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Effects of Seed Hydro-Priming Duration on Seedling Emergence and Growth of African Bird's Eye Pepper (*Capsicum Frutescens* L.)

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Abstract
African Bird's eye pepper (*Capsicum frutescens* L.) growers have a problem with establishment due to poor seed germination and emergence and there is a need to proffer solution to this problem. There is assertion that the germination of seeds of African bird's eye pepper is restricted by physiological dormancy and only germinates after the seeds have passed through the digestive track certain birds. This process whereby the seeds have to pass through digestive track is impracticable for commercial growers. There is need therefore to proffer method of seed treatment that can solve this problem. Seed priming has been reported to improve germination, seedling emergence and growth in crops; therefore an experiment was conducted to examine effects of 24, 48, 72 or 96 h hydro-priming with 0 h as control on seedling emergence and growth of African Bird's eye pepper. Data were collected on emergence and growth variables and data analysis was conducted using Analysis of Variance (ANOVA). Significant treatment means were separated with Duncan's Multiple Range Test at $p \leq 0.05$. Hydro-priming affected days to first, 50% emergence and seedling growth. The 48 h hydro-priming duration had the shortest days-to-first emergence – DE1 (7 days) and the control recorded the longest DE1which was 11 days. The increase in hydro-priming durations (72 and 96 h) led to longer DE1 (9 and 11 days) respectively while 24 h duration had DE1 to be 8 days. The 48 h hydro-priming enhanced seedlings growth variables like the number of leaves (9), shoot height (8cm) and seedling dry weight (0.05g/plant) compared to control, 24, 72 and 96 h hydro-priming with lower values that ranged from 6-8, 3-6 cm and 0.0-0.03g/plant for number of leaves, shoot height and seedling dry weight respectively. Hydro-priming as a seed pre-sowing treatment is useful for ensuring early emergence and production of vigorous seedlings in pepper. This study showed that the optimum hydro-priming period for African Bird's eye pepper is 48 hours.

Keywords: Dormancy, germination, pre-sowing, seed treatment, stand establishment, vigour.

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Introduction

Pepper (*Capsicum* spp.) is an annual but it can be grown as a perennial where there is adequate water and appropriate temperatures. The African bird's eye pepper (*C. frutescens* L) is a hot chilli pepper grown for the consumption either as fresh fruit or as dried and processed hot pepper (Baral and Bosland, 2002; Pathirana, 2013). Growers have a problem of poor emergence in the nursery characterised by uneven stands. This is due to poor seed germination and emergence occasioned by restricted by physiological dormancy in the seeds.The attendant costs associated with re-sowing or re-transplanting seedlings are an important reason why farmers in difficult areas get into debt during crop production (Harris *et al.,* 2001). Production or raising of vigorous seedlings for good crop establishment on the field can only be from seed with high vigour and germination capacity. Seed vigour is defined by Association of Seed Analysts (AOSA) as those properties that determine the potential for rapid, uniform emergence and development of normal seedlings under a wide range of field conditions (AOSA, 2014).

Seed properties such as vigour and germination capacity and crop growth in the field improve by seed priming using different priming methods including hydro-priming, osmo-priming, halo-priming, hormonal-priming (Harris *et al.,* 1999). Priming of seeds in osmoticums such as mannitol, polyethylene glycol and sodium chloride has been reported to be an economical, simple and a safe technique for increasing the capacity of seeds to osmotic adjustment and enhancing seedling establishment and crop production under stressed conditions. Among above methods for seed priming soaking and misting seeds in water and redrying them before they complete germination (hydro-priming) is the simplest approach to hydrating seeds (Mc Donald, 2000). The adverse effects of drought and salinity stress can be alleviated by various measures, including seed priming (Ashraf and Foolad, 2005). Hydro-priming seed is hydration to a point of pre-germination without actual germination (Rakshit and Singh, 2018; Sheer *et al.,* 2019). Hydro-primed seeds have early, higher and synchronized germination as a result of reduction in lag time of imbibition (Brocklehurst and Dearman, 2008), build-up of germination enhancing metabolites (Farooq *et al.,* 2009), more uniform germination, or by higher germination index (GI) and heavier seedlings (Moghanibashi *et al.,* 2012). Despite positive effects of hydro-priming on other crops' seedsthe optimum or '*ideal or safe'* duration for pepper, especially African Bird's eye pepper has not be established. *Capsicum frutescens* seed exhibits slow and uneven emergence, resulting in production of uneven sized seedlings. This is attributable to existence of a restricted physiological dormancy in seed of the

genus which may be corrected by pre-sowing treatment like hydro-priming. Hydro-priming which is a simple method had been successfully used on *Capsicum annum* cv. Goliath (Uche *et al.,* 2016) but not on African Bird's eye landrace. The success of hydro-priming as a seed pre treatment option that enhanced synchro-nisation of germination did not consider the possible implication of over priming or duration of priming as it affects the germination and emergence of seedlings. The experiment was conducted to determine the optimum hydro-priming duration for seedling emergence, growth and vigour in African bird's eye pepper.

Materials and Methods

The experiment was carried out at the Horticultural Nursery, behind College of Veterinary Medicine, Federal University of Agriculture, Abeokuta, Nigeria, between July and August 2017. Routine soil analysis was conducted at the College of Environmental Resource Management laboratory prior to potting. The physical and chemical properties were determined by standard protocol as described by AOAC, (2016). Fifteen pots (25 cm × 22 cm) with perforated bottom were filled with 5 kg sieved soil each and watered to field capacity and left for 3 days to ensure a fine tilth before sowing. Seeds were extracted from locally sourced landrace African bird's eye pepper. Seeds were cleaned and stored in paper bags at average ambient temperature of 27^{o}C for three days. Seeds were soaked for priming in distilled water in transparent polyvinyl bottles for 24, 48, 72 and 96 hours, and non-primed seeds were used as control. At the end of each hydro-priming period, seeds were air-dried on cotton wool for 2 hours.One hundred (100) seeds were selected per treatment (Hydro-priming duration) and sown into pots filled with OxicPaleustalf soil (Sotona *et al.,* 2014). The treatments were arranged in a completely rando-mized design with 3 replications. Data collection started 3 days after sowing (DAS) for days-to-first emergence (DE1; number of first emerged seedlings (ES1) and days-to-50% emergence (DE50%). Emergence was considered to have occurred at the sight of plumule above the soil line. Data on level of emergence at 7 days after sowing (DAE7) was collected by adding number of seedlings that emerged and dividing by number of seeds sown multiplied by 100 percent. Emergence in percentage (EP) was determined by counting the number of normal seedlings that emerged at 14 days after sowing divided by the number of seeds sow multiplied by 100 (Saeedeh *et al.,* 2019).

Growth variables assessed between 6 and 8 weeks after sowing were number of leaves by counting, seedling shoot height measured from soil level to stem apex with metre rule, number of roots by counting and root length with metre rule. The seedling shoot vigour index and root vigour index were calculated using the formula (Saeedeh *et al.,* 2019):

i. Seedling shoot vigour index = Seedling emergence % x Seedling shoot height ÷ 100.
ii. Seedling root vigour index = Seedling emergence % x Seedling mean root height ÷ 100.

Seedling fresh weight was determined (6-8WAS) from 10 uprooted normal seedlings using a sensitive weighing balance. These seedlings were oven-dried at 135^{o}C for 1 hour to determine the dry weight and dry weight measured using a sensitive weighing balance. Data analysis was done using Analysis of Variance (ANOVA) in GENSTAT 12th edition (VSN International, 2012) and significant treatment means were separated with Duncan's Multiple Range Test at $p \leq 0.05$.

Results

The soil was sandy-loam, slightly acidic, high in organic matter, phosphorus and potassium but low in nitrogen (Table 1). Hydro-priming significantly affected Days-to-first emergence and 50% emergence ($p \leq 0.05$) but not number of seedlings for DE1, RE DAE 7 and emergence percentage 14 days post emergence ($p \leq 0.05$). Days-to-50% seedling emergence (DE50%) followed a similar trend for the DAE1. The non-primed and 96 h hydro-primed seeds recorded the longest days to attain DE50%, followed by 72 and 24 h hydro-priming period while the shortest time was in 48 h hydro-priming. Rate of emergence (RE) at 7 days after emergence was not affected by hydro-priming duration ($p \leq 0.05$). Highest emergence percent at14 days after emergence was obtained from the seeds hydro-primed for 48 h, followed by 24 and 72 h, respectively while control and 96 h hydro-priming had lower emergence percent (Table 2). Seedlings growth response varied with treatments. The effect of hydro-priming on number of leaves of the seedlings was not significant. However, 48 h hydro-priming had highest number of leaves followed by 24 h while control had the least number of leaves 6-8 weeks after sowing (WAS) (Figure 1). Hydro-priming treatments had significant effect on seedling shoot height of *Capsicum frutescens* between 7 and 8 WAS ($p \leq 0.05$). Seedlings from 48 h hydro-primed seed at 7 and 8 weeks after sowing were the tallest followed by those from 24 h hydro-primed seed. Seedlings from 72 and 96 h hydro-primed seed had shorter shoots and control had the shortest shoot height (Figure 2). The number of roots of *Capsicum frutescens* seedlings was not affected by hydro-priming duration at 6 and 7 WAS ($p \leq 0.05$), but was significantly affected at 8 WAS ($p \leq 0.05$). At this growth period (8 WAS), 48 h hydro-priming period recorded the highest number of roots followed by 24h, while 96 h hydro-priming period and control had the same number, and 72 h duration recorded the least number of roots (Figure 3). The seedling root length of *Capsicum*

frutescens was affected by the hydro-priming treatments between 7 and 8 WAS ($p \leq 0.05$). At 7 and 8 WAS, seedlings from 48 h hydro-priming period had longest roots which were similar to 24 h hydro-priming period; while 72, 96 h hydro-priming and control had the shortest roots (Figure 4).

The effect of hydro-priming was significant on seedling fresh weights at 7 and 8 WAS ($p \leq 0.05$). At 7 and 8 WAS, 48 h hydro-primed seed had the highest seedling fresh weight followed by 24 and 96 h hydro-priming period, while 72 h hydro-priming and control had the lowest seedling fresh weight (Figure 5).

Effect of treatments on seedling dry weight of *Capsicum frutescens* varied but not significantly different ($p \leq 0.05$). At 6-8 WAS, 48 and 24 h hydro-priming period had higher seedling dry weight which was similar to 72 and 96 h hydro-priming duration and control had lowest dry weight (Figure 6). The Seedling root vigour index of *Capsicum frutescens* was significantly affected by hydro-priming throughout period of observation. Hydro-priming at 24 h had the highest root vigour index while 48 and 96 h durations had higher similar root vigour index values. Control and 72 h duration recorded the least values (Figure 7). The seedling shoot vigour index was influenced by the hydro-priming treatments 7 and 8 WAS. Hydro-priming for 48 and 24 h produced seedlings having highest shoot vigour index (5.5 and 4.73) respectively compared to 96 h hydro-priming while control and 72 h treatments had the least seedling shoot vigour index 1.7 and 1.42 respectively as shown in Figure 8.

Table 1: Pre-cropping physical and chemical properties of soil

Soil properties	Values
pH	6.8
Soil organic matter (%)	5.0
Organic carbon (%)	2.9
Total Nitrogen (%)	0.87
Available Phosphorus ($mgkg^{-1}$)	36.14
Exchangeable bases ($cmolkg^{-1}$)	
Ca	0.236
Mg	0.294
K	0.694
Na	0.621
Particle size (gkg^{-1})	
Sand	81.2
Clay	17.4
Silt	1.4
Textural class	Sandy-loam

Table 2: Effects of hydro-priming on seedling emergence variables in *Capsicum frutescens* (African bird's eye pepper)

HpD	DE1	Number of seedlings DE1	Days to50% SE	RE DAE7	EP 14 DAE
Control	11.0b	4	14.00c	21.7	41.0
24 hours	8.0ab	6	4.0b	54.7	67.0
48 hours	7.7a	7	3.0a	53.3	59.7
72 hours	9.0ab	3	4.0b	15.7	58.0
96 hours	11.0b	4	14.0c	42.7	31.3
Se	0.88	2.04	1.48	15.13	13.43
Mean	9.33	4.80	1.87	37.60	51.40

HpD = Hydro-primin durations, DE1= Days to first Emergence, RE DAE7 = Rate of emergence at 7 Days after Emergence. EP = Emergence Percentage 14 DAE.se = Standard error

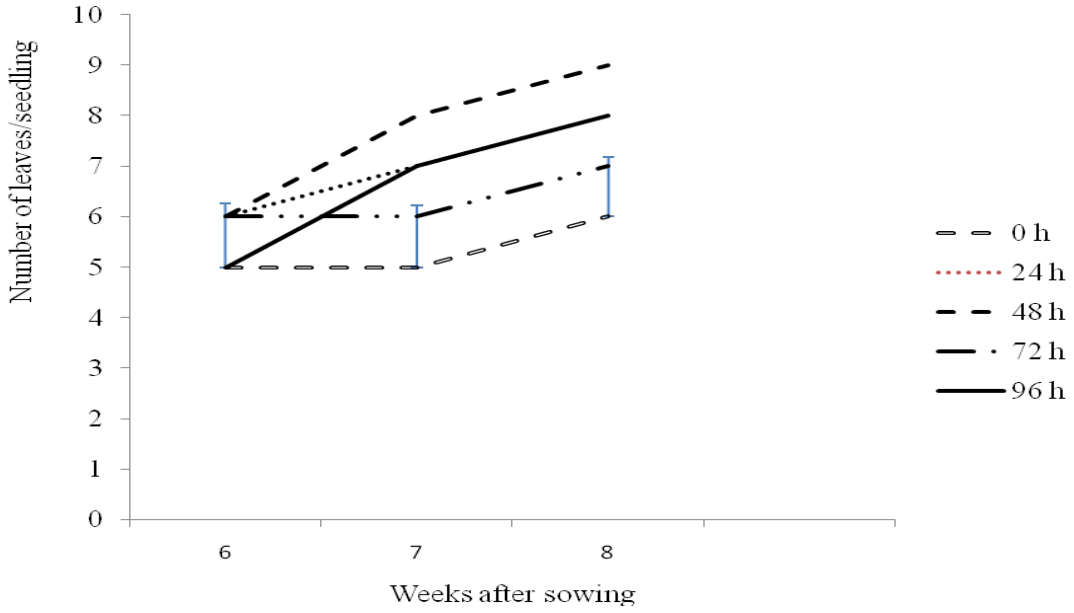

Figure 1: Effects of hydro-priming duration on number of leaves of *Capsicum frutescens* (African bird-eye pepper) seedlings at 6, 7 or 8 weeks after sowing.

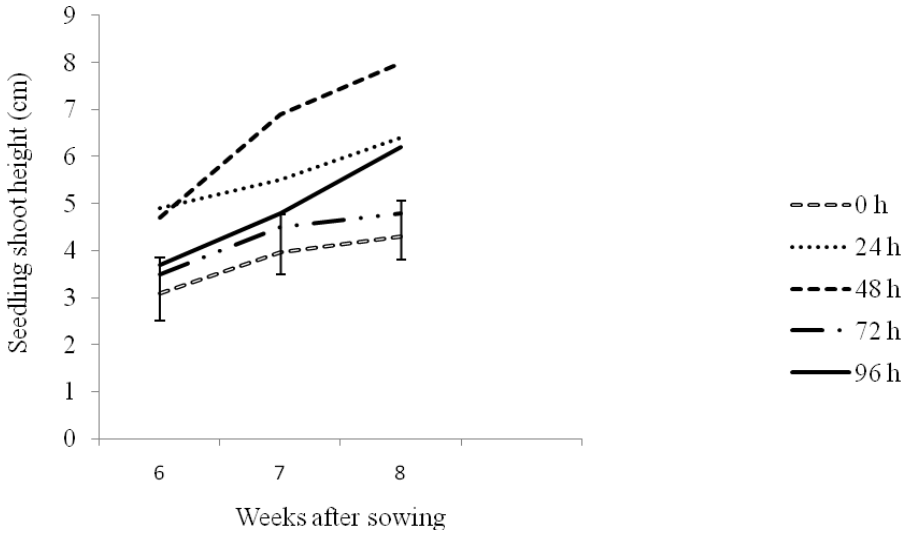

Figure 2: Effects of hydro-priming duration on *Capsicum frutescens* (African bird-eye pepper) seedling shoot height (cm) at 6, 7 or 8 weeks after sowing.

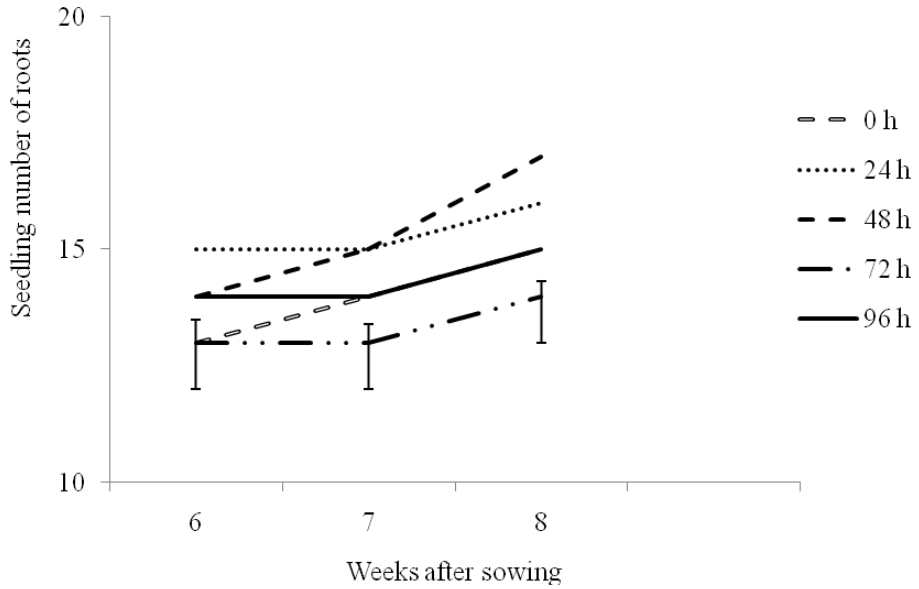

Figure 3: Effects of hydro-priming duration on the number of roots of *Capsicum frutescens* seedlings (African bird-eye pepper) at 6, 7 or 8 weeks after sowing.

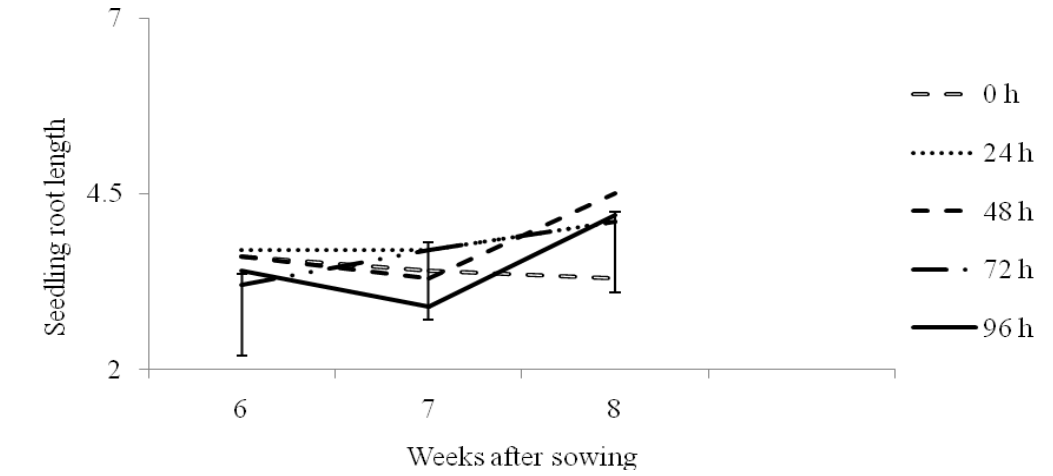

Figure 4: Effects of hydro-priming duration on the seedling root length of *Capsicum frutescens* (African bird-eye pepper) at 6, 7 or 8 weeks after sowing.

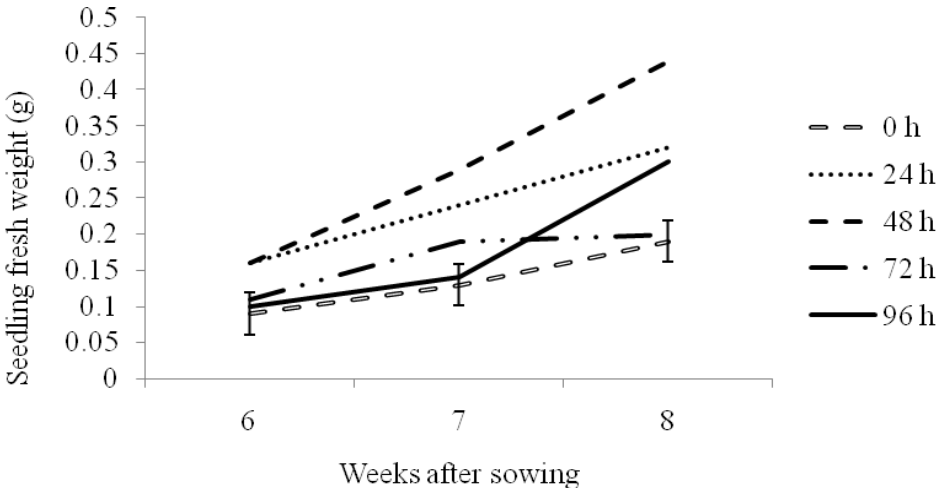

Figure 5: Effects of hydro-priming duration on the seedling fresh weight of *Capsicum frutescens* (African bird-eye pepper) at 6, 7 or 8 weeks after sowing.

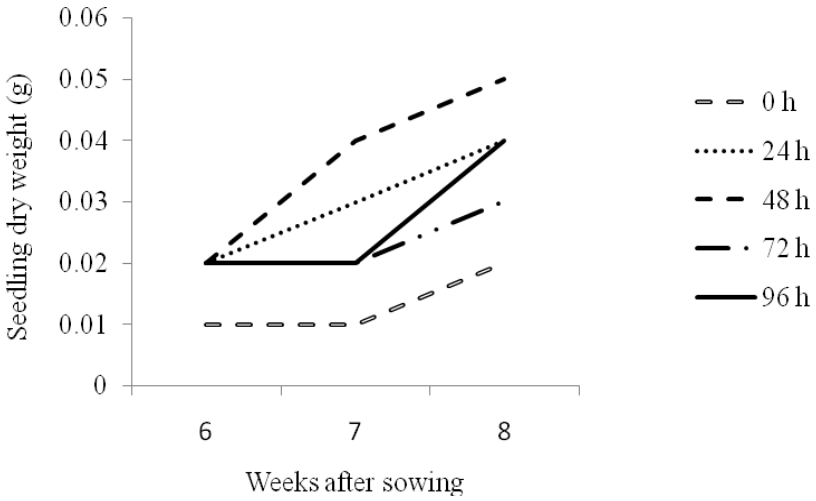

Figure 6: Effects of hydro-priming duration on the seedling dry weight (g/plant) of *Capsicum frutescens* (African bird-eye pepper) at 5, 6, 7 or 8 weeks after sowing.

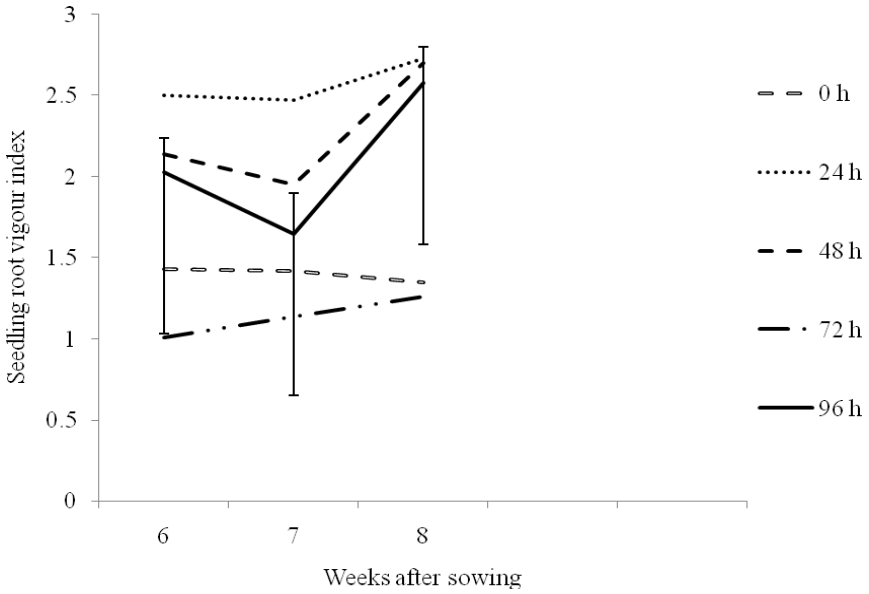

Figure 7: Effects of hydro-priming duration on the seedling root vigour index of *Capsicum frutescens* (African bird-eye pepper) at 5, 6, 7 or 8 weeks after sowing.

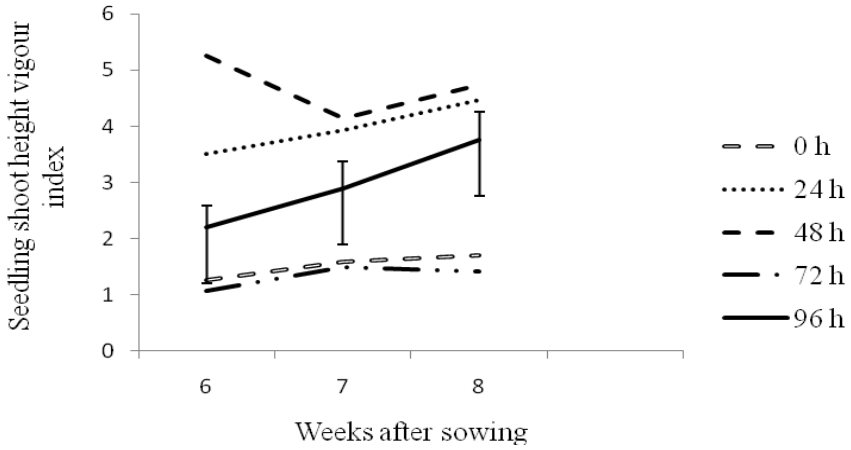

Figure 8: Effects of hydro-priming duration on seedling shoot height vigour index of *Capsicum frutescens* (African bird-eye pepper) at 6, 7 or 8 weeks after sowing.

Discussion

The observed variations in the responses of *Capsicum frutescens* L.to hydro-priming durations imply that pre-sowing seed treatments can impact seedlings emergence and vigour for field establishment. Many methods of seed treatment such as priming osmo-priming-using mannitol, polyethylene glycol and sodium chloride) and hydro-priming (using water) have been reported to be an economical, simple and a safe technique for increasing the seeds' capacity to osmotic adjustment and enhancing seedling establishment. This is very apt to crop production under stressed conditions. Anther method is mechanical scarification of seed which has been employed with varied success. Hydro-priming is reported to ensure rapid and uniform germination with minimal abnormal seedling percentage (Shivankar *et al*, 2003; Singh *et al*, 2018). From the current study, 48 hour hydro-priming of chilli pepper seeds resulted in earliness in emergence and Days-to-50% emergence. The poor performance observed in 72, 96 h hydro-priming could be attributed to over imbibition and in control no or under imbibition. The seeds of different cultivars have critical soaking duration which is lower than safe-limit as such they should not stay too long during priming in the medium (Harris *et al.*, 2002).As earlier asserted, exceeding this critical or safe-limit can lead to subsequent imbibition damage characterized by reduced germination and emergence of abnormal seedlings (Anca, *et al.*, 2017). According to Harris (2006) there is need to establish a "safe limits" – the maximum length of time for which

seeds can be soaked and which, if exceeded, could lead to seed or seedling damage.

The superior growth performance with 48-hour treatment (higher seedling dry weight) is similar to the findings of Uche *et al.*,(2016) who reported superior performance of 24 h hydro-primed seed of bell pepper a hybrid compared to African bird's eye which is a landrace.

Seedling root length, shoot height, and shoot vigour index were significantly affected by hydro-priming, 48 h hydro-primed seeds had long roots, shoot and high shoot vigour index with other hydro-priming durations being comparable but not with control seed. Hydro-priming significantly affected the number of leaves but notthe number of root at 8 Weeks after Sowing *Capsicum frutescens*, this was in contrast to findings of Chivasa *et al.*,(2000) who reported that hydro-primed seeds of sorghum produced more number of leaves.

Conclusion

Hydro-priming is versatile and practicable but requires empirical optimation for different species, cultivars and seed lots. This experiment demonstrated that seed of *Capsicum frutescens* (African bird-eye pepper) can be hydro-primed for 48 h for increased emergence and growth performance.

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