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THE EFFECT OF MULCHING PERCENTAGE AND WATERING FREQUENCY ON *Grevillea robusta SEEDLING PRODUCTION:* IN THE CASE OF KELEM MEDA NURSERY SITE, SOUTH WOLLO ZONE, ETHIOPIA[1]

EFEITO DA PORCENTAGEM DE MULCHING E DA FREQUÊNCIA DE MOLHAGEM NA PRODUÇÃO DE MUDAS DE *Grevillea robusta*: NO CASO DO VIVEIRO KELEM MEDA, ZONA SUL DE WOLLO, ETIÓPIA[1]

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ABSTRACT - *Grevillea robusta* is recognized by the pinnate and deeply lobed fernlike leaves, dark green adaxial, silky with whitish, by showy yellowish flowers clustered on and by black curved pod. Techniques of seed dormancy avoidance were written for different species by different authors. However, a combined effect of watering frequency and germination percentage for successful germination of *G. robusta* seed is scantly documented. Therefore, this study was conducted with the aim of evaluating the effect of mulching and watering frequency on seed germination, height and leaf number. The research design was factorial experiment in the arrangement of eight different treatments with three replications. The plot size was 1m by 1m and the spacing between plot and block were 0.4m and 1m respectively. The frequency of watering (w) and mulching (M) percentage results variation in height and germination percentage. M0% with watering in one day gap (w1), M0% with watering all day (wa), mulching above 75% and no mulching generally delay total germination percentages of seedling. The optimum mulching (%) and frequency of water for rate of normal seed germination was between mulching M25% wa to M50% wa. The optimum mulching and frequency of water for seedling height was attended at M50% wa. Therefore, the germination responses of seed of *G. robusta* vary as per mulching percentage and watering frequency it has. Further study on how mulching and watering frequency improve the soil microbial activity and temperature during seed germination of *G. robusta* species on the seedbed across Agroecology is needed.

Keywords: Leaf number; Seedling height; Seed germination; Silk oak; Silver oak.

RESUMO - *Grevillea robusta* é reconhecida pelas folhas pinadas e profundamente lobadas em forma de samambaia, adaxial verde escura, sedosas com esbranquiçadas, pelas vistosas flores amareladas agrupadas e pela vagem preta curvada. Técnicas de prevenção da dormência de sementes foram escritas para diferentes espécies por diferentes autores. No entanto, um efeito combinado de frequência de rega e porcentagem de germinação para germinação bem sucedida de sementes de *G. robusta* é pouco documentado. Portanto, este estudo foi conduzido com o objetivo de avaliar o efeito da cobertura morta e da frequência de rega na germinação, altura e número de folhas das sementes. O delineamento da pesquisa foi o experimento fatorial no arranjo de oito tratamentos diferentes com três repetições. O tamanho da parcela foi de 1m por 1m e o espaçamento entre parcela e bloco foi de 0,4m e 1m respectivamente. A frequência de porcentagem de rega (w) e cobertura morta (M) resulta em variação na altura e porcentagem de germinação. M0% com rega no intervalo de um dia (w1), M0% com rega o dia todo (wa), cobertura acima de 75% e sem cobertura geralmente atrasam as porcentagens totais de germinação das plântulas. A cobertura ótima (%) e a frequência de água para taxa de germinação normal das sementes foi entre cobertura morta M25% wa a M50% wa. A cobertura ótima e a frequência de água para altura de plântulas foram atendidas em M50% wa. Portanto, as respostas germinativas das sementes de *G. robusta* variam de acordo com a porcentagem de cobertura morta e a frequência de irrigação que possui. São necessários mais estudos sobre como a cobertura morta e a frequência de rega melhoram a atividade microbiana do solo e a temperatura durante a germinação de sementes de espécies de *G. robusta* no canteiro em Agroecologia.

Palavras-chave: Número de folhas; Altura de plântulas; Germinação de sementes; Carvalho de seda; Carvalho de prata.

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1 INTRODUCTION

Over the last century, *Grevillea robusta* (silky oak), has widely planted in subtropical and tropical highland environment of eastern and central Africa, south and central America, and south Asia (Orwa et al., 2009; Harwood, 1992; Kalinganire, 1994). *Grevillea robusta* is a popular species for farm plantings in the eastern and central Africa highlands including Ethiopia. In Africa, it is grown mainly as shade tree for tea, coffee plantation (Nesper et al., 2017), fuel wood and timber products (Owate et al., 2018).

