EFFECT OF SEED PRIMING WITH JELLYFISH *Chiropsoides buitendijki* POWDER ON SEED GERMINATION AND SEEDLING ESTABLISHMENT OF MAIZE AND WATERMELON

V.D. Samaraweera[1*], D.C.T. Dissanayake[1] and S.H.N.P De Silva[2]

[1]Department of Zoology, Faculty of Applied Sciences, University of Sri Jayewardenepura
[2]Department of Crop Science, Faculty of Agriculture, University of Peradeniya

ABSTRACT

Jellyfish make seasonal blooms and are increasing rapidly worldwide. Despite the negative effects of jellyfish blooms, there are potential benefits in many industries including agriculture. The potency of jellyfish *Chiropsoides buitendijki* in seed priming to enhance seed germination and seedling establishment of maize (*Zea mays*) and watermelon (*Citrullus lanatus)* was studied. Three concentrations of jellyfish (T1, T2, and T3) were prepared by dissolving oven-dried *C. buitendijki* powder (0.4g, 0.5g, and 0.6g per 40mL of DW) in distilled water and water (C) was used as the control. After a 12-hour soaking period of experimental seeds (n=20 for each treatment), a Petri plate method was used to determine seed germination. Seedling emergence and establishment were tested by sowing seeds on trays filled with sterilized sands with adequate moisture. Appearance of sprout was counted in each day and seedlings were tested for vigor after 14 days. Soaking maize seeds in jellyfish liquid did not inhibit the normal seed germination confirming that *C. buitendijki* has no lethal effect on seeds when used as a seed primer. Seedling emergence of jellyfish-treated maize seeds was greater than the control, and a significant increment in their root lengths was recorded. All jellyfish-treated watermelon seeds had significantly higher maximum germination percentage, maximum emergence, and Seedling Vigor Index than the control ($p<0.05$). However, there were no significant differences among treatments for measured parameters except seedling emergence percentage where T1 showed higher value than T2 and T3. The watermelon seeds treated with jellyfish germinated and emerged three times faster than the control. *C. buitendijki* powder can be successfully used for seed priming to overcome seed germination delays by enhancing seed germination, seedling emergence and establishment of watermelon.
Jellyfish, Maize, Watermelon, Seed priming, Germination, Emergence

[*] *Corresponding Author: vishwadulanji.tmp@sjp.ac.lk*

EFFECT OF SEED PRIMING WITH JELLYFISH *Chiropsoides buitendijki* POWDER ON SEED GERMINATION AND SEEDLING ESTABLISHMENT OF MAIZE AND WATERMELON

V.D. Samaraweera[1*], D.C.T. Dissanayake[1] and S.H.N.P De Silva[2]

[1]*Department of Zoology, Faculty of Applied Sciences, University of Sri Jayewardenepura*
[2]*Department of Crop Science, Faculty of Agriculture, University of Peradeniya*

INTRODUCTION

Jellyfish populations are highly changeable even without exploitation (Brotz *et al.*, 2012). Although jellyfish blooms were considered a seasonal and natural feature of a healthy pelagic ecosystem earlier, remarkable and rapid increases in jellyfish populations have been reported recently throughout the world (Brotz *et al.*, 2012; Purcell *et al.*, 2007; Kogovšek *et al.*, 2014). Changes in the marine and coastal environment such as meteorological conditions, water currents, sea surface temperature, pressure, salinity, and predation have been predicted as the most likely reasons for the rapid increase in jellyfish biomass (Hsieh *et al.*, 2001; Kogovšek *et al.*, 2014). Further, human activities such as overfishing, eutrophication, tourism, aquaculture, translocation, and habitat modification have also contributed to jellyfish blooms. These factors might act separately and potentially result in outbreaks of jellyfish blooms which interfere with human activities in various ways (Purcell *et al.*, 2007; Richardson *et al.*, 2009; Torri *et al.*, 2020). Blooms affect tourism by stinging thousands of tourists and swimmers. Meanwhile, fisheries are harmed by clogging nets, killing fish in nets and pens in aquaculture. Large jellyfish blooms are clogging the cooling water intake system in power plants and structures in coastal areas (Santhanam, 2020; Falkenhaug, 2014; Fukushi *et al.*, 2004).

