Seed Germination and Vigour Indices of Celocia (*Celosia argentea* L.) as Affected by Chemical Concentrations in Osmo-priming Solution

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Abstract

Seeds that are directly sown need a long time to absorb water from the soil; by shortening this period, seeds may be made ready to germinate and seedlings can emerge sooner. The seed priming technique is the simplest approach to do this. Thus, the study was conducted ***to*** *determine the effect of chemical concentration in osmo-priming solutions on the germination and seedling parameters of celocia seeds. Three osmo-priming chemicals (Calcium chloride CaCl, Potassium nitrate $KN0_3$ and Polyethylene glycol PEG6000) and four chemical concentrations (Control, 5 g, 10 g, 15 g and 20 g of the above chemicals in a water solutions) as treatments in the study. Parameters were final germination percentage, germination rate index, germination index, mean germination time, coefficient of velocity of germination, root length and seedling fresh weight. For most of the parameters, osmo-priming was statistically significant. Results showed that 15 g chemical concentration treatments had significant effect on final germination percentage (92.50 – 94.00 %), mean germination time 3.35 – 4.00 days), germination rate index (40.92 – 48.56 %), germination index (860.00 – 924.50), coefficient of velocity of germination (85.60 – 88.37 %), root length (0.58 – 0.77 cm) and seedling fresh weight of celocia seeds (0.08 g). The un-primed treatment showed the lowest final germination percentage (12.50 %), germination rate index (1.52 %), coefficient of velocity of germination (1.58 %), germination index (45.00%) but higher mean germination time (72.88 days) of celocia seeds. Priming with $KNO_{3,}$ PEG6000 and CaCl solution at a concentration of 15 g is a remarkable technique for improving seed germination and seedling growth of celocia.Therefore, the present study concludes that improvement of germination capacity and rapidity of germination of celocia seed could be possible by employing osmo-priming treatment.*

Keywords: Celocia; Osmo-priming; Concentration; Seed; Germination; Seedling and Parameters

Indices de germination et de vigueur des graines de Celocia (*Celosia argentea L.*) affectés par les concentrations chimiques dans la solution d'osmo-amorçage

Résumé

Les graines directement semées ont besoin de beaucoup de temps pour absorber l'eau du sol ; en raccourcissant cette période, les graines peuvent être prêtes à germer et les semis peuvent émerger plus tôt. La technique d'amorçage des semences est l'approche la plus simple pour y parvenir. Ainsi, l'étude a été menée pour déterminer l'effet de la concentration chimique dans les solutions d'osmo-amorçage sur les paramètres de germination et de semis des graines de Celocia. Trois produits chimiques osmo-amorçants (chlorure de calcium CaCl, nitrate de potassium KN03 et polyéthylène glycol PEG6000) et quatre concentrations chimiques (contrôle, 5 g, 10 g, 15 g et 20 g des produits chimiques ci-dessus dans une solution aqueuse) comme traitements dans l'étude . Les paramètres étaient le pourcentage de germination finale, l'indice de taux de germination, l'indice de germination, le temps moyen de germination, le coefficient de vitesse de germination, la longueur des racines et le poids frais des plantules. Pour la plupart des paramètres, l'osmo-amorçage était statistiquement significatif. Les résultats ont montré que des traitements à une concentration chimique de 15 g avaient un effet significatif sur le pourcentage de germination final (92,50 – 94,00 %), le temps de germination moyen 3,35 – 4,00 jours), l'indice de taux de germination (40,92 – 48,56 %), l'indice de germination (860,00 – 924,50), le coefficient. de la vitesse de germination (85,60 – 88,37 %), de la longueur des racines (0,58 – 0,77 cm) et du poids frais des graines de célocie (0,08 g). Le traitement sans amorçage a montré le pourcentage de germination final (12,50 %), l'indice de taux de germination (1,52 %), le coefficient de vitesse de germination (1,58 %), l'indice de germination (45,00 %) les plus faibles, mais un temps de germination moyen plus élevé (72,88 jours) de graines de célocie. L'amorçage avec une solution de KNO3, PEG6000 et CaCl à une concentration de 15 g est une technique remarquable pour améliorer la germination des graines et la croissance des plantules de célocie. Par conséquent, la présente étude conclut que l'amélioration de la capacité germinative et de la rapidité de germination des graines de célocie pourrait être possible en en utilisant un traitement d'osmo-amorçage.

Mots-clés : Célocie; Osmo-amorçage ;Concentration; Graine; Germination; Semis et paramètres

وتحتاج البذور التي تزرع مباشرة إلى وقت طويل لامتصاص المياه من التربة ؛ من خلال تقصير هذه الفترة، قد تكون البذور جاهزة للإنبات ويمكن أن تظهر الشتلات في وقت أقرب تقنية تهيئة البذور هي أبسط نهج للقيام بذلك وبالتالي، أجريت الدراسة لتحديد تأثير التركيز الكيميائي في محاليل تهيئة الأوزمو على بارامترات الإنبات والبذر لبذور السيلوكيا ثلاث مواد كيميائية لتهيئة الأوزمو (كلوريد الكالسيوم ونترات البوتاسيوم والبولي إيثيلين جليكول) أربعة تركيزات كيميائية (التحكم، خمسة جرام، عشرة جرام خمسة عشر جرام عشرون جرام من المواد الكيميائية المذكورة أعلاه في محاليل المياه) كعلاجات في الدراسة. كانت البارامترات هي النسبة المئوية النهائية للإنبات، ومؤشر معدل الإنبات، ومؤشر الإنبات، ومتوسط وقت الإنبات، ومعامل سرعة الإنبات طول الجذر وشتلة الوزن الطازج. بالنسبة لمعظم المعلمات، كان تهيئة الأوزمو ذات دلالة إحصائية. أظهرت النتائج أن خمسة عشر جرامًا من علاجات التركيز الكيميائي كان لها تأثير كبير على نسبة الإنبات النهائية (92.50 - 94.00٪) متوسط وقت الإنبات 3.35 - 4.00 أيام)، مؤشر معدل الإنبات (40.92 - 48.56٪)، مؤشر الإنبات (860.00 - 924.50) معامل سرعة الإنبات (85.60 - 88.37 في المائة)، وطول الجذر (0.58 - 0.77 سم) وشتلة الوزن الجديد لبذور السيلوكيا (0.08 غ).أظهر العلاج غير المستعد أدنى نسبة إنبات نهائية (12.50٪)، ومؤشر معدل الإنبات (1.52٪)، ومعامل سرعة الإنبات (1.58٪)، مؤشر الإنبات (45.00٪) ولكن متوسط وقت الإنبات (72.88 يومًا) لبذور السيلوكيا أعلى لذلك، تخلص هذه الدراسة إلى أن تحسين القدرة على الإنبات وسرعة إنبات بذور السيلوكيا يمكن أن يكون ممكنًا من خلال استخدام علاج الأوزمو.

Introduction

Celocia argentea, a native of India, is known in southern Nigeria as "Lagos spinach" or "Sokoyokoto." Adediran *et al*. (2015) described it as an erect, short-lived annual plant belonging to the Amaranthaceae family. Protein, calcium, iron, and vitamins A, C, and E are all abundant in the plant (Adegbaju *et al*., 2019). As a result, it is a nutrient-dense green vegetable widely grown in West Africa, where the leaves and succulent shoots are used to make stews, sauces, and soups with a variety of other ingredients. Celosia *argentea* is also used to treat diabetes, diarrhea, ulcers, and menstrual irregularities (Makinde *et al*., 2016).

Seeds that are directly sown need a long time to absorb water from the soil; by shortening this period, seeds may be made ready to germinate and seedlings can emerge sooner. The seed priming technique is the simplest approach to do this. Seed priming or pre-plant seed treatments such as osmo-conditioning, matri-conditioning, rehydration, and humidification can be used to shorten the time it takes for low-quality seeds to germinate, synchronize germination, and enhance the germination rate in the lab and in the field (Khan, 1992). Because uneven stands result in low yields, good crop establishment is critical in the development of annual crops from seed. In rice, variety of seed priming strategies such as hydro-priming, osmo-priming, hormone priming, nutritional priming, and chemical priming has been recommended (Farooq et al., 2006). Seed priming is the process of immersing seeds in water or osmotic solutions, then drying them before radical emergence (McDonald, 2000). This method has been utilized to promote germination, decrease seedling germination time, improve stand establishment, boost emergence, and induce early blooming and maturation, all of which led to increased grain yields (Basra *et al*., 2005a). Additionally, priming (osmo-conditioning) is a physiological strategy that promotes seed performance and allows for quicker and more coordinated germination (Sivritepe and Dourado, 1995).

Although various investigations have been carried out to examine the effects of pre-treatment on seed germination performance in commercially cultivated celosia, little attention has been paid to the use of seed osmo-priming in celosia production. As a result, this experiment was carried out to investigate the effects of $KN0_3$, CaCl, and PEG concentrations in osmo-priming solutions on seed germination parameters and celosia seedling features.

Materials and Methods

Experimental Site and Materials Used

The experiment was conducted in the Plant Breeding and Seed Science Laboratory, of Joseph Sarwuan Tarka University, Makurdi in the year 2021. Celocia seeds obtained from National Horticultural Research Institute Bagauda Station Kano were used for the study. Also, blotter paper, plastic containers and measuring instrument were used for the experiment.

Treatment and Experimental Design

The experiment was a single factor treatment laid out in a Completely Randomized Design (CRD) with four replications. The various treatments assigned were 14 priming chemical combinations (Unprimed Seeds, Hydro-primed seeds and seeds primed in the following combinations; Hydro + CaCl 5 g, Hydro + $KN0_3$ 5 g, Hydro + PEG6000 5 g, Hydro + CaCl 10 g, Hydro + $KN0_3$ 10 g, Hydro + PEG6000 10 g, Hydro + CaCl 15 g, Hydro + $KN0_3$ 15 g, Hydro + PEG6000 15 g, Hydro + CaCl 20 g, Hydro + $KN0_3$ 20 g and Hydro + PEG6000 20 g)

Seed Priming

About 15 g of untreated celocia seeds were soaked in 500L of osmo-priming solutions for a period 24 hours by the treatments and re-dried under room temperature for a period of 24 hours before use in the germination test.

Germination Test

Germination test was set up on 400 seeds per treatment according to ISTA (1996). Seeds were tested using sand method in plastic containers. One hundred seeds were broadcasted in each container to represent a replicate. Broadcasted seeds were constantly moistened with clean and uniform quantity of water at 8 am and 5pm daily until 14 days that the experiment was terminated. Germinated seeds were counted daily until the number of days for a treatment to attain a recommendable germination percentage was attained.

Data Collection

Data was recorded on the following parameters:

Final Germination Percentage (FGP): FGP $= \frac{\mathrm{Ng}}{\mathrm{Nt}} \times 100$ where Ng = Total number of seeds germinated and Nt = Total number of seeds evaluated according to Scott *et al.* (1984)

Mean Germination Time (MGT): MGT = $\frac{\Sigma \mathrm{NiTi}}{\Sigma \mathrm{Ni}} = 100 / \mathrm{CVG}$ where Ni = Number of seeds germinated per day and Ti = Number of days from the starting the experiment as described by Orchard, (1977).

Germination Index (GI - in decimal): (13 × N1) + (12 × N2) +.... + (1 × N13) where N1, N2 and … are the number of germinated seeds at first day, second and other days and numbers 6, 7 and ... are respectively the weights imposed on the number of seeds germinated at first day, second and other days. Bench Arnold *et al*. (1991)

Coefficient of Velocity of Germination (CVG): $100 \times \frac{\Sigma \mathrm{Ni}}{\Sigma \mathrm{NiTi}}$ where Ni = Number of germinated seeds per day and Ti = Number of days from the start of the experiment Jones and Sanders, (1987)

Germination Rate Index (GRI): G1 / 1 + G2 / 2 + …. + Gx /X where G1 = Germination percentage at first day and G1 = Germination percentage at the second day and so on Esechi (1994) after modification.

Root Length (RL): Ten normal seedlings were randomly selected from each replicate on the 8th day of broadcasting. Root length was measured from the point of attachment to the embryo (endosperm), down to the tip of the growing root and the average root length was computed. The average shoot length was computed according to (ISTA, 1996)

Seedling Fresh Weight (SFW): Ten normal seedlings were randomly selected from each replicate on the 8th day of broadcasting. The seedling fresh weight was measured by weighing the sampled seedlings in grams and finding the average. The average shoot length was computed according to (ISTA, 1996)

Data Analysis

The data collected from germination test was subjected to analysis of variance (ANOVA). Treatment means were separated and ranked at 0.05% and 0.01% level of probability using Duncan Multiple Range Test (DMRT). All data analysis was carried out using GenStat Seventeenth Edition 64 - bit Release 17.1.

Results

Table below shows result of the effects of chemical concentrations in Osmo-priming solutions on Celosia seed germination and vigour.

From the table, result showed that FGP significantly increased with increase in chemical concentrations up to 15 g and decreases with increase in chemical concentrations above 15 g.

Table 1: Effects of Chemical and Concentrations on Celocia Seeds Germination Parameters.

PRIMING TREATMENTS	FGP	GRI	GI	CVG	MGT	RL	SFW
Un-primed	12.50f	1.52j	45.00j	1.58f	72.88a	0.92a	0.08ab
Hydro-primed	52.25d	20.76fg	432.00fh	27.09d	9.04cd	0.77ab	0.09a
Hydro + 5 g CACL	61.75c	23.69de	519.20de	38.14c	7.44de	0.58ab	0.08ab
Hydro + 5 g KNO_3	60.75c	18.74gh	450.50fgh	36.91c	9.20cd	0.42bc	0.09a
Hydro + 5 g PEG6000	64.00c	21.04efg	479.00efg	41.00c	8.63cde	0.93a	0.08ab
Hydro + 10 g CACL	70.00b	28.66c	603.20c	49.01b	6.26e	0.91a	0.08ab
Hydro + 10 g KNO_3	72.25b	24.08d	551.50d	52.24b	7.43de	0.36bc	0.09a
Hydro + 10 g PEG6000	71.75b	27.93c	607.00c	51.49b	6.32e	0.48bc	0.08ab
Hydro + 15 g CACL	93.75a	48.56a	924.50a	87.91a	3.35f	0.58ab	0.08ab
Hydro + 15 g KNO_3	94.00a	40.92b	875.00b	88.37a	3.93f	0.79ab	0.08ab
Hydro + 15 g PEG6000	92.50a	43.09b	860.00b	85.61a	4.00f	0.77ab	0.08ab
Hydro + 20 g CACL	54.75d	16.56h	405.50h	30.12d	10.20c	0.96a	0.07b
Hydro + 20 g KNO_3	59.75c	21.78def	479.00efg	35.97c	8.42cde	0.51ab	0.08ab
Hydro + 20 g PEG6000	45.25e	13.06i	331.20i	20.59e	12.77b	0.64ab	0.07b
Standard Error	2.78	1.78	30.78	3.42	1.49	0.52	0.01
Coefficient of Variation	4.30	7.10	5.70	7.40	12.10	19.70	14.00
Significant Level	**	**	**	**	**	*	*

Key: ** = Significant at 0.01, * = Significant at 0.05, FGP = Final Germination Percentage, GRI = Germination Rate Index, GI = Germination Index, CVG = Coefficient of Velocity of Germination, MGT = Mean Germination Time, RL = Root Length and SFW = Seedling Fresh Weight.

From the result, Un-primed seeds recorded the least FGP with mean value of 12.50 % while the highest FGP was recorded from the 15 g concentration across all the chemicals used with mean values ranging from 94.00 %, 93.75 % and 92.50 %. The result showed no interaction difference between chemical and concentrations from 5 g, 10 g and 15 g. However, in 20 g (KNO_3) recorded the highest FGP, followed by CaCl and the least was observed from PEG6000 with mean values of 59.75 %, 54.75 % and 45.25 %, respectively.

The result showing the effects of chemical and concentrations on GR1 recorded highly significant difference. Result showed an increase in the GR1 with increase in chemical concentrations up to 15 g and a decrease in GR1 as the concentration increases to 20 g. The interaction showed that, 15g (CaCl) significantly gave the highest GR1 with mean values of 48.56 followed by 15g (PEG 6000) and 15 g (KNO_3) with mean values of 43.09 and 40.92, respectively which are statistically not significant. The least GR1 was recorded from Un-primed seeds with mean value of 1.52. The result in GI presented showed significant difference at 0.01 probability level. From the result, 15g (CaCl) recorded the highest GI which was significantly difference from 15 g (KNO_3) and 15 g (PEG 6000) with mean values of 924.50, 875.00 and 860.00, respectively. The least GI was observed from Un-primed seeds with mean value of 45.00.

The result on effects of chemical and concentrations on CVG of Celocia also followed a similar trend as in GR1 and GI. From the result, CVG was increasing with an increase in chemical concentrations irrespective of chemical up to 15g and reduced when the chemical concentration was increase to 20 g. There was no significant difference with respect to chemical at 5 g, 10 g and 15 g concentration. The least CVG was recorded in Un-primed seeds with mean value of 1.58. The result of MGT showed a significant decrease in MGT with increase in chemical concentrations from 0 – 15 g. However, as the chemical concentration was increase to 20 g, the MGT begins to increase. The least MGT was recorded from 15 g concentrations with mean values ranging from 3.35 days (CaCl), 3.93 days (KNO_3) and 4.00 days (PEG6000), respectively. However, the highest MGT was recorded from Un-primed seeds with mean values of 74.88 days. There were no interaction effects of chemical and concentrations observed in the result except at 20 g concentration where PEG 6000 recorded significant higher MGT of 12.77 days over CaCl and KNO_3 with mean values of 10.20 days and 8.42 days, respectively.

There was significant difference with RL at 0.05 % level of probability. The result recorded the higher RL from Un-primed seeds, 5g (PEG 6000), 10g (CaCl), and 20 g (CaCl) with mean values of 0.92 cm, 0.93 cm, 0.91 cm and 0.96 cm, respectively. The result in RL was not consisted with respect to treatment as recorded in other parameters. The least RL was recorded from 5 (KNO_3), 10g (KNO_3), 10g (PEG 6000) with mean values of 0.42 cm, 0.36 cm, and 0.48 cm, respectively. The result showing the effects of chemical and concentrations on SFW was significant at 0.05% level of probability. From the result, Hydro-primed seeds, 5 g (KNO_3), 10g (KNO_3) showed the highest SFW with mean values 0.09 g each. The result was however, different from the least SFW recorded from 20 g (CaCl) and 20 g (PEG 6000) with mean values of 0.07 g each.

Discussion

Positive effects of primed seeds over Un-primed seeds could be due to increased water content in the primed seeds, which is important in activating enzymes responsible for embryo development and mining of the starchy endosperm (Paparella *et al*., 2015). Primed seeds absorb water more rapidly than non-primed seeds and revive the seed metabolism which enhance germination. Result could also be due to the initiation of biochemical mechanism of cell repairs, which increase the RNA content and enhances DNA replication (Mirza *et al*., 2015). Priming appears to strengthen the defense system by increasing the activity of oxidant enzymes such as superoxide dismutase, catalase, and glutathione reductase (Zhana *et al.,* 2015).

Reduction in germination because of increase in priming concentration could be due to the inability of seed metabolize due to high abiotic stress (Abiri *et al*., 2016). Increase RL and SFW because of priming could be due to increased nuclear replication in the tissues of primed seeds (Yari *et al.,* 2010). Reason could also be that primed seed may contain higher potassium, zink and calcium content, as those minerals are responsible for cell elongation according to Mousavi *et al.,* (2011). Increased FGT with increasing chemical concentration could be due to an increased rate of cell division in the seed, and the completion of pre-germinative metabolic activities and repair process (Ghiyasi *et al.,* 2008). All the above process makes the primed seeds sooner ready in radical protrusion than the control. Farooq *et al.* (2007) also observe a similar trend in primed melon seeds. Hassanpouraghdam *et al*. (2009) again observes high RL and SH in primed seeds over the Unprimed seeds. Nawaz *et al.* (2013) observe increase in RL from primed seeds with PEG.

Conclusion

The study showed that osmo-priming treatments enhanced rapid seed germination while lessening the mean germination time and enhancing seedling growth by different priming chemicals and concentrations. The results showed that chemical priming treatments had significant effect on final germination percentage, mean germination time, germination rate index, coefficient of velocity of germination, root length, germination index and seedling fresh weight of celocia seeds. Primed with **KNO_3, PEG 6000 and** CaCl solution in a concentration of 15g is a remarkable technique for improving seed germination and seedling growth of celocia. The un-primed treatment showed the lowest final germination percentage, germination rate index, coefficient of velocity of germination, seedling height and seedling weight but higher mean germination time of celocia seeds. Therefore, the present study concludes that improvement of germination capacity and rapidity of germination of celocia seed could be possible by employing osmo-priming treatment.

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