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Improving seed germination and seedling growth of maize (*Zea mays,* L.) seed by soaking in water and *moringa oleifera* leaf extract

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A B S T R A C T

Germination traits are the key factor in higher productivity of crops. Thus, laboratory tests were made to enhance the germination of the seeds. One of the best strategies to promote seed germination was soaking the seeds in water and Moringa leaves extracts (MLE.) before planting. This experiment was carried out to evaluate the optimal soaking duration to enhance seed germination and seedling growth of hybrid 178 maize. There were three soaking durations; 12 hours, 16 hours, and 20 hours, along with the un-treatment (0 hour or without soaking). While the other factor was the concentration of the soaking seeds solution in Moringa leaves extract which was (0.25, 0.5 and 1.00 g) at the ratio of 1:10 (w/v) beside to hydro-priming (soaking in water) and control (un-treatment), each with four replications. Seed germination (%), germination index (GI), germination speed index (SGI), germination rate (GR, day), mean germination rate (MGR, day), seedling shoot length (cm), seedling root length (cm), seedling length (cm), seedling fresh weight (g), seedling dry weights, (g) seedling vigor 1 (SV1) and seedling vigor 2 (SV2) were evaluated. Results showed that maximum value germination traits were found in hybrid 178 of Maize which soaked at 20 hours of duration, followed by soaked at 16 hours then at 12 hours soaking compared with un-soaked seed. The germination and seedling characters, improved with soaking in Moringa leaves extract. 0.25 g/mm MLE. was the best treatment, followed by 0.5 (g) and hydro-priming gave higher values, as to seed germination and seed vigour compared with other treatment. Field emergence experiment gave the best values for dry weight(g) and seedling vigour (SVII) with 0.25 g/mm then 0.5 g/mm and hydro-priming under soaked seed to 20 hour com. This suggests that soaking in Moringa leaves extract as 0.25 concentrate under 20 hour soaking was a suitable treatment that can improve germination and seedling growth in hybrid 178 maize.

1. Introduction

Different applications for organic compounds in agriculture and other fields are well-known.[1-18] Seed priming is a pre-soaking treatment which aids in the physiological process that allows seeds to germinate more efficiently. Priming techniques such as hydro-priming, osmo-priming, chemical priming, hormonal priming, and biological priming have all been used. Seed priming is a low-cost technique that involves soaking the seeds in a solution for a specific amount of time after which they are hydrated to allow the metabolic process of germination to occur while preventing the emergence of radicals. The seeds perform well under both normal and stressful conditions.

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Germination stage is a direct indicator of higher crop production. The main focus for increased maize productivity is to promote maize germination. [39] reported that prolonged germination duration could result in late emergence of seedlings as a result of direct interaction with soil-borne pathogenic bacteria. The amount of oxygen and light supplied by the soil, as well as other edaphic factors. Most farmers believe that pre-soaking seed in water before planting improves germination.[28] Soaking seeds in water aims to reduce the lag-phase in seedling germination, which can harm seedlings and result in a noticeable decrease in crop productivity.

Soaking seed prior to planting reduced the negative effects of high temperatures and improved seed germination. Furthermore, it provides a sufficient amount of moisture content to the seed, which may improve germination rate.[30] Some tree extracts and crop residues have been shown to influence crop growth and yield.[29,22, 26] M. oleifera leaf extract has been shown to accelerate plant growth in the early stages, strengthen plants, improve resistance to diseases and pests, increase leaf area duration, produce larger and more fruits, and increase overall yield productivity by 20 to 35 percent.[31] With high global prices for inorganic fertiliser, water pollution and land degradation associated with inorganic fertiliser use, and the contribution of climate change, there is a need to search for alternative plant nutrient sources. Moringa is one of the important alternatives being studied to determine its effect on crop growth and productivity, so that M. oleifera can be improved as a possible supplement or substitute for inorganic fertiliser, and it has begun to be promoted as a multipurpose plant among farmers.[45] Moringa leaf extract was sprayed on the leaves of bell pepper, soyabeans, onions, sorghum, tea, melon, maize, and chilli, and it increased crop yield.[31] MLE application has proven to be an extremely valuable source of plant growth-promoting substances. Moringa oleifera extracts are either used as a seed priming agent or as a foliar spray to promote growth.[40, 43]

The purpose of this study was to compare the effect of soaking in M. oleifera leaf extracts on germination traits and early seedling growth of hybrid 178 maize in Egypt to soaking in water and untreated seed (control).