Managing the increasing jellyfish population is an important task to reduce the negative impact of blooms. Mechanical collection of jellyfish is most recommended in many countries (Fukushi *et al.*, 2004). Meanwhile, the development of jellyfish products, use of cutting nets, and destructive cleaning of artificial hard structure and bio controlling are recommended as short-term management measures to reduce the jellyfish biomass. The potential use of some jellyfish species as fertilizer was described by a few researchers including Chun *et al.* (2012) and Fukushi *et al.* (2004). According to Emadodin et al. (2020b), applying jellyfish fertilizer improves the soil's physical structure and bacterial communities by enhancing soil moisture and supplying nutrients. However, the lethal effects of jellyfish on seedlings due to high chlorine content have also been documented (Fukushi *et al.*, 2004). Many attempts such as mixing jellyfish with liming material (Chun *et al.*, 2012), and heating the jellyfish suspension in a vacuum (Fukushi *et al.*,2004) have been exercised to overcome this problem.

Seed germination is one of the most important aspects of plant growth (Soltani *et al.*, 2015). Seed germination delays, poor seedling establishment, and seed germination ratio are some of the problems related to farming commercially valuable crops (Kumar *et al.*, 2018). However, different treatments were reported to enhance seed germination in various field crops and vegetables and seed priming is one such treatment and it permits pre-germination physiological and biochemical changes (Pandya *et al.*, 2012).

Maize (*Zea mays*) is one of the important cereal crops and maize seeds germinate rapidly. Therefore, it is an ideal seed to assess the lethal effects of seed priming on seed germination Watermelon (*Citrullus lanatus*) seeds always show delayed germination, high susceptibility to diseases, and low level of seedling establishment (Grange *et al.*, 2000; Pandya *et al.*, 2012). Therefore, this study aims to assess the possible use of the jellyfish *Chiropsoides buitendijki* which is a bloom-forming, highly abundant jellyfish on the west coast of Sri Lanka making a huge impact on coastal fisheries, for seed priming in order to utilize jellyfish blooms more effectively and economically.

METHODOLOGY

Chiropsoides buitendijki which is a major by-catch species of small mesh gill nets in the coastal fishing practices off Beruwala were collected from Maggona (6° 30′ 21.542″, 79° 58′ 43.431″) and Payagala (6° 31′ 54.448″, 79° 58′ 29.474″) fish landing sites during July and August 2022. The samples were individually packed in plastic bags, stored at -20°C and immediately transported to the laboratory of the Department of Zoology, University of Sri Jayewardenepura, Sri Lanka for further analysis. *Chiropsoides buitendijki* samples were properly cleaned and oven-dried following the method described by Emadodin *et al*., (2020) to prepare a powder. Three concentrations (T1, T2, and T3) were prepared by dissolving *C. buitendijki* powder (0.4g, 0.5g, and 0.6g per 40mL) in distilled water and they were used as three treatments for seed priming experiments while taking distilled water as the control (C).

Maize (*Zea mays*) and watermelon (*Citrullus lanatus*) seeds were selected as experimental seeds. The seed viability test was performed for each seed type before seed priming experiments. Seeds (n=20) were soaked in distilled water and three concentrations of *C. buitendijki* for 12 hours, washed with distilled water, and dried to their original weight with forced air under shade before starting the seed germination experiment.

The Petri plate method was conducted to determine the seed germination as proposed by Pandya ***et al*.,** (2012). Seeds were tested for germination on wet filter paper (4 ml distilled water) in darkness at 30°C. Germinated seeds (appearance of radical) were counted for 14 days. All experiments were conducted in triplicates. The percentage of maximum germination and time taken to maximum germination were calculated (Hussein and Saleh,2014).

To test the seedling emergence and establishment, treated seeds were sown on trays filled with sterilized sands (8cm) with enough moisture (Farooq *et al*., 2007). Seedling emergence (appearance of sprout) was counted 14 days after initiation. All experiments were conducted in triplicate. The percentage of maximum emergence and time taken to maximum emergence were calculated. Seedlings were tested for vigour after 14 days. To calculate the seedling vigour index, seedlings were carefully removed and the number of leaves, root length, shoot length, fresh weight, and chlorophyll content of specific leaves were measured.

All the experimental data were checked for normality and subjected to the analysis of variance (ANOVA) and the means were compared by Tukey’s test at $p<0.05$ with Minitab 17.

