Mulch	0.12

Non-mulching did not significantly suppress the emergence of weeds on 03/04/2002 (Table 2.3b). This can be due to lighter mulch on the plots, as it was long not added again. Therefore, the thinner the mulch, the lesser the effect on weeds.

There was a highly significant difference in weed mass between mulched and non-mulched plots with the combined or overall data (Table 2.3c). Mulching was highly effective in reducing the number of weeds in the plots.

Table 2.3a Weeds harvested on 31/01/2002

Treatment	Fresh weed mass (g)
Non-mulch	1136.7
Mulch	265.4
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Table 2.3b Weeds harvested on 03/04/2002

Treatment	Fresh weed mass (g)
Non-mulch	572.6
Mulch	382.3
	NS

Table 2.3c Combined data for the two sampling dates in Tables 2.3a and 2.3b

Treatment	Fresh weed mass (g)
Non-mulch	854.6
Mulch	323.8
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2.3.4 Initial fresh rhizome mass and circumference

Fresh rhizome mass and rhizome circumference were measured in all the rhizomes before planting to determine if they would influence measured parameters at harvest. At harvest, initial fresh rhizome mass and initial rhizome circumference measured before planting were found to be correlated with fresh rhizome mass, enlarged fresh root mass and rhizome circumference but not with root length. Therefore, where there were correlations, initial rhizome mass and rhizome circumference were linked with these parameters during statistical analyses. However, for simplicity, only data linked with initial fresh rhizome mass is reported.

2.3.5 Fresh rhizome mass

Spacing and mulching alone did not influence fresh rhizome mass (Tables 2.4a and 2.4b). However, the interaction between spacing and mulching was showing significance for fresh rhizome mass (Fig. 2.2). At 15 and 45cm spacing, fresh rhizome mass was greater with mulching than with non-mulching. However, at 30cm spacing, the opposite was true. Plants from non-mulched plots gave greater fresh rhizome mass than plants from mulched plots. Fresh rhizome mass at the spacing of 30cm in non-mulched plots was also significantly greater than at either 15 or 45cm spacings. In mulched plots, however, 15cm spacing gave greater fresh rhizome mass than either the 30 or the 45cm spacing. Therefore, optimum plant spacing was a function of mulching.

Table 2.4a Fresh rhizome mass as influenced by spacing

Spacing (cm)	Means (g)	Spacing (cm)	Means (g)	P value
15	10.50	30	11.13	0.5412^{NS}
15	10.50	45	8.94	0.2279^{NS}
30	11.13	45	8.94	0.1293^{NS}

Table 2.4b Fresh rhizome mass (g) as influenced by mulching

Mulching	Means	Mulching	Means	P value
Non-mulch	9.72	Mulch	10.63	0.3934^{NS}

2.3.6 Rhizome circumference

There were no interactions between spacing and mulching for rhizome circumference. Neither did spacing (Table 2.5a) nor mulching (Table 2.5b) affect rhizome circumference.