The demand by farmers for *Grevillea robusta* seedlings is increased from time to time. However, the availability of properly germinated seedling is often a limiting factor for current planting programs in most eastern and central African countries (Harwood, 1989). As a result, understanding the factors influencing seed and seedling production has important practical applications for genetic improvement (Harwood et al., 2001).

Unlike recalcitrant and intermediate seeds (Ballesteros et al., 2021), seeds of *Grevillea robusta* can be stored conventionally (Getachew and Derero, 2011). Seed coat (a defensive external coverage) plays a critical role in the process of seed germination. If the seed coat able to transfer temperature, oxygen and air to the embryo, seed germination process is starts. Seed germination is a mechanism in which morphological and physiological changes result in embryo activation (Miransari and Smith, 2014). In the seed germination method, water is retained by the embryo, which occurs during rehydration and development of the cells (Bradford, 1990). After imbibition, the respiratory rate increases and various metabolic forms that are exposed or greatly reduced in the midst of drowsiness increase again. These occasions are relate to fundamental changes within the organelles (membrane bodies that deal with the digestive system) of developing life (Heslop, 2018; Malarney et al., 2019).

The above mentioned process is achieved if and only if the hard cover of tree seed is broken. Previously, Scientists were used different seed coat dormancy avoidance techniques for different species. This includes: Scarification, exposure to light, pressure application (Padmavati et al., 2017), gibberellic acid (GA3,250 ppm) application (Padmavati et al., 2017; Masilamani and Dharmalingam, 2002), pre chilling (Andriamparany and Buerket, 2019; Rusdy, 2017), pre washing, pre heating (Koutouan-kontchoi et al.,2020; Koutouan-kontchoi et al.,2020), pre-soaking (Masilamani and Dharmalingam, 2002; Xia et al., 2002; Neelambari et al., 2018; Siddique et al., 2018), Smoke treatment, hot water treatment, tissue culture, microbial inoculation and mulching (Liang et al., 2002), Increasing watering frequency (Domenech and Vila, 2007) , preventing inhibitors from exiting the embryo (the inhibitor exit model), limiting water uptake (the water-impermeable model), and limiting oxygen uptake (the oxygen diffusion model) (Mvila et al., 2016).

Through keeping constant other factors, in areas where there is high soil temperature and low soil moisture content, mulching of the seed bed improves the germination of tree seeds. The types of material where mulch consists (organic and inorganic) and their thickness/depth is critically influence seed germination as well as plant growth (Liang et al., 2002). Though this is the fact, the impact of mulching percentage in combined with watering frequency on the number of leaf, growth of seedling and germination of seed *G. robusta* is scantly documented. This is true in south Wollo zone Dessie zuriya Wereda. Therefore, this paper was aimed to solve the above mentioned combined factors on the stated parameters of *G. robusta* seed.

2 MATERIAL AND METHODS

2.1 Description of the study area

The experiments were conducted at south Wollo zone Dessie zuriya Wereda during the dry season in 2016 at kelem meda nursery site (Figure 1). The experiment area is found in 11º10’49.69’’N to 11º10’51.02’’N latitude and 39º36’58.14’’E to 39º37’0.08’’E longitude at altitude ranges from 2616.6 to 2622.7 m.a.s.l. The area was situated in Wollo administrative zone of Amhara region states of Ethiopia. It is 410 km far from Addis Ababa and 6 km far from Dessie town in North east Direction. It received maximum 1800 mm and minimum 1036 mm mean annual rain full. The mean annual minimum and maximum temperature was 12.44ºC and 26.87ºC, respectively. The soil of the area was characteristically range from heavy to light texture and pH was about 6.5.

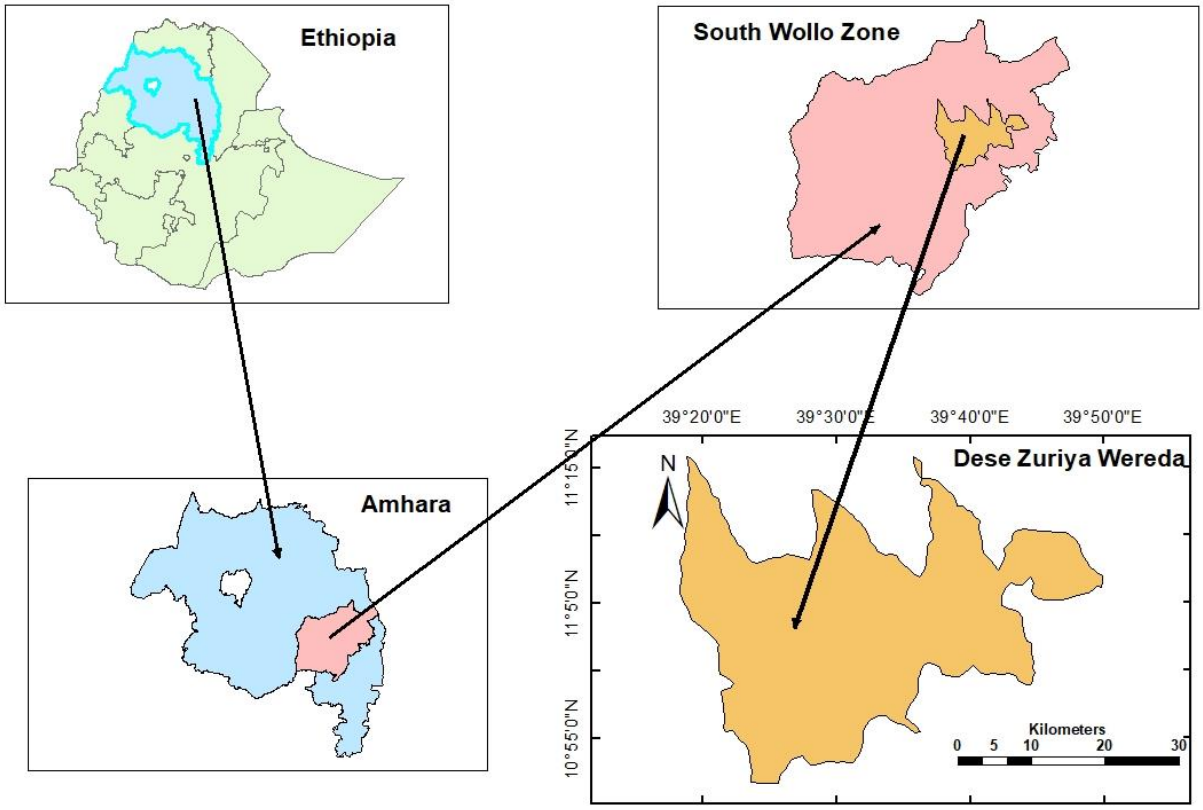

Figure 1. Study area map.

Figura 1. Mapa da área de estudo.

3 METHODS

3.1 Experimental design

The design of an experiment was randomized complete block design (RCBD) in the factorial arrangement of eight different treatments with three replications. The plot size was 1 m × 1 m. Spacing between plot and block was 0.4 m and 1m respectively. 10 cm boarder effect was considered during randomization. The mulch material was grass (organic mulch). The experiment was done during the dry season (February to April). The area of the field was 10.8 m by 5 m with total area of 54 m^2.

In the study area, farmers traditionally used 20 cm grass straw as a mulching material for their seed beds. Based on the farmers' traditional practice (75% mulching and watering the seed bed once a day (control treatment) very few seed of *G. robusta* were germinated. To alleviate such problem different treatments were used. First, out of 20 cm grass straw, 0%, 25%, 50% and 75% mulching were taken and used separately. Then this separate mulching percentage was combined with different watering frequency and considered as a treatment for this experiment (Figure 2).The treatments were zero percent mulching and watering of the bed throughout the week (M0% wa), zero percent mulching and watering the bed in one day interval (M0%w1), twenty five percent mulching and watering the bed throughout the weeks (M25%wa), twenty five percent mulching and watering the bed in one day interval (M25%w1), fifty percent mulching and watering the bed throughout the weeks (M50%wa), fifty percent mulching and watering the bed in one day interval (M50%w1), seventy five percent mulching and watering the bed throughout the week (M75%wa)and seventy five percent mulching and watering the bed in one day interval (M75%w1 control treatment) (Figure2).

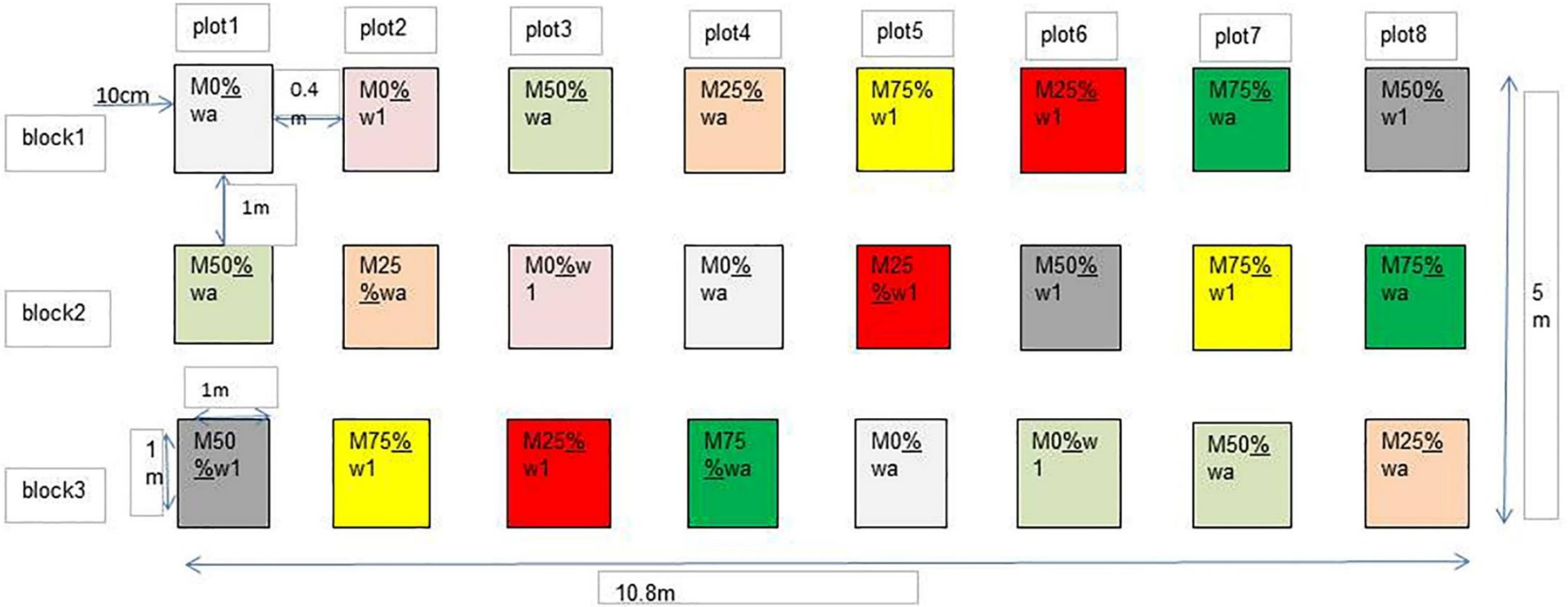

Figure 2. Picture of field lay out.

Figura 2. Layout do campo.

3.2 Method of planting

The nursery of the university which has an area of 54 m2 was used. The seed beds were prepared by using nursery equipment's like spade, shovel, pick-axe, furrow-opener, hand levelers, kudali, knife and pots. All the cultural practices were applied. The seed were sown on the seed bed in rows.

3.3 Method of data collection and analysis

The effect of mulching and frequency of watering on different parameters like seed germination (the sprouting of seedling from a seed of angiosperm or gymnosperm), seedling height (the vertical distance between the ground and the living central apex) and number of leaves were collected. Seedlings were taken randomly from each rows in each plots and their height, numbers of leaves and germination percentage were measured. These data were recorded within seven day intervals for two consecutive months. The data were analyzed by using statistical software (SPSS). Every treatment group mean should be compared to a control mean rather than every pairwise comparison. Therefore, general linear model multivariate Dunnett's correction post hock analysis at 5% level of significance was done.

4 RESULTS AND DISCUSSIONS

4.1 Effects of mulching and frequency of watering on leaf number

In comparison of treatment mean with control mean, the presence and absence of mulching percentage and frequency of watering at different level weren't shown statically significant difference on the number of leaf of G. robusta (Table 2). Though the difference is statically insignificant, the maximum and minimum number of leaf were observed under treatment M50%wa and M0%w1 respectively (Figure 3, Table 1).

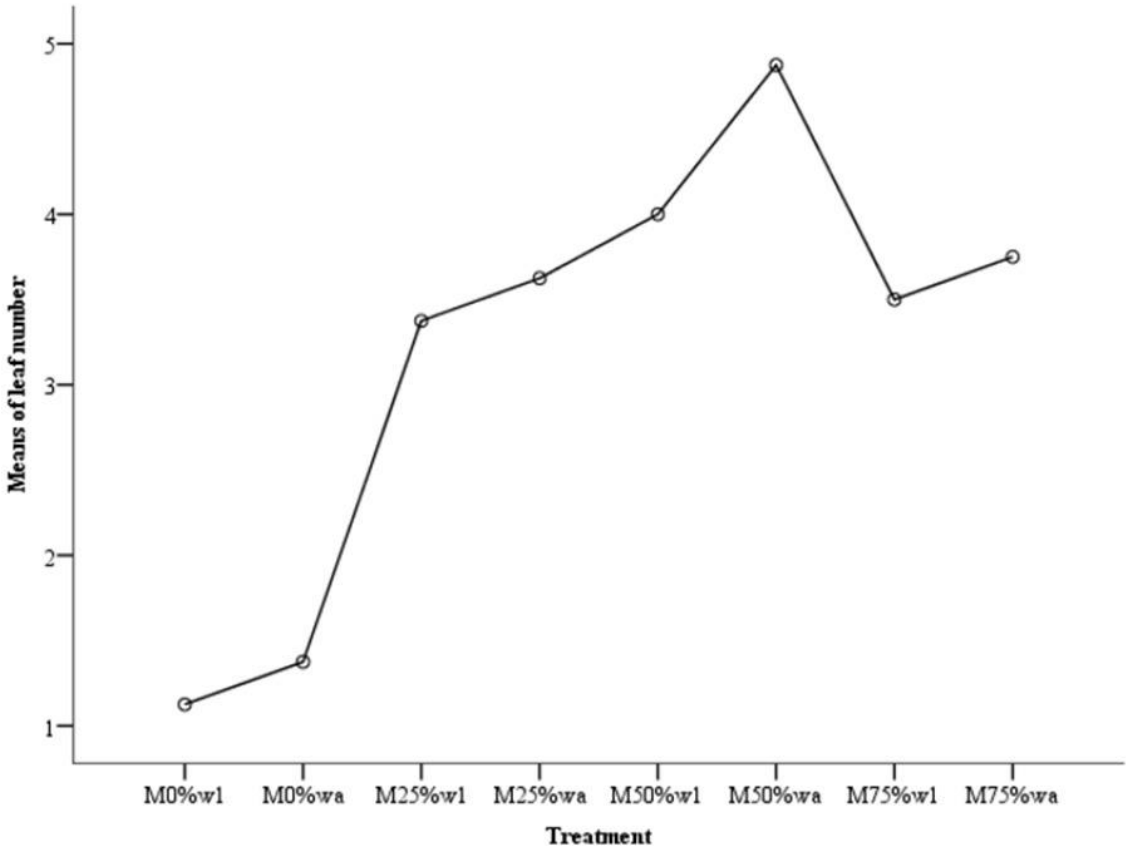

Figure 3. Effect of mulching percentage and watering frequency on leaf number.

Figura 3. Efeito da porcentagem de cobertura morta e frequência de irrigação no número de folhas.

Table 1. Estimated marginal mean.

Tabela 1. Média marginal estimada.

Dependant variable	Treatments	Mean ± SD	95% Confidence Interval
GP (%)	control	6.25±1.49	(5.69,6.81)
	M0%w1	0.83±0.19	(0.28,1.39)
	M0%wa	0.83±0.19	(0.28,1.39)
	M25%w1	5.84±0.78	(5.28,6.39)
	M25%wa	11.68±0.82	(11.12,12.23)
	M50%w1	7.55±0.24	(6.99,8.11)
	M50%wa	16.256±0.45	(15.7,16.81)
	M75%wa	8.75±1.04	(8.19,9.31)
leaf number	control	3.5±2.83	(1.35,5.65)
	M0%w1	1.13±1.64	(-1.03,3.28)
	M0%wa	1.38±2.07	(-0.78,3.53)
	M25%w1	3.38±2.62	(1.22,5.53)
	M25%wa	3.63±2.97	(1.47,5.78)
	M50%w1	4±3.59	(1.85,6.15)
	M50%wa	4.88±4.49	(2.72,7.03)
	M75%wa	3.75±3.2	(1.6,5.9)
seedling height (cm)	control	4.12±0.17	(3.84,4.41)
	M0%w1	0.39±0.14	(0.1,0.67)
	M0%wa	0.86±0.24	(0.57,1.14)
	M25%w1	3.73±0.74	(3.45,4.01)
	M25%wa	4.24±0.38	(3.96,4.52)
	M50%w1	4.31±0.34	(4.03,4.6)
	M50%wa	5.17±0.32	(4.89,5.46)
	M75%wa	4.63±0.51	(4.35,4.91)

4.2 Effects of mulching and frequency of watering on germination percentage of *Grevillea robusta* seed

Germination percentage (GP) was calculated according to the following formulas.

$$GP = \frac{n}{N} \times 100$$

Where:
n= total number of seed germinate per plot;
N= total number of seed in the sample.