RESULTS AND DISCUSSION

All jellyfish treated and control maize seeds were germinated within 48 hours showing no significant variations between treated and control seeds with respect to percentage of maximum germination and time taken for 50% germination ($p > 0.05$; ANOVA). This proves that there is no lethal effect of jellyfish on seed germination (table 1).

Table 1: Percentage of maximum germination, and time taken for 50% of seed germination of jellyfish treated and control experimental seeds.

		Maximum germination %	Time taken for 50% germination
Maize	T1	100.00[a] ±0.00	37.54[a] ± 2.14 (h)
	T2	100.00[a] ±0.00	36.87 [a] ± 2.33 (h)
	T3	100.00[a] ±0.00	31.57[a] ± 4.73 (h)
	C	98.33[a] ±2.89	33.82[a] ± 2.98 (h)
Watermelon	T1	75.00[a] ± 8.66	7.27[b] ± 0.80 (D)
	T2	61.67[a] ± 10.43	8.00 [b] ± 0.42 (D)
	T3	63.33[a] ± 10.47	7.84[b] ± 0.63 (D)
	C	30.00[a] ± 8.66	22.11[a] ± 1.25 (D)
Treatments denoted by same letter do not differ significantly (*p<0.05,* Tuke's test)			

Table 2: Percentage of maximum seedling emergence, seedling emergence, time taken for 50% of seedling emergence and seedling vigour index of jellyfish treated and control experimental seeds.

		Maximum Seedling emergence (%)	Time taken for 50% emergence (Days)	Seedling Vigour Index
Maize	T1	81.66 [a] ± 11.55	3.49[a] ± 0.50	9.41[a] ±0.36
	T2	88.33[a] ± 11.55	3.42[a] ± 0.33	9.21[a] ± 0.51
	T3	80.00[a] ± 8.66	3.61[a] ± 0.21	8.49[a] ± 0.81
	C	75 .00[a] ± 18.03	3.76[a] ± 0.46	8.17[a] ± 0.58
Watermelon	T1	46.67[a] ± 7.64	9.51[a] ±0.87	6.48[a] ± 1.45
	T2	68.33[b] ± 2.89	6.81[a] ± 0.31	6.09 [a] ± 1.06
	T3	68.33[b] ± 7.64	7.01[a] ± 0.56	7.06 [a] ± 0.43
	C	5.00[c] ± 5.00	36.97[b]±4.85	2.31 [b] ± 0.53

Treatments denoted by same letter do not differ significantly (*p<0.05,* Tuke's test)

Watermelon seeds were used to test the effect of the jellyfish *C. buitendijki* on seed priming. Jellyfish treated watermelon seeds reported significantly higher germination and maximum germination percentage than the control group ($p< 0.05$; table 1).

In the seedling emergence experiment, all the maize seeds treated with jellyfish emerged before the control group, and maize seeds subjected to T2 treatment showed higher maximum emergence than ($p< 0.05$, ANOVA) the other treatments (table 2). Significantly higher root length was reported in the jellyfish-treated seedlings than in the control ($p<0.05$).

Jellyfish-treated watermelon seeds also showed higher maximum emergence than the control ($p<0.05$). The seeds treated with T2 and T3 reported 68% of maximum seedling emergence and it was 46% and 5%, respectively for T1 and the control (table 2). Water lemon seeds treated with jellyfish reported significant variations in germination percentage, time taken for 50% germination, shoot length, leaf area, and chlorophyll content than the control ($p<0.05$). The seedling Vigour Index was also significantly higher in the treatment groups than in the control. Highest root length was reported in T3-treated seeds (table 3)

Table 3: Shoot length, Root length, Number of leaves, Leaf area, Fresh weight, and Chlorophyll content of treated and control Maize and Watermelon seedlings

		Shoot length	Root length	Number of leaves	Leaf area	Fresh weight	Chlorophyll content
Maize	T1	$9.45^{a} \pm 0.81$	$30.22^{a} \pm 6.52$	3 .00 ± 0.00	$24.99^{a} \pm 0.94$	$1.74^{a} \pm 0.14$	$4.16^{b} \pm 0.82$
	T2	$9.47^{a} \pm 1.02$	$31.08^{a} \pm 5.79$	2.97 ± 0.04	$22.31^{bc} \pm 1.45$	$1.42^{bc} \pm 0.21$	$5.75^{a} \pm 1.20$
	T3	$8.68^{b} \pm 1.14$	$30.58^{a} \pm 6.59$	3.10 ± 0.09	$25.02^{ab} \pm 1.97$	$1.5^{ab} \pm 0.13$	$5.42^{a} \pm 0.46$
	C	$8.27^{b} \pm 1.19$	$18.87^{b} \pm 7.35$	2.88 ± 0.27	$20.06^{c} \pm 1.32$	$1.29^{c} \pm 0.29$	$4.45^{b} \pm 0.61$
Watermelon	T1	$8.61^{b} \pm 1.35$	$7.02^{b} \pm 1.40$	3 .76 ± 0.69	$0.75^{b} \pm 0.48$	$0.58^{a} \pm 0.11$	$5.86^{a} \pm 0.22$
	T2	$9.81^{a} \pm 1.81$	$5.73^{b} \pm 1.75$	4.00 ± 0.00	$1.76^{a} \pm 0.75$	$0.66^{a} \pm 0.18$	$5.75^{a} \pm 1.04$
	T3	$10.01^{a} \pm 1.85$	$10.15^{a} \pm 1.77$	4.00 ± 0.00	$1.76^{a} \pm 0.68$	$0.66^{a} \pm 0.08$	$5.45^{a} \pm 0.61$
	C	$7.33^{c} \pm 1.02$	$6.37^{b} \pm 1.67$	2.48 ± 0.32	$0.20^{c} \pm 0.17$	$0.47^{b} \pm 0.12$	$4.35^{b} \pm 0.22$

Treatments denoted by same letter do not differ significantly (*$p<0.05$,* Tuke's test)

Chun et al., (2012) reported the potential benefit of jellyfish for seedling growth and to increase the soil productivity. According Emadodin *et al*., (2019), oven-dried jellyfish *Aurelia aurita*, applied to ryegrass seeds showed a positive effect on seed germination. Hussein *et al*., (2015) proved that liquefied jellyfish of *Cyanea capillata*, applied to different types of seeds such as anise, canola, coriander, cumin, and dill exhibited a high rate of germination compared to the control. In the present study, all jellyfish-treated maize seeds and control seeds were rapidly germinated proving that there was no lethal effect of jellyfish *C. buitendijki* on seed germination. Meanwhile, the present study identified the seed-priming effect of *C. buitendijki* jellyfish powder on watermelon seeds. Priming of watermelon seeds using jellyfish powder increased both germination and seedling emergence number and reduced delayed germination which is a typical problem in watermelon seeds.

Emadodin *et al*., (2020a) reported the effect of both oven-dried and alcohol-dried jellyfish (*Aurelia aurita* and *Cyanea capillata*) on seed germination and seedling survival of ryegrass. Jellyfish-treated seedlings showed greater vitality with a better establishment rate. This is because of the ability of jellyfish dry matter to absorb water and nutrients from the soil. The present study identified the significance of root development in jellyfish-treated maize and watermelon seedlings. This factor may help better establishment of seedlings. High fresh weight of seedlings also observed due to the high root mass of the seedlings.

An experiment carried out by Kim *et al.,* (2012) in the eroded hillside areas of Japan, proved the importance of jellyfish fertilizer on seedling and tree growth. According to their findings, the application of jellyfish fertilizer improved the seedling growth, seedlings' height, and root diameters as well as reduced seedling mortality (Kim *et al*., 2012).

CONCLUSIONS

This preliminary study reveals the possible use of the jellyfish *C. buitendijki* powder for seed priming to overcome delayed germination in watermelon and to enhance the seedling establishment in maize.

REFERENCES

Adebisi, M.A. and Bello, F.Y., 2015. Seed germination and seedling vigour attributes of Gmelina (Gmelina arborea) seeds affected by fruit maturity levels and pre-storage invigoration treatments under ambient tropical conditions. *Nigeria Agricultural Journal*, *46*(1), pp.155-170.

Brotz, L. and Pauly, D., 2017. Studying jellyfish fisheries: toward accurate national catch reports and appropriate methods for stock assessments. *Jellyfish: ecology, distribution patterns and human interactions. Nova Publishers, New York*, pp.313-329.

Chun, K.W., Damdinsuren, E., Kim, Y.R. and Ezaki, T., 2012. Effect of Jellyfish fertilizer on Seedling Growth and Soil Properties. Journal of the Japanese Society of Revegetation Technology, 38(1), pp.192-195.

Emadodin, I., Reinsch, T. and Taube, F., 2019. Potential of jellyfish as a seed germination promoter. *Jahrestag. Arbeitsgem. Grünl. Futterb*.

Emadodin, I., Reinsch, T., Ockens, R.R. and Taube, F., 2020a. Assessing the potential of jellyfish as an organic soil amendment to enhance seed germination and seedling establishment in sand dune restoration. Agronomy, 10(6), p.863.

Emadodin, I., Reinsch, T., Rotter, A., Orlando-Bonaca, M., Taube, F. and Javidpour, J., 2020b. A perspective on the potential of using marine organic fertilizers for the sustainable management of coastal ecosystem services. Environmental Sustainability, 3(1), pp.105-115.

Falkenhaug. T., 2014. Review of Jellyfish Blooms in the Mediterranean and Black Sea, Marine Biology Research, 10, pp.1038-1039

Farooq, M., Basra, S.M.A., Rehman, H., Ahmad, N. and Saleem, B.A., 2007. Osmopriming improves the germination and early seedling growth of melons (Cucumis melo L.). *Pakistan Journal of Agricultural Sciences*, *44*(3), pp.529-536.

Fukushi, K., Ishio, N., Tsujimoto, J.I., Yokota, K., Hamatake, T., Sogabe, H., Toriya, K.I. and Ninomiya, T., 2004. Preliminary study on the potential usefulness of jellyfish as fertilizer. Bulletin of the Society of Sea Water Science, Japan, 58(2), pp.209-217.

Grange, S.L., Leskovar, D.I., Pike, L.M. and Cobb, B.G., 2000. Excess moisture and seedcoat nicking influence germination of triploid watermelon. *HortScience*, *35*(7), pp.1355-1356.

Hsieh, Y.P. and Rudloe, J., 1994. Potential of utilizing jellyfish as food in Western countries. *Trends in Food Science & Technology*, *5*(7), pp.225-229.

Hussein, O.S. and Saleh, O.I., 2014. Effect of soaking in jellyfish on some parameters of wheat and lentil seedlings. *Journal of Environmental Science, Toxicology and Food Technology*, *8*(4), pp.32-39.

Hussein, O.S., Sayed, R.M. and Saleh, O.I., 2015. Uses of jellyfish in pre sowing seeds treatment and pest control. *Journal of Experimental Agriculture International*, pp.60-69.

Kim, Y.R., Kim, S.W., Damdinsuren, E., Ezaki, T. and Chun, K.W., 2012. The effect of jellyfish (Nemopilema nomurai) fertilizer on tree growth in hillside erosion control works. Journal of forest and environmental science, 28(4), pp.227-231.

Kogovšek, T., Tinta, T., Klun, K., and Malej, A., 2014. Jellyfish biochemical composition: Importance of standardised sample processing. Marine Ecology Progress Series. 510. 275-288.

Kumar, S., Poonia, R.C. and Chaudhary, K., 2018. Assessment of the seed vigour potential in different varieties of wheat. *International Journal of Current Microbiology and Applied Sciences*, *7*(7), pp.354-361.

Pandya, J., Patel, P., Patale, V. and Mehta, K., 2012. Germination treatments for watermelon seeds. *Bioscience Guardian*, *2*, pp.197-200.

Purcell, J.E., Uye, S.I. and Lo, W.T., 2007. Anthropogenic causes of jellyfish blooms and their direct consequences for humans: a review. *Marine Ecology Progress Series*, *350*, pp.153-174.

Richardson, A.J., Bakun, A., Hays, G.C. and Gibbons, M.J., 2009. The jellyfish joyride: causes, consequences and management responses to a more gelatinous future. *Trends in ecology and evolution*, *24*(6), pp.312-322.

Santhanam, R., 2020. Biology and ecology of venomous marine Cnidarians, Thoothukudi: Springer. pp. 7-27.

Soltani, E., Ghaderi-Far, F., Baskin, C.C. and Baskin, J.M., 2015. Problems with using mean germination time to calculate rate of seed germination. *Australian Journal of Botany*, *63*(8), pp.631-635.

Torri, L., Tuccillo, F., Bonelli, S., Piraino, S. and Leone, A., 2020. The attitudes of Italian consumers towards jellyfish as novel food. Food Quality and Preference, 79, p.103782.

ACKNOWLEDGMENTS
This study was financially supported by the University Research Grant ASP/01/RE/SCI/2022/33 of the University of Sri Jayewardenepura, Sri Lanka