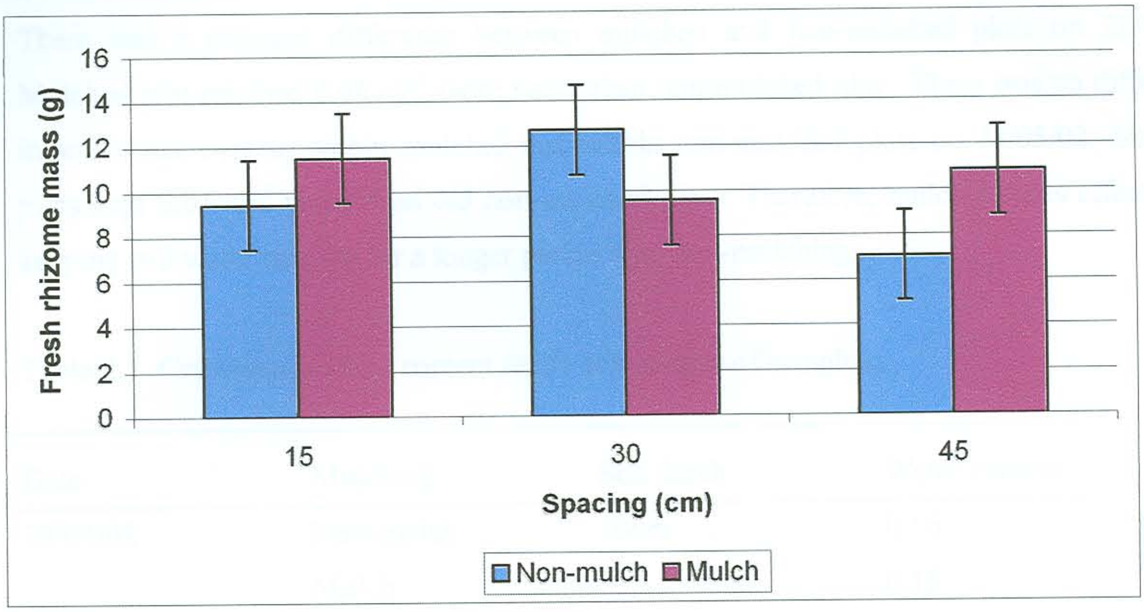

Fig. 2.2 Fresh rhizome mass as affected by mulching and non-mulching at three levels of spacing

Table 2.5a Rhizome circumference as influenced by spacing

Spacing (cm)	Means (cm)	Spacing (cm)	Means (cm)	P value
15	2.47	30	2.38	0.5388 ^{NS}
15	2.47	45	2.55	0.5767 ^{NS}
30	2.38	45	2.55	0.3389 ^{NS}

Table 2.5b Rhizome circumference (cm) as influenced by mulching

Mulching	Means	Mulching	Means	P value
Non-mulch	2.49	Mulch	2.44	0.6917 ^{NS}

2.3.7 Fresh enlarged root mass

There were no interactions between spacing and mulching for fresh enlarged root mass. Neither did spacing (Table 2.6a) nor mulching (Table 2.6b) affect fresh enlarged root mass.

Table 2.6a Fresh enlarged root mass as influenced by spacing

Spacing (cm)	Means (g)	Spacing (cm)	Means (g)	P value
15	14.55	30	14.90	0.7893 NS
15	14.55	45	13.18	0.3615 NS
30	14.90	45	13.18	0.3160 NS

Table 2.6b Fresh enlarged root mass (g) as influenced by mulching

Mulching	Means	Mulching	Means	P value
Non-mulch	13.58	Mulch	14.84	0.3185 NS

2.3.8 Enlarged root length

There were no interactions between spacing and mulching for enlarged root length. Neither did spacing (Table 2.7a) nor mulching (Table 2.7b) affect enlarged root length.

Table 2.7a Enlarged root length as influenced by spacing

Spacing (cm)	Means (cm)	Spacing (cm)	Means (cm)	P value
15	4.31	30	4.18	0.3659 NS
15	4.31	45	4.24	0.6621 NS
30	4.18	45	4.24	0.7558 NS

Table 2.7b Enlarged root length (cm) as influenced by mulching

Mulching	Means	Mulching	Means	P value
Non-mulch	4.34	Mulch	4.14	0.1262 NS

2.4 SUMMARY

An experiment was conducted to determine whether mulching and spacing were important in the production of wild ginger. Treatments used were mulching or non-mulching in combination with three levels of spacing. Wheat straw mulch was applied at a thickness of about 6cm and rhizomes were spaced at 15, 30 and 45cm.

Mulching was effective in reducing the soil temperature, keeping the soil moisture content for a longer period and suppressing weed growth. The main effects of mulching and spacing did not affect wild ginger growth, but interactions between mulching and spacing were significant. Plant spacing of 30cm with non-mulching was better than both 15cm and 45cm spacings. On the other hand, 15cm spacing with mulching was better than both 30cm and 45cm. There were no interactions between spacing and mulching for rhizome circumference, fresh enlarged root mass and enlarged root length.

This experiment demonstrated that 30cm spacing was ideal if no mulch is used. However, when mulch is used, a spacing of 15cm is recommended.