2. Material and Methods

Experiments of laboratory and field emergence were conducted at the Seed Tech. Res. Laboratory, Seed Technology Research Department, Field Crops Research Institute, Agriculture Research Center, and at Greenhouse of Agriculture Research Center, Giza, Egypt. The study aims to evaluate the effect of seed soaking durations (control, 12, 16 and 20 hours) under different concentration (0.25 , 0.50 and 1.00 g at the ratio of 1:10 (w/v) from Moringa leaves extract) beside to soaking in water only (hydro-priming) and control (untreated seed) on germination parameters, seedling vigor and field emergence of maize (*Zea maize* ,L.). The experiment was laid out in completely randomized design (CRD) with four replications. Maize seeds (hybrid 178) were obtained from Maize Research Department, FCRI, ARC. Experiment was artificially created in the sterilized Petri dishes. Four replicates of 20x5 seeds each from every treatment were planted in 15-cm diameter Petri dishes moistened with distilled water, incubated in a growth chamber at 25ºC and laid in factorial Completely Randomized Design (CRD). Normal seedlings were counted and then germination percentage was calculated according to the rules outlined before.[35]

2.1 Preparation of MLE

Fresh M. oleifera leaves were air-dried before being processed into powder. The crude powders were kept at room temperature in paper bags. Moringa leaves powder was soaked in distilled water for 24 hours at room temperature (20 ± 2ºC) with intermittent shaking to obtain stock moringa leaves extract (0.25, 0.5, and 1 g at a ratio of 1:10 (w/v) turn to 100mm). To eliminate fibre debris, the mixture was filtered through four layers of cheesecloth, followed by Whatman No.1 filter paper. In addition to the control (distilled water), three different concentrations of MLE (i.e., 0.25, 0.5, and 1 g at a ratio of 1:10 (w/v) turn to 100mm) were created. The mineral content and chemical composition in Moringa leaf extract were summarized in **Table (1 and 2)**.

Table 1. The mineral contents of Moringa Leaf Extract (MLE).[33]

Mineral contents (mg/100g.d.wt)							
Essential macro-elements					**Essential micro-elements**		
N (g/100g)	P	k	Mg	Ca	Fe	Cu	Zn
1.78	9.7	2.8	3.5	1.28	1.18	0.87	2.46

Table 2. Chemical composition analysis of moringa leaf extract.[19]

Chemical composition	**(mg/100g. d.wt)**	**Chemical composition**	**(mg/100g. d.wt)**
Water	5.90	**Ascorbic acid**	3.26
Protein	27.20	**Total carotenoids**	2.24
Fiber	19.20	**Soluble phenols**	2.24
Total sugar	38.60	**Gibberellins**	0.802
Lipids	17.10	**Zeatin**	0.936

2.2 Seed preparation

To remove any traces, seeds were disinfected for 5 minutes with a 0.1 percent $HgCl_2$ solution before being rinsed 5-6 times with distilled water. This was achieved by randomly selecting 20 viable seeds from each replicate and soaking them in each MLE treatment solution and hydro-priming them for 12, 16, and 20 hours before rinsing them with distilled water and air drying them for 24 hours before planting them in the laboratory.

Four replications of 100 seeds (each replicate 5 times x20 seeds) of treated and untreated maize seeds were sown in each sub replication in sterilised Petri dishes covered at the bottom with two sheets of Whitman filter paper, then placed in an incubator at 25±2°C for 7 days, according to ISTA rules.[39] The total number of seeds that germinated was tallied every day, and the percentage was computed on the seventh day. Germination (%): (The number of germinated seeds/The total number) × 100.

Germination speed test: For each replicate, seeds were inspected daily and considered germinated following radical emergence. The seeds that had germinated were counted and removed from the Petri dishes. Speed Germination Index (SGI), it was calculated as described in the Association of Official Seed Analysis[23] by following formula:

SGI = (No. of germinated seed/days of first count) + (…. /….) + (No. of germinated seed/days of final count). When the radical of a seed was at least 2 mm long, it was deemed germinated.

Germination Rate (GR), it was defined according to the following formula:

GR= a + (a +b) + (a + b + c)…. (a + b + c + m)/ n (a + b + c + m). Where a, b, c are No. of seedlings in the first, second and third count, m is no. of seedlings in final count, n is the number of counts.[25]

Mean Germination Time (MGT), it was calculated based on the following equation: MGT= Σ Dn/ Σn, where (n) is the number of seeds which were germinated on day (D) is number of days counted from the beginning of germination.[27]

Ten normal seedlings were used to measure seedling root and shoot length (cm) at 7 days after soaking. While ten typical seedlings were measured for fresh and dry weight (g) 7 days after planting, the seedlings were dried in a hot-air oven at 85^o C for 12 hours to determine the seedlings dry weight (g).

The product of the germination percentage, seedling length, and seedling dry weight was used to calculate seedling vigour. Seedling vigour was estimated as follows:
Vigour index I = Germination (%) x Seedling length (Root +Shoot).
Vigour index II = Germination (%) x Seedling dry weight (Root +Shoot).[20]

2.3 Field emergence experiment

Field emergence (percent), seedling dry weight, and seedling vigour after 14 days from planting were all tested characters in a screen house experiment.

2.4 Statistical analysis

Statistical analysis of the results was performed using analysis of variance ANOVA and least significant differences (L.S.D.) were obtained using ANOVA tables.[48]

3. Results

Soaking of seeds in different times (12, 16 and 20 hour), resulted in a significant effect on the germination traits compared to- non soaking seed as shown in **Table (3)**. The seed germination increased to 14.2, 13.6 and 13.2 % for 20, 16 and 12 h receptively, compared with non-soaked seed. Soaking at 20 h was the best compared with other treatments. The results indicated that Germination Rate (GR; day) was significant and increased to 11.5, 7.7 and 5.7 % by 20, 16 and 12 h soaking, respectively. While, it was decreased the mean germination time with soaking treatments to 3.0 for 20 h, 3.2 for 16 h and 3.2 for 12 h compared with control which was 3.3. However, the speed germination index was significant between all treatments; the higher speed germination was increased by 20.1 % to 20 h then 17.4 to 16 h then 15.0 to 12 h.

Table 3. Effect of different soaking durations on the germination traits of maize seeds.

Soaking duration	GP (%)	Increase% over control	GR/day	Increase% over control	MGT/ day	Increase % over control	SGI	Increase % over control
12 hour	80.3 b	13.2	0.55 b	5.8	3.2 a	-5.3	15.3 b	15.0
16 hour	80.5 ab	13.5	0.56 b	7.7	3.2 a	-5.6	15.7 ab	17.4
20 hour	81.0 a	14.2	0.58 a	11.5	3.0 b	-7.3	16.0 a	20.1
Control	70.9 c	–	0.52 c	–	3.3 a	–	13.3 c	–
F test	**		**		**		**	
LSD $_{5\%}$	**0.56**		**0.013**		**0.06**		**1.77**	

GP: Germination Percentage, GR: Germination Rate, MGT: Mean Germination Time, SGI: Speed Germination Index.

Soaking duration significantly affected the seedling characters of hybrid 178 maize. Seedling characters (shoot, root and seedling length) were recorded lower values with unsoaked seeds while, it gave higher value with seed soaking at 20 h ,which were increased to 21.0, 19.2 and 22.7% for shoot, root and seedling length respectively, comparing with 16 h (16.3% for shoot, 15.0% for root and 18.0% for seedling), and 12 h soaking which was (13.4% for shoot, 9.0% for root and 13.9% for seedling) **(Table 4)**.

Data in **Table (5)** showed that soaking treatments had an effect on seedling fresh and dry weight. However, heavier fresh seedling was achieved by soaking 24.0, 20.8 and 12.5% for 20, 16 and 12 h respectively, whereas minimum fresh weight was recorded for non-soaked seeds. The same trend with dry weight which recorded higher values 25.0, 20.0 and 15.0% with 20, 16 and 12 h respectively compared with control.

Maximum seedling vigor increase was obtained in seed soaking for 20 h, which was 22.8% and 17.0% for SV1 and SV2 respectively. Followed by 16 h was increased to 11.7% and 14.8 % for SV1 and SV2 respectively then 12 h was 6.2% and 12.1% with SV1 and SV2 respectively compared with control (non-soaked) **(Table 5)**.

Table 4. Effect of different soaking durations on the Seedling length (cm) of maize seeds.

Soaking duration	Seedling length (cm)					
	Shoot length	Increase% over control	Root length	Increase% over control	Seedling length	Increase % over control
12 hour	12.5 a	13.4	7.1 ab	9.0	19.6 b	13.9
16 hour	12.8 a	16.3	7.5 a	15.0	20.3 a	18.0
20 hour	13.3 a	21.0	7.8 a	19.2	21.1 a	22.7
Control	11.0 b	–	6.5b	–	17.2 c	–
F test	**		**		**	
LSD $_{5\%}$	1.00		0.72		1.21	

Table 5. Effect of different soaking durations on the Seedling weight (g) and Seedling vigor of maize seeds.

Soaking duration	Seedling weight (g)				Seedling vigor			
	Fresh	Increase% over control	Dry	Increase% over control	SV1	Increase % over control	SV2	Increase % over control
12 hour	1.08ab	12.5	0.23 a	15.0	1637.0 bc	6.2	20.4 ab	12.1
16 hour	1.16 a	20.8	0.24 a	20.0	1721.6 ab	11.7	20.9 a	14.8
20 hour	1.19 a	24.0	0.25 a	25.0	1891.6 a	22.8	21.3 a	17.0
Control	0.96 b	–	0.20 b	–	1541.1 c	–	18.2 b	–
F test	**		**		**		**	
LSD $_{5\%}$	**0.19**		**0.029**		**171.7**		**2.58**	

Using MLE treatments were effective in increasing all germination and seedling traits. Germination % in Table 6 was recorded large value with using 0.25g and 0.50g concentrate reach to 28.12 and 28.08 % increasing then hydro-priming and 1g which were 14.66 and 0.31 % respectively, compared with control (untreated seed).

Data showed that 0.25 was significantly greater than 0.50, hydro-priming and 1 g which were 5.6, 3.7, 3.7 and 1.8 respectively, compared with control for germination rate trait.

Mean germination time was recorded with high values with control and smallest values with 0.25 g which was -3.9 %. while increasing speed germination seed as compared to that of untreated seeds and gave high speed germination with 0.25g (34. 9% increase) and lowest speed with 1 g (11.2 % increase) compared with control **(Table 6)**.

Table 6. Effect of *Moringa oleifera* leaf extract (MLE) on germination traits of maize seeds.

MLE. Conc. (g/mm)	GP (%)	Increase% over control	GR/day	Increase% over control	MGT/day	Increase % over control	SGI	Increase % over control
0.25 g/10mm	90.3 a	28.1	0.57 a	5.6	3.17 b	-3.9	17.6 a	34.9
0.50 g/10mm	90.2 a	28.0	0.56 ab	3.7	3.17 b	-3.9	16.8 ab	28.6
1.00 g/10mm	70.7c	00.3	0.55 bc	1.8	3.19 b	-3.3	14.5 bc	11.2
Water	80.7 b	14.7	0.56 ab	3.7	3.18 b	-3.6	16.5 ab	26.3
Control	70.4 c	–	0.54 c	–	3.30 a	–	13.0 c	–
F test	**		**		**		**	
LSD $_{5\%}$	**0.72**		**0.017**		**0.09**		**2.28**	

MLE.Conc.: Moringa Leaves Extract Concentration, GP: Germination percentage, GR: Germination Rate, MGT: Mean Germination Time, SGI: Speed Germination Index.

Seedling characters were also improved by most seed treatments. The present study also indicates that all the treated seed significantly improved shoot, root and seedling length, however, treated with 0.25 g success to improve these traits and gave higher values compared with another priming and control **(Table 7)**.

Table 7. Effect of *Moringa oleifera* leaf extract (MLE) on the Seedling length (cm) of maize seeds.

MLE. Conc. (g/mm)	Seedling length (cm)					
	Shoot	**Increase% over control**	**Root**	**Increase% over control**	**Seedling**	**Increase % over control**
0.25 g/10mm	13.6 a	17.2	8.4a	14.4	21.9a	11.1
0.50 g/10mm	13.5 a	16.3	7.6b	4.7	21.0a	6.3
1.00 g/10mm	12.3b	5.6	7.3d	00.0	19.7b	0.00
Water	13.2a	13.0	7.4c	1.6	20.8a	5.5
Control	11.6c	–	7.3d	–	19.7b	–
F test	**		**		**	
LSD $_{5\%}$	**0.85**		**0.09**		**1.00**	

MLE.Conc.: Moringa Leaves Extract Concentration.

Table 8. Effect of *Moringa oleifera* leaf extract (MLE) on the Seedling weight (g) and Seedling vigor of maize seeds.

MLE. Conc. (g/mm)	Seedling weight (g)				Seedling vigor			
	Fresh	**Increase % over control**	**Dry**	**Increase % over control**	**SV1**	**Increase % over control**	**SV2**	**Increase % over control**
0.25 g/10mm	0.119 a	21.7	0.027 a	22.7	2091.9 a	48.9	22.6 a	30.1
0.50 g/10mm	0.119 a	21.7	0.024 ab	9.1	1940.1 a	38.1	21.5 a	23.5
1.00 g/10mm	0.113 c	11.3	0.022 b	0.0	1479.0 c	5.30	20.7 a	19.3
Water	0.114 b	16.3	0.023 ab	4.6	1834.6 b	30.6	21.4 a	23.0
Control	0.098 d	–	0.022 b	–	1404.5 c	–	17.4 b	–
	**		*		**		**	
LSD $_{5\%}$	**0. 035**		**0.04**		**221.69**		**2.33**	

MLE.Conc.: Moringa Leaves Extract Concentration.

Most seed treatments resulted in higher seedling fresh weight compared with that of control whereas seedling dry weight was a non-significant increase with 1 g by priming compared with control **(Table 8)**.

Maximum seedling vigour (SVI and SVII) was improved with all treated seed, which was 48.9 ,38.1, 30.6 and 5.3% Increase over control by 0.25, 0.5, hydro-priming and 1 g respectively, for SV1. Whereas, it was increased by 30.1, 23.5, 23.0 and 19.3% Increase over control for 0.25, 0.5, hydro-priming and 1g for SV2 compared with control **(Table 8)**.

Data indicated that significant interaction between soaking duration and MLE for all germination traits and seedling growth.

Significant differences were shown in recorded germination % trait with interaction between soaking duration and MLE treatments.0.25 g MLE under 20 h soaked gave the highest value of all recorded parameters (100.0), followed by 0.5 g MLE and hydro-priming compared with other treatments and control. Whereas the lowest value was 70.67 for untreated seed in **Fig. (1)**. The present study also indicates that all the treated seed significantly improved shoot, root and seedling length, however, treated with 0.25 g MLE success to improve these traits and gave higher values under 20 h (14.3, 9.2 and 22.2 for shoot, root seedling respectively.) and 16 h which were (14.8, 8.5 and 23.3 for shoot, root seedling respectively.) and low values were for untreated seed **(Fig. 2)**.

The results showed that increasing speed germination seed as compared to that of untreated seeds **(Fig. 3)** and gave high speed germination with 0.25g MLE (17.9) under 20h and lowest speed with 1 g MLE followed by control which was the lowest speed.

Most of seed treatments resulted in higher seedling fresh and dry weight compared with control, seedling dry weight was non-significant with 0.25 g MLE under 20 and 16 hour soaking followed by 0.5g and hydro-priming comparing whereas, untreated seed had low number comparing with other treatments and control **(Fig. 4)**.

Maximum seedling vigor was seen in seed soaking for 20 h with 0.25 g (2245.2 and 23.6 for SVI and SVII (20 h) respectively and 2245.2 and 22.6 for SVI and SVII, (16 h), respectively) then 0.5 and hydro-priming under 20 h compared with non-soaked **(Fig. 5 and Fig. 6)**.

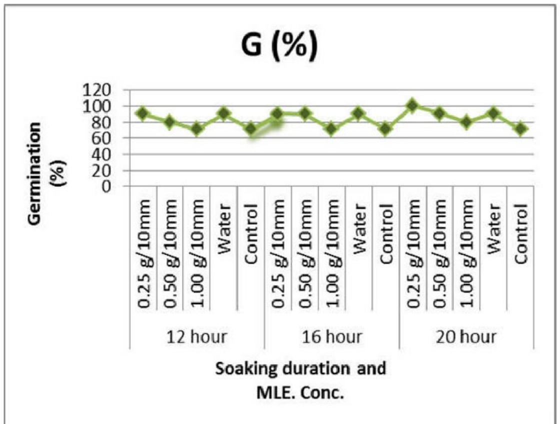

Figure 1: Effect of interaction between soaking durations and concentrations of MLE on germination percentage of maize seeds.

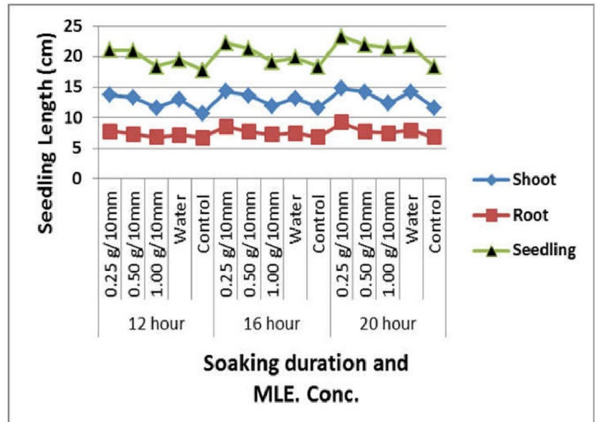

Figure 2: Effect of interaction between soaking durations and concentrations of MLE on the seedling length of germinated maize seeds.

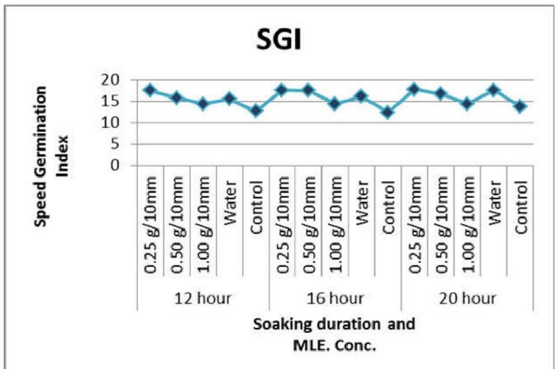

Figure 3: Effect of interaction between soaking durations and concentrations of MLE on speed germination index of maize seeds.

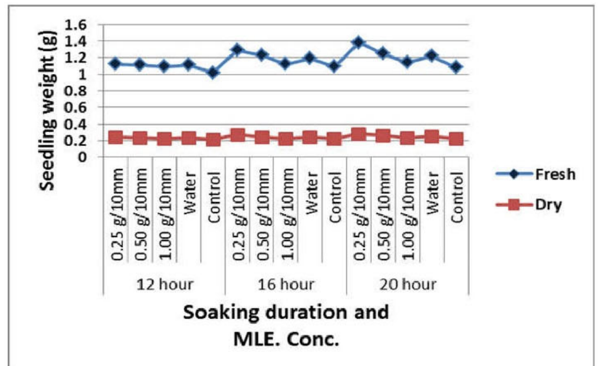

Figure 4: Effect of interaction between soaking durations and concentrations of MLE on seedling weight of maize seeds.

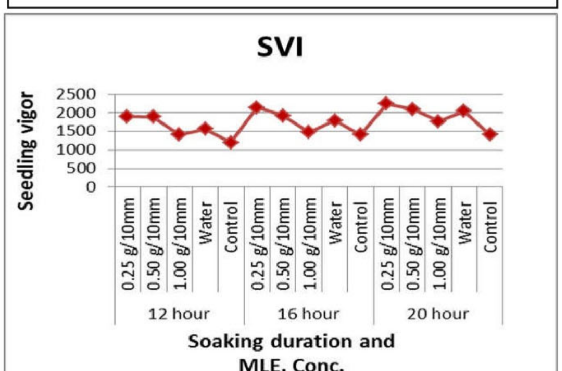

Figure 5: Effect of interaction between soaking durations and concentrations of MLE on seed vigor I of maize seeds.

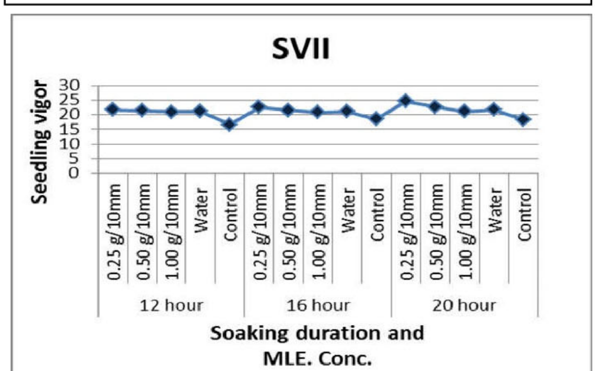

Figure 6: Effect of interaction between soaking durations and concentrations of MLE on seed vigor II of maize seeds.

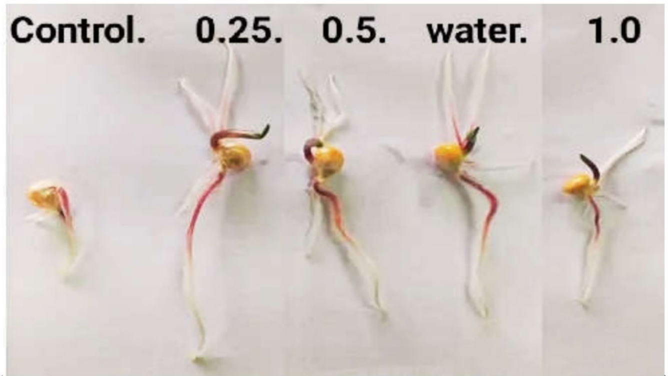

Figure 7: Effect of different soaking durations and MLE concentrations on seedling traits after three days from germination of seed maize.

Field emergence experiment

Table 9 shows significant effects of soaking duration, MLE. Conc. (g/mm) and its interaction treatments on hybrid 178 maize field emergence.

Table 9. Effect of seed soaking duration and *Moringa oleifera* leaf extract (MLE) on field emergence (%), seedling dry weight (g pot^{-1}) and seedling vigor (SVII) parameters of hybrid 178 maize.

Treatment				
Soaking duration	MLE. Conc. **(g/mm)**	**Field emergence (%)**	**Seedling dry wt. (g)**	**Seedling vigor (SVII)**
12 hour	**0.25 g/mm**	10	0.21	21.7
	0.50 g/mm	10	0.21	20.2
	1.00 g/mm	9	0.20	21.0
	Water	9.5	0.21	20.1
	Control	9.5	0.19	19.1
16 hour	**0.25 g/mm**	9.5	0.25	24.6
	0.50 g/mm	10	0.24	22.2
	1.00 g/mm	9.5	0.22	21.7
	Water	10	0.23	21.8
	Control	9	0.22	21.5
20 hour	**0.25 g/mm**	9.5	0.27	26.2
	0.50 g/mm	10	0.26	25.6
	1.00 g/mm	9.5	0.24	21.7
	Water	9.5	0.25	25.0
	Control	9.5	0.23	19.7
F test		ns	**	**
LSD $_{5\%}$		**1.25**	**0.03**	**2.73**
Soaking hour	**12 hour**	9.6	0.21	20.3
	16 hour	9.6	0.23	22.4
	20 hour	9.6	0.24	22.8
F test		ns	**	**
LSD $_{5\%}$		**0.56**	**0.016**	**1.32**
Concentration	**0.25 g/mm**	10	0.25	22.9
	0.50 g/mm	9.6	0.23	22.0
	1.00 g/mm	9.5	0.22	20.7
	Water	9.5	0.23	21.9
	Control	9.3	0.19	19.7
F test		ns	**	**
LSD $_{5\%}$		**0.72**	**0.01**	**0.73**

Regarding germination % in **Table 9**, there was non-significant with soaking and MLE. Conc. (g/mm) and interaction between them. While Seedling dry wt. gave significant increases which were obtained through soaked seeds 20 h (0.24 g) followed by 16 h (0.23 g). Whereas it was increased with 0.25 g MLE (0.25g) followed by 0.5 g MLE (0.23g) and hydro-priming (0.23g) compared to 12 hour soaked, 0.1 g MLE and control treatments in barley field emergence. Addition to the best dry weight in interaction was between soaked in 0.25 g MLE under 20 hours (0.27g). The increment reached to 22.8

and 22.4% by soaked 20 h and 16 h and retracted to 22.9 by 0.25 MLE followed by 22.0 and 21.9 by 0.5g /mm and hydro-priming, respectively in field emergence for Seedling vigor (SVII). Significant differences were showed in recorded maize traits at field emergence with interaction between soaking duration and MLE treatments.0.25 g MLE under 20 h soaked gave the highest value of all recorded parameters (25.2), followed by 0.5 g MLE (25.6) and hydro-priming (25.0) compared with other treatments and control in **Table 9**.

4. Discussion

Rate of germination, germination percentage, speed germination and seedling biomass are important contributors of seed vigour. Increasing emergence rate is the main foundation, which ensures improving of overall seedling performance. Our results showed that optimum soaking time (20 then 16 hours) was better than 12 h and control using MLE concentrate (0.25 g/mm). According to[50] most seeds treated in water before sowing resulted in faster germination. Additionally,[44] showed that sufficient moisture is required for quick seed germination. Higher germination (percentage) was also mentioned as an important factor in determining the amount and viability of seeds.[42] This mechanism was triggered by high water availability, which induced leaching of important soluble food reserves in the seeds, as well as exosmosis of hormones and enzymes, which lowered respiration and protein synthesis rates.[37]

Hydrolysis of complex carbohydrates into simple sugars, which are easily consumed during protein synthesis and auxins, increases germination. The development of new tissues is aided by the production of additional auxins, which softens the cell wall and supports protein use and growth. These results are ascribed to moringa leaf extract (MLE), which contains plant hormones that cause seed germination to improve.[47] Furthermore,[34,46] ensure that moringa leaf extract (MLE) is a source of vital amino acids as well as various minerals such as N, K, Zn, and Ca, all of which are considered natural growth boosters. Moringa leaf extract was tested for mineral content and chemical composition according to[33,19] who reported that moringa leaves content on essential minerals as P, K, Mg, Ca, Fe, Cu and Zn in addition to ascorbic acid, lipids, soluble phenols, gibberellins and zeatin. In contrast to the 2 percent and 4 percent values, the high level of MLE (6%) has an inhibitory influence on prior parameters.[33] According to[38] soaking maize seeds in a high concentration of MLE solution caused imbibition damage, which resulted in a decrease in germination features. These results are attributable to the seed being treated with MLE solution, which causes a variety of biochemical changes such as starch hydrolysis, enzyme activation, and dormancy break.[24] MLE extract, on the other hand, improves the mobilisation of reserves from seed storage as endosperms or cotyledons for partitioning to embryo by lowering sugars and increasing amylase activity, adding to early seed vigour.[21] According to reports, the MLE extract can boost germination percentage, index, and rate.[49,41] According to[41] the effect of activity, MLE solution, can be linked to the presence of growth-promoting chemicals in MLE extract, which increased seed germination features and seedling growth. This paper can be considered as a good evidence for the importance of scientific research in agriculture and other fields.[51-58]

5. Conclusion

In general, soaking hybrid 178 maize seeds in Moringa leaf extract at a concentration of 0.25 g/mm was the superior treatment for achieving the highest values of germination traits and early seedling growth. Furthermore, by using Moringa leaf extract at a concentration of 0.25 g/mm for 20 /or 16 hour durations as a seed soaking treatment, it can stimulate the rapid of germination, promote germination percentage, and have positive effects on seedlings growth, resulting in healthy and strong seedlings.

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