In this study, seed germination of *Grevillea robusta* were began 21-35 days after sawing and completed within 42-47 days in the treatment including M50%wa, M25%wa, M75%wa, M50%w1, M75%w1 and M25%w1. This might be related with the presence of sufficient moisture which was saved by mulching. Frezghi et al. (2021), Sharma and Bhardwaj (2017) and Kader et al. (2017) reported that mulching improves the soil moisture content via preventing the soil surface from incoming solar radiations. Teame et al. (2017) also investigated that the use of organic much had significantly improve the soil moisture content. This result was similar to Jones (1967) and Moslem et al (2014) finding. As they described, the seed germination of *Grevillea robusta* was occurred between two and four weeks on average of three week under optimal condition. Comparison of all except treatment M25%w1 with control group (M75%w1) had shown a statistically significant different result (Table 2).

Table 2. Post Hock Multiple Comparison.

Tabela 2. Comparação múltipla de Post Hock.

Multiple Comparisons

Dunnett t (2-sided)

Dependent Variable	(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
GP (%)	M0%w1	control	-5.4188*	0.39188	0.00	-6.4754	-4.3621
	M0%wa	control	-5.4188*	0.39188	0.00	-6.4754	-4.3621
	M25%w1	control	-0.4125	0.39188	0.825	-1.4692	0.6442
	M25%wa	control	5.4250*	0.39188	0.00	4.3683	6.4817
	M50%w1	control	1.3000*	0.39188	0.01	0.2433	2.3567
	M50%wa	control	10.0062*	0.39188	0.00	8.9496	11.0629
	M75%wa	control	2.5000*	0.39188	0.00	1.4433	3.5567
Leaf number	M0%w1	control	-2.38	1.519	0.469	-6.47	1.72
	M0%wa	control	-2.13	1.519	0.585	-6.22	1.97
	M25%w1	control	-0.13	1.519	1.00	-4.22	3.97
	M25%wa	control	0.13	1.519	1.00	-3.97	4.22
	M50%w1	control	0.5	1.519	1.00	-3.6	4.6
	M50%wa	control	1.38	1.519	0.904	-2.72	5.47
	M75%wa	control	0.25	1.519	1.00	-3.85	4.35
Seedling height (cm)	M0%w1	control	-3.735000*	0.199942	0.00	-4.27413	-3.19587
	M0%wa	control	-3.265000*	0.199942	0.00	-3.80413	-2.72587
	M25%w1	control	-0.3925	0.199942	0.243	-0.93163	0.146627
	M25%wa	control	0.11875	0.199942	0.988	-0.42038	0.657877
	M50%w1	control	0.19125	0.199942	0.879	-0.34788	0.730377
	M50%wa	control	1.051250*	0.199942	0.00	0.512123	1.590377
	M75%wa	control	0.50875	0.199942	0.072	-0.03038	1.047877

Based on observed means.

The error term is Mean Square (Error) = .160.

*. The mean difference is significant at the .05 level.

a. Dunnett t-tests treat one group as a control, and compare all other groups against it.

Com base em médias observadas.
O termo de erro é Média quadrada (Erro) = .160.
*. A diferença média é significativa no nível de 0,05.
a. Os testes t de Dunnett tratam um grupo como um controle, e comparam todos os outros grupos com ele.

For most *G. robusta* seeds, the rapid and highest germination percentage were occurred at M50%wa. The lowest germination percentage were happened at M0%wa and M0%w1 (Figure 4). It might be due to the absences of mulching and sufficient moisture. Less amount of water loss by evaporation might contribute to such germination percentage. Mulching and watering the seed bed stabilize the amount of soil temperature and moisture required for seed dormancy avoidance (Moslem et al., 2014; Mechergui et al., 2021). Mollard et al. (2014) also support this study in that high mulching of the seed bed in comparison with no mulch significantly reduces daily and weekly average soil temperature needed for seed germination.

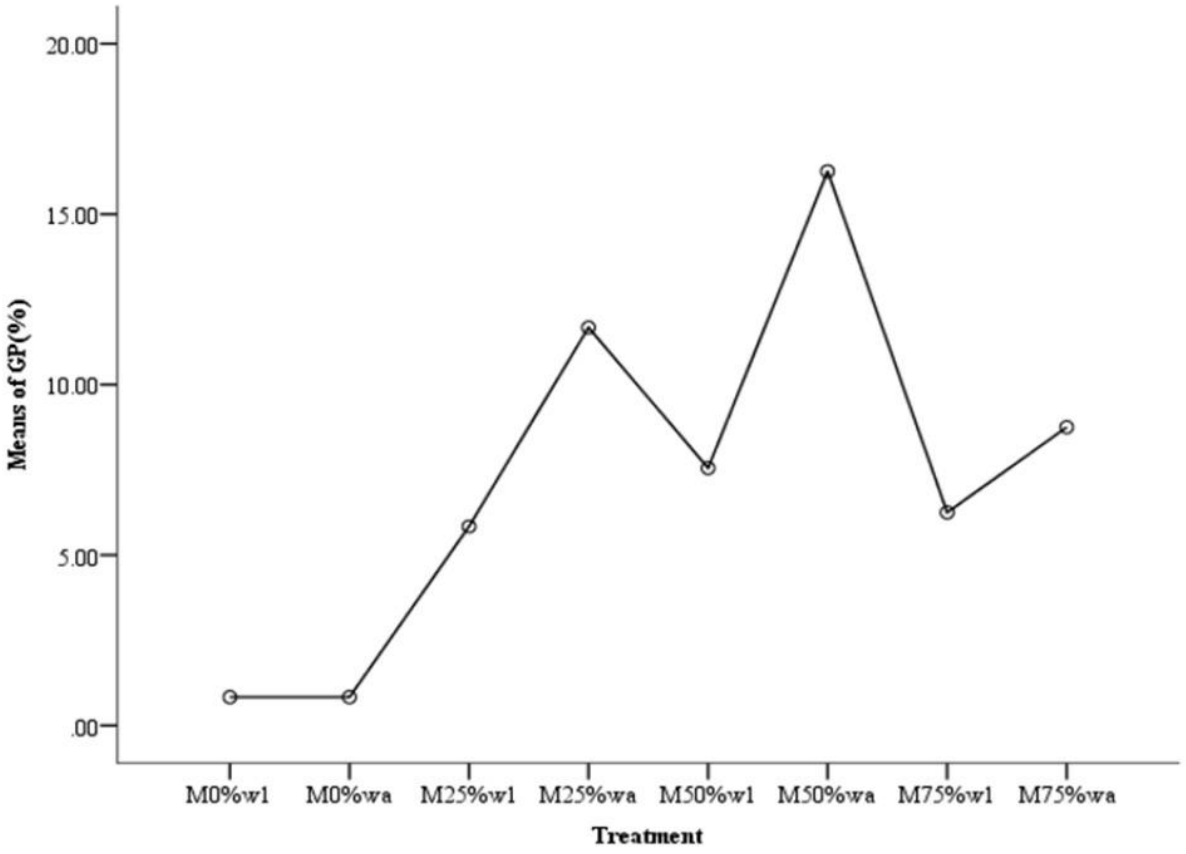

Figure 4. Effect of mulching percentage and watering frequency on seed germination.

Figura 4. Efeito da porcentagem de cobertura morta e frequência de irrigação na germinação das sementes.

4.3 Effects of mulching and frequency of watering on seedling height

The effect of mulching and frequency of watering on Grevillea robusta seedling height were recorded until 8th week after sowing. Survived seedling height was measured according to the following formula which was used by Gardiner et al. (2019).

$$\text{seedling height} = \frac{\text{height}_{\text{t1i}} - \text{height}_{\text{t0i}}}{\text{t1i} - \text{t0i}}$$

Where:

t0i=the date that seedling i was initial mapped and measured;

t0i=the date that seedling i was re-measured;

Seedling height was expressed in the unit of centimeter per day (cm/day).

Statistical difference in height growth of seedling *G. robusta* were observed in comparison of treatment M0%wa, M0%w1, and M50%wa with control group (Table 2). The difference in moisture retention capacity and temperature of soil, reduction of leaching of nutrient under different mulching percentages and watering frequency might relate to such variations. This finding is in argument with Frezghi et al. (2021), Thakur et al. (2000) and Ojeniyi et al. (2007).

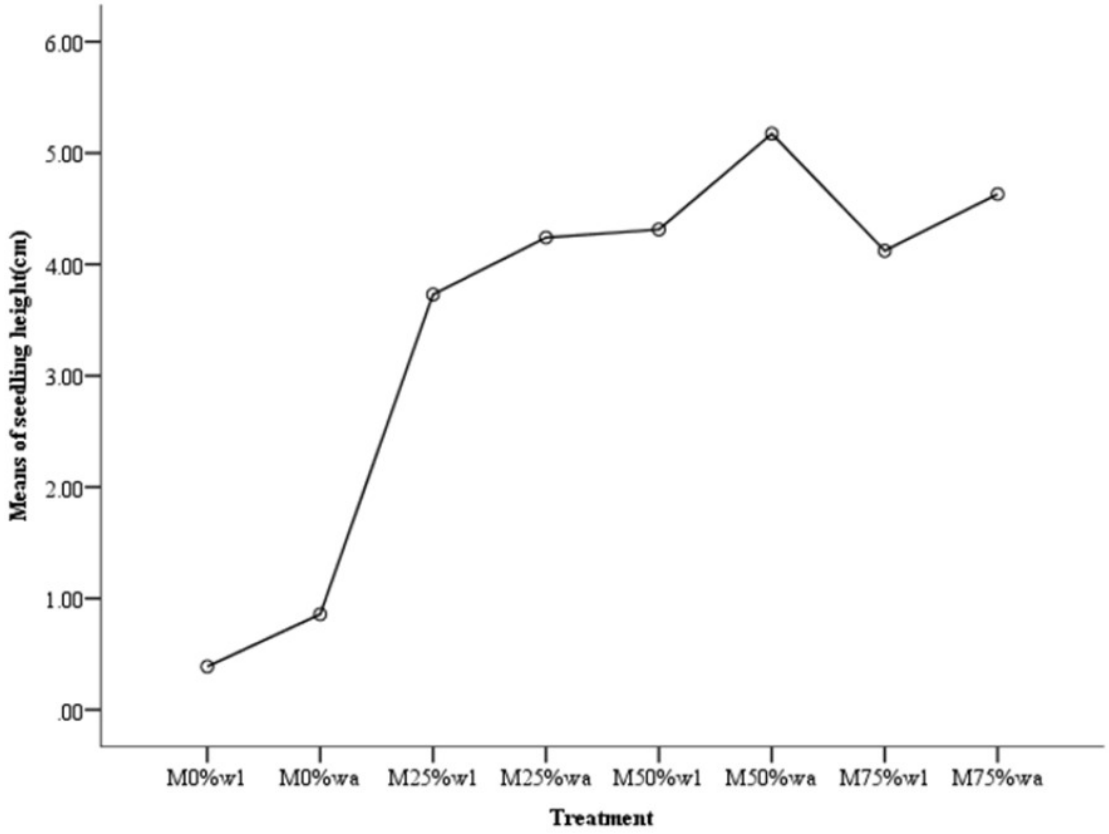

Figure 5. Effect of mulching percentage and watering frequency on seedling height.

Figura 5. Efeito da porcentagem de cobertura morta e frequência de irrigação na altura das mudas.

The tallest and shortest height of *Grevillea robusta* seedlings were recorded at M50%wa and M0%w1 respectively (Figure 5). Absence of sufficient moisture and presence of high evapotranspiration as well as improved soil temperature (environmental factors) might results for different seedling height of the same species. This result was in comparison with Hudu et al. (2002).

4 CONCLUSIONS

From the current study it was concluded that, mulching percentage and watering frequency had significant impact on seed germination and seedling height. 50% mulching (grass cover) and watering of the seed bed regularly at all day had shown better in seed germination percentage and seedling height growth than the farmers' practice of seed germination (75% mulching and watering the seed bed at one day interval in the week). Finally, it was concluded that optimum mulching percentage and watering frequency is a viable strategy for improvement of *G. robusta* seed germination and should be pursued vigorously. The impact of integrated factors (different mulching material-watering frequency) on the improvement of soil organic matter, microorganism as well as on how to create optimum soil temperature for seed germination of *G. robusta* species across different soil types and depth is needs further studies.

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