IJCST

International Journal of Crop Science and Technology

Volume 1, Issue 2, 2015

Effect of Seed Priming with Potassium Nitrate on Bulb Yield and Seed Quality of Onion (*Allium Cepa* L.), under Rift Valley Conditions, Central Ethiopia

Jima Nego[1*], Nigussie Dechassa[2] and Lemma Dessalegