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Priming seeds of sorghum and sudangrass using water and aquatic extracts of willow and banana

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A B S T R A C T

The aim of this study was to examine the impact of seed priming on seed quality parameters (germination energy, germination, seedling length and vigor index) of sorghum (*Sorghum bicolor* L. Moench) and sudangrass (*Sorghum sudanense* Pers.). The experiment was performed at the Institute of Field and Vegetable Crops, Novi Sad, Serbia. The research was conducted on the seeds of the sorghum variety NS Džin and sudangrass variety Srem. Distilled water and aqueous extracts of young willow branches (*Salix matsudana*) and mature banana fruits (*Musa x paradisiaca*) were used to prime the seeds. The seeds were primed for: 1 h, 3 h, 6 h, 12 h and 24 h. The results showed that priming sorghum and sudangrass seeds in aqueous extracts of young willow branches and mature banana fruits can have a positive effect on seed quality parameters: germination energy, germination, seedling length and vigor index. The greatest effect on germination energy and seed germination was achieved in sudangrass by using an aqueous extract of young willow branches. The increase was 9.30% and 9.20%, respectively. Priming sorghum seeds in aquatic extracts of mature banana fruits had the greatest effect on seedling length and vigor index. The increase was 36.86% and 40.33%, respectively. For all research parameters, priming for 3 h was the most effective. However, in addition to the positive effect, priming can also have a negative effect. The most significant reduction was found on sorghum seeds, when primed in an aqueous extract of mature banana fruit for 24 hours. Germination energy and germination were reduced by 7.14% and 9.30%, respectively.

***Keywords**:* aqueous plant extracts, priming, seed, sorghum, sudangrass.

И З В О Д

Циљ овог рада је био да се испита утицај потапања семена крмног сирка (*Sorghum bicolor* L. Moench) и суданске траве (*Sorghum sudanense* Pers.) на параметре квалитета семена (енергија клијања, клијавост, дужина клијанца и вигор индекс). Оглед је изведен на Институту за ратарство и повртарство у Новом Саду. Истраживања су спроведена на семену крмног сирка сорте НС Џин и суданске траве сорте Срем. За потапање семена коришћена је дестилована вода, и водени екстракт младих грана врбе (*Salix matsudana*) и зрелих плодова банане (*Musa x paradisiaca*). Семе је потапано у трајању од: 1 h, 3 h, 6 h, 12 h и 24 h. Резултати су показали да потапање семена крмног сирка и суданске траве у водене екстракте младих грана врбе и зрелих плодова банане може имати позитиван ефекат на параметре квалитета семена: енергију клијања, клијавост, дужину клијанца и вигор индекс. Најбољи ефекат на енергију клијања и клијавост семена остварен је употребом воденог екстракта младих грана врбе на семену суданске траве. Повећање је износило 9,30% и 9,20%. Потапањем семена крмног сирка у водени екстракт зрелих плодова банане остварен је бољи ефекат на дужину клијанца и вигор семена. Повећање је износило 36,86% и 40,33%. Код свих параметара истраживања најбољи ефекат је остварен при потапању од 3 h. Међутим, поред позитивног, потапање може имати и негативан ефекат. Најзначајније смањење утврђено је на семену крмног сирка, приликом потапања у водени екстракт зрелих плодова банане у трајању од 24 h. Клијавост је смањена за 9,30%.

***Кључне речи**:* водени биљни екстракти, потапање семена, семе, крмни сирак, суданска трава.

1. Introduction

From time immemorial, seed quality has been considered a cardinal element in the development of agriculture. Man established contact with seed physiology right from the beginning of agriculture and quickly realized that many seeds do not germinate easily and uniformly (Lekić, 2003). Ancient civilization was fascinated by the capacity of an apparently "dead seed" to resurrect and produce a viable young and healthy seedling after germination (Miric and Brkic, 2002). Seed priming involves partial hydration of seeds and metabolic activity is attained in a desirable manner thereby allowing important pregermination steps to be initiated within the seeds (McDonald, 2000). Since seeds are physiologically closer to germination, primed seeds have an increased germination rate, early and uniform germination, better growth attributes, faster emergence and better stand establishment (Farooq et al., 2007; Alipour-Abookheili et al., 2019). The Greek Theophrastus (ca. 372–287 BC) already focused on seed physiology and suggested that germination process may be temporarily interrupted. Prehydration of legume seeds before sowing was performed by Roman farmers in order to increase the germination rate and synchronize germination, as reported by the Roman naturalist Gaius Plinius Secundus (Evenari, 1984). On-farm seed priming increased the yield of maize in Zimbabwe and India to a tune of 22 per cent, sorghum in Zimbabwe and Pakistan to a tune of 31 per cent, wheat in India and Pakistan to a tune of 37 percent and upland rice in West Africa to a tune of 70 percent (Das et al., 2015). In numerous cases, the beneficial impact of priming on plant growth is more obvious under nonoptimal than under optimal conditions, leading to the global concept that a major advantage of priming lies in an increase in stress resistance (Miladinov et al., 2020a; Garcia et al., 2021).

Miladinov et al. (2018) pointed out that, in addition to the positive effect, immersion can also have a negative effect on seed germination, because the effect of immersion depends on many factors. In cultivated plant species, a given priming treatment also has contrasting effects on various cultivars. It may be hypothesized that the ability to respond to priming treatment might be genetically controlled but, to the best of our knowledge, no data are available concerning this important aspect. Thus, further progresses are needed not only to identify the set of genes that are regulated by priming, but also the set of genes that putatively regulate priming response and efficiency themselves (Bittner et al., 2020). Another challenge is to identify appropriate treatments able to restore the vigor of old dry seed lots in order to increase their mean percentage of germination to values compatible with commercial purposes (Miladinov et al., 2018). A large number of studies are devoted to the impact of seed priming on the seed germination phase and early seedling growth. Most of those studies are conducted under controlled environmental conditions in greenhouses. Data reporting real improvement under field conditions remain rare (Čanak et al., 2020). The priming-induced decrease in storage capacity is a major limitation to the application of the priming technique by seed companies (Miladinov, 2020b). In order for seed priming to be used without negative consequences, it is necessary to determine its optimal time that leads to the activation of metabolic processes without allowing radicle protrusion through the seed coat (Miladinov et al., 2015).

Therefore, the aim of the study was to examine the optimal time for the priming of sorghum and sudangrass seeds.

2. Materials and methods

In order for seed priming to be used without negative consequences, it is necessary to determine its optimal time for the initiation of metabolic processes, but to a point where radicle penetration through the seed coat does not occur. The experiment was performed in 2022 at the Institute of Field and Vegetable Crops, Novi Sad, Serbia. The research was conducted on the seeds of the sorghum (*Sorghum bicolor* L.) variety NS Džin and sudangrass (*Sorghum Sudanense* Pers.) variety Srem (Table 1).

Table 1.
Main characteristics of sorghum and sudangrass seeds

Species	1000-grain weight (g)	Moisture (%)	Proteins (%)	Starch (%)
Sorghum	14.25	14.90	11.42	77.27
Sudangrass	13.08	13.0	10.80	76.28

Before priming, the seeds were surface sterilized with 3% sodium hypochlorite (NaOCl) solution for two minutes and washed with distilled water. In order to determine the role of priming, the seeds were primed in:

1. Distilled water (H_2O)
2. An aqueous extract of willow (*Salix matsudana*) was prepared by chopping one kilogram of the top parts of willow twigs to a length of 2–3 cm. Then, the twigs were placed in barrels and 10 liters of rainwater were poured over. During fermentation, the content was mixed daily. After fermentation, the aqueous extract was filtered through cheesecloth. For the priming of sorghum and sudangrass seeds, the aqueous extract was diluted with distilled water in a ratio of 1:15.
3. An aqueous extract of banana fruits (*Musa x paradisiaca*) was prepared by chopping one kilogram of mature banana fruits together with the peel into pieces about 1 cm wide and adding 10 liters of rainwater. After the fermentation process was completed, the aqueous extract was filtered through cheesecloth. For the priming of sorghum and sudangrass seeds, the aqueous extract was diluted with distilled water in a ratio of 1:15.
4. Control (non-primed seed)

The seeds were primed for: 1 h, 3 h, 6 h, 12 h and 24 h. Thereafter, they were air-dried to the original moisture, and then 4x100 seeds were taken from each seed variant. Germination tests were established according to the ISTA methodology and performed on a pleated filter paper at a temperature of 30 °C for 10 days (ISTA, 2009). On the fourth day, the germination energy of seeds was read, and on the tenth day, their germination was determined. Seeds with 3 mm or longer radicles were considered germinated. After ten days, five seedlings were taken per replicate and seedling length was measured. After measuring the average value of seedling length, the vigor index was determined according to the formula: Vigor index = Germination (%) x Total seedling length (cm) (Abdul-Baki and Anderson, 1973).

The obtained results were processed by the analysis of variance (ANOVA) for two-factorial trials. Means were compared using Duncan's multiple range test. The coefficients of correlation between the traits were tested. All analyses were performed in STATISTICA 10. Sorghum and sudangrass seeds were tested separately.

3. Results and discussions

3.1. Germination energy

In order to reduce the use of synthetic and chemical agents in agriculture, more and more research is turning to ecological, more environmentally friendly methods. Therefore, the influence of aqueous extracts of plant material on other plants has increasingly been investigated recently. Although the effects of some plants have been known for decades, there are very few natural preservatives or growth stimulants on the market (Đurić et al., 2019). Aqueous extracts for agricultural use are made from over 2000 plant species known today, but only a small number of them have positive effects (Goreta Ban, 2017). Various plant organs can be used to prepare aqueous extracts: root, rhizomes, leaves, stem, flowers, fruits, seeds (Aldrich and Kremer, 1997). Cultivated and wild forms of aromatic and medicinal plant species contain numerous active substances that have a pesticidal effect, which is why they are the subject of numerous studies today (Đikić, 2005; Baličević et al., 2014). The results of the analysis showed that the priming of sudangrass seeds for 3 h had the greatest effect on seed germination energy. Germination energy was increased by 4.88%. However, there was no significant effect on sorghum. Similar results were obtained for the influence of aqueous extracts and distilled water. None of the two aqueous extracts, nor distilled water, led to a significant increase in germination. The results of the analysis also showed that priming sudangrass and sorghum seeds can have a positive effect only if the seeds are primed in a certain aqueous solution for a suitable time (Table 2).

Table 2.
Effect of priming on germination energy

Species	Treatment	Priming time					Mean
		1	3	6	12	24	(B)
Sorghum	Control	84	84	84	84	84	84
	H_2O	85^{ns}	86^{ns}	86^{ns}	84^{ns}	84^{ns}	85^{ns}
	Willow	87^{ns}	90^{*}	87^{ns}	85^{ns}	84^{ns}	87^{ns}
	Banana	84^{ns}	89^{*}	87^{ns}	84^{ns}	78^{*}	85^{ns}
Mean (A)		85^{ns}	88^{ns}	87^{ns}	84^{ns}	83^{ns}	-
Sudangrass	Control	78	78	78	78	78	78
	H_2O	77^{ns}	78^{ns}	83^{*}	76^{ns}	76^{ns}	78^{ns}
	Willow	77^{ns}	86^{*}	79^{ns}	79^{ns}	76^{ns}	79^{ns}
	Banana	79^{ns}	81^{ns}	79^{ns}	79^{ns}	80^{ns}	80^{ns}
Mean (A)		78^{ns}	82^{*}	80^{ns}	78^{ns}	77^{ns}	-

**P*<0.05; ** *P* <0.01; ns – not significant; H_2O – distilled water; willow – aqueous extract of young willow branches; banana – aqueous extract of mature banana fruits; A – priming time; B – treatment.

In the case of sorghum, the greatest effect was achieved by priming the seeds in aqueous extracts of young willow branches and banana fruit for 3 hours. The banana extract increased germination energy by 5.62%, while the willow extract had a slightly better effect, leading to an increase of 6.67%. Unlike sorghum, priming sudangrass seeds in distilled water had a positive effect on germination energy, but only at a priming time of 6 h. Germination energy was increased by 6.02%, while the best effect was achieved by the 3-hour treatment with the aqueous extract of young willow branches. Germination energy increased by 9.30%. The positive effect of the water extract of young willow branches can be attributed to the high content of growth-stimulating phytohormones, but also to salicylic acid, which prevents the growth of various bacteria and improves the plant's immune system (Mahdi, 2010). The positive effect of the aqueous extract of the banana fruit can be attributed to the chemical composition of this fruit. Banana fruit is rich in potassium, phosphorus, calcium, manganese, magnesium, and selenium, and contains vitamins C, B and A (Sidhu and Zafar, 2018).

3.2. Seed germination

The results on the influence of priming time on seed germination are similar to those on germination energy. Seed priming for 3 h had the greatest effect on seed germination in sudangrass. Germination was increased by 5.95% (Table 3).

There was no significant effect on sorghum. Similar results were obtained when the influence of aqueous extracts and distilled water was observed. None of the two aqueous extracts, not distilled water, led to a significant increase in seed germination. Here, too, the results of the analysis showed that the priming of sudangrass and sorghum seeds can have a positive effect only if the seeds are primed for a certain time in a certain water extract. Priming the seeds for 3 h in both aqueous extracts significantly increased germination, by 5.49%. However, seed priming in the aqueous banana extract for 24 hours significantly reduced the germination energy and germination of sorghum seeds, by as much as 7.14% and 9.30%, respectively. Unlike sorghum, priming sudangrass seeds in distilled water had a positive effect on seed germination, but only when the seed were primed for 6 hours. Germination increased by 7.06%. The greatest effect was achieved by the 3-hour treatment with the aqueous extract of young willow branches. Germination increased by 9.20%. As found by McDonald (2000), the beneficial effects of priming are associated with nucleic acid synthesis and increased protein synthesis. In addition, priming ensures the optimal development of physiological processes during germination, stimulates the activation of various enzymes, mobilizes protein and carbohydrate reserves, and prepares cells for division (Soleimanzadeh, 2013). This measure encourages embryo growth, repairs damaged parts of the seed and reduces metabolite loss (Basra et al., 2002). Also, the effect of priming is reflected in more efficient mobilization of carbohydrates (Srinivasan et al., 1999) and restoration of the antioxidant mechanism of seeds (Siri et al., 2013). In other cases, germination is increased or decreased, but with no significant impact. There are numerous studies reporting that the use of certain aqueous extracts can significantly increase but also reduce seed germination (Table 3). Petrova et al. (2015) found that the seeds of wheat (*Triticum aestivum* L.), wild sorghum (*Sorghum halepense* L.), lambsquarters (*Chenopodium album* L.), Bermuda grass (*Cynodon dactylon* L.) and curly dock (*Rumex crispus* L.) experienced a negative impact of the treatment with aqueous extracts on seed germination and seedling growth. The treatment involved the use of the aqueous extracts of dried lavender (*Lavandula angustifolia* L.) flowers, great basil (*Ocimum basilicum* L.), and mint (*Mentha longifolia* L. and *Mentha piperita* L.) leaves. The aqueous extracts showed significant negative effects, primarily at the highest concentration of 5%, which in some cases reduced the germination and growth of seedlings by up to 100%. In the red clover crop, the effect of aqueous sage (*Salvia officinalis* L.) extract was examined on the seed germination of velvetleaf (*Abutilon theophrasti* Medik.), red-root amaranth (*Amaranthus retroflexus* L.), wild oats (*Avena sterilis* L.), hemlock (*Conium maculatum*), perennial ryegrass (*Lolium perenne* L.), curly dock (*Rumex crispus* L.) and flixweed (*Descuriania sophia* L.). A positive effect on seed germination was found only in flixweed (*Descuriania sophia* L.), while in the other plant species there was a significant decrease, by up to 91.7% (Kadioğlu and Yanar, 2004).

Table 3.
Effect of priming on germination

Species	Treatment	Priming time					Mean
		1	3	6	12	24	(B)
Sorghum	Control	86	86	86	86	86	86
	H_2O	86^{ns}	86^{ns}	88^{ns}	88^{ns}	87^{ns}	87^{ns}
	Willow	89^{ns}	91^{*}	89^{ns}	87^{ns}	87^{ns}	89^{ns}
	Banana	86^{ns}	91^{*}	86^{ns}	84^{ns}	78^{*}	85^{ns}
Mean (A)		87^{ns}	89^{ns}	88^{ns}	86^{ns}	84^{ns}	-
Sudangrass	Control	79	79	79	79	79	79
	H_2O	79^{ns}	80^{ns}	85^{*}	78^{ns}	78^{ns}	80^{ns}
	Willow	83^{ns}	87^{*}	82^{ns}	80^{ns}	77^{ns}	82^{ns}
	Banana	82^{ns}	84^{ns}	82^{ns}	82^{ns}	81^{ns}	82^{ns}
Mean (A)		81^{ns}	84^{*}	83^{ns}	80^{ns}	79^{ns}	-

* *P* <0.05; ** *P* <0.01; ns – not significant; H_2O – distilled water; willow – aqueous extract of young willow branches; banana – aqueous extract of mature banana fruits; A – priming time; B – treatment.

In addition to the positive effect on seed quality parameters, priming can have an inhibitory effect, depending on the genotype and age of the seed (Miladinov et al., 2018). The success of seed priming depends on many factors, including the plant species, the water potential and composition of the priming solution, the duration of priming, post-priming storage conditions, and others (Parera and Cantliffe, 1994).

3.3. Seedling length

The results showed that the longest seedling was formed in both plant species after seed priming for 3 h. In sorghum, the seedling was 5.8 cm or 26.48% longer than the control. In sudangrass, the seedling was 5.2 cm or 19.40% longer. In sorghum, a large effect on seedling length was achieved after priming for 6 h. The seedling increased by 3.7 cm or 18.69%. In sudangrass, a good effect, in addition to the 3-hour treatment, was achieved by a priming time of 1 hour. The seedling increased by 3.8 cm or 14.96% (Table 4).

Table 4.
Effect of priming on seedling length

Species	Treatment	Priming time					Mean
		1	3	6	12	24	(B)
Sorghum	Control	16.1	16.1	16.1	16.1	16.1	16.1
	H_2O	17.8^{ns}	18.4^{ns}	20.5^{*}	19.5^{ns}	18.5^{ns}	18.9
	Willow	20.6^{*}	21.7^{*}	19.7^{*}	18.8^{ns}	18.6^{ns}	19.9^{*}
	Banana	18.8^{ns}	25.5^{**}	19.2^{ns}	18.4^{ns}	16.1^{ns}	19.6^{ns}
Mean (A)		19.1^{ns}	21.9^{*}	19.8^{*}	18.9^{ns}	17.7^{ns}	-
Sudangrass	Control	21.6	21.6	21.6	21.6	21.6	21.6
	H_2O	24.2^{ns}	24.5^{ns}	21.2^{ns}	21.0^{ns}	20.8^{ns}	22.3^{ns}
	Willow	26.0^{*}	29.1^{**}	25.7^{*}	25.6^{*}	25.5^{*}	26.4^{*}
	Banana	26.1^{*}	26.9^{*}	24.7^{*}	24.0^{ns}	22.5^{ns}	24.8^{ns}
Mean (A)		25.4^{*}	26.8^{*}	23.9^{ns}	23.5^{ns}	22.9^{ns}	-

* *P* <0.05; ** *P* <0.01; ns – not significant; H_2O – distilled water; willow – aqueous extract of young willow branches; banana – aqueous extract of mature banana fruits; A – priming time; B – treatment.

In both plant species, the best effect was achieved by using the aqueous extract of young willow branches. In sorghum, seedling length was increased by 3.8 cm or 19.10% than in the control. In sudangrass, the effect was somewhat smaller. The seedling increased by 4.8 cm, which is 18.18% more than in the control. The interaction priming time x aqueous extract showed that priming in water had a significant effect only in sorghum, after 6 h of priming. The seedling increased by 4.4 cm and 21.46%, respectively. A large effect of the aqueous extract of young willow branches was achieved after priming the seeds for 1 hour, 3 hours and 6 hours. The increase was from 18.27% to 25.81%. However, the best effect was achieved by priming the seeds in the aqueous extract of banana fruit. The seedling was 9.4 cm or 36.86% longer than the control. By priming the seeds of sudangrass in the aqueous extract of young willow branches, seedling length increased, regardless of priming time. The increase ranged from 15.29% to 25.77%. A significant increase was also achieved by the use of the aqueous banana fruit extract, with priming lasting 1 h, 3 h and 6 h. The increase was from 12.55% to 19.70%. Seed priming in an aqueous extract of young willow branches for 3 hours was the most effective treatment. However, the best effect was achieved by priming the seeds in an aqueous extract of banana fruit. The seedling was longer by 7.5 cm or 25.77% compared to the control.

3.4. Vigor index

Total percentage germination after a specific period of time does not give a full explanation of the dynamics of germination (Joosen et al., 2010). The real potential of seed germination was estimated using a number of parameters (Singhal and Bose, 2020). Seed vigor, an important indicator of seed quality, is the first guarantee for maintaining plant population as well as stable yield. High seed vigor determines the potential for rapid and uniform emergence of seed, and can increase yield by up to 20% (Tao and Zhen, 1991). The results showed that vigor index in both plant species was significantly better after priming the seeds for 3 h. In sorghum, the vigor index was higher by 28.96%, and in sudangrass by 24.20% than in the control. In sorghum, vigor index was also greatly positively affected by priming for 6 h, its increase being 20.53%. Unlike sorghum, in sudangrass, a large effect, in addition to the 3-hour priming treatment, was achieved by a priming time of 1 hour, which gave a 17.06% increase in vigor index. In both plant species, the best effect was achieved by the treatment with the aqueous extract of young willow branches. In sorghum, the vigor index increased by 21.82% compared to the control (Table 5).

Table 5.
Effect of priming on vigor index

Species	Treatment	Priming time					Mean
		1	3	6	12	24	(B)
Sorghum	Control	1384.6	1384.6	1384.6	1384.6	1384.6	1384.6
	H_2O	1530.8^{ns}	1582.4^{ns}	1804.7*	1696.5^{ns}	1609.5^{ns}	1644.3^{ns}
	Willow	1833.4*	1974.7*	1753.3*	1635.6^{ns}	1618.2^{ns}	1771.1*
	Banana	1616.8^{ns}	2320.5**	1651.2^{ns}	1545.6^{ns}	1255.8^{ns}	1666^{ns}
Mean (A)		1661.7^{ns}	1949.1*	1742.4*	1625.4^{ns}	1486.8^{ns}	-
Sudangrass	Control	1706.4	1706.4	1706.4	1706.4	1706.4	1706.4
	H_2O	1911.8^{ns}	1960^{ns}	1802.0^{ns}	1638.0^{ns}	1622.4^{ns}	1784.0^{ns}
	Willow	2158.0*	2531.7**	2107.4*	2048.0*	1963.5^{ns}	2164.8*
	Banana	2140.2*	2259.6*	2025.4*	1968.0^{ns}	1822.5^{ns}	1984.4^{ns}
Mean (A)		2057.4*	2251.2*	1983.7^{ns}	1880^{ns}	1809.1^{ns}	-

* P <0.05; ** P <0.01; ns – not significant; H_2O – distilled water; willow – aqueous extract of young willow branches; banana – aqueous extract of mature banana fruits; A – priming time; B – treatment.

For sudangrass, this effect was somewhat smaller, 21.18%. The interaction priming time × aqueous extract showed that priming in water had a significant effect on vigor index only in sorghum, after 6 h of priming. The vigor index increased by 23.25% compared to the control. The treatment with the aqueous young willow branches extract produced a large effect after seed priming for 1 hour, 3 hours, and 6 hours. The increase ranged from 21.03% to 29.88%. However, the greatest effect was achieved by seed priming in an aqueous extract of banana fruit. The vigor index was 40.33% higher than in the control.

3.5. Analysis of the examined properties using the correlation coefficient

In both plant species, similar correlation coefficients were determined between the tested traits (Table 6, 7). A high positive correlation was observed between germination energy and seed germination. Therefore, the seeds with a higher germination energy ability showed a higher radicle emergence percentage compared to seeds with lower germination energy. Also, a significant correlation was observed between seed germination and seedling length, in a way that seeds with a higher germination percentage had a greater seedling length.
Moreover, seed germination was highly significantly correlated with vigor index, and significantly correlated with all of the traits tested.

Table 6.
Coefficients of correlation between seed characters in sorghum

Characters	Germination energy	Germination	Seedling length	Vigor index
Germination energy	1	0.94**	0.79*	0.76*
Germination		1	0.77*	0.74*
Seedling length			1	0.93**
Vigor index				1

* P <0.05; ** P <0.01

Table 7.
Coefficients of correlation between seed characters in sudangrass

Characters	Germination energy	Germination	Seedling length	Vigor index
Germination energy	1	0.95**	0.81*	0.80*
Germination		1	0.83*	0.81*
Seedling length			1	0.86**
Vigor index				1

* P <0.05; ** P <0.01

Hampton (2002) reported that seed vigor has a high influence on plant establishment and growth, and therefore crop yield, because high vigor seeds can emerge better and faster in field conditions than low vigor seeds, which leads to better plant establishment and faster development, and hence stronger plants that have a greater ability to compete with weeds, better efficiency in using resources and better tolerance of environmental stresses, which finally results in a higher yield.

4. Conclusions

The results showed that priming sorghum and sudangrass seeds in aqueous extracts of young willow branches and banana fruit can have a positive effect on seed quality parameters: germination energy, germination, seedling length and vigor index.

The greatest effect on germination energy and seed germination was achieved in sudangrass. The increase was 9.30% and 9.20%, respectively, after a 3-hour priming treatment in the aqueous extract of young willow branches.

In sorghum, a better effect was achieved for the other two research parameters. The treatment with the aqueous extract of the banana fruit for 3 h gave an increase of 36.86% in seedling length and 40.33% in vigor index. .

The application of water had a significant effect only on seedling length and vigor index in sorghum, when the seed were primed for 6 h.

However, this presowing practice can have a positive effect only if the seed is primed for an appropriate time. Otherwise, priming as a presowing treatment leads to a decrease in seed quality. The most significant reduction was found in sorghum seeds, when primed in an aqueous extract of banana fruit for 24 hours. Germination was reduced by 9.30%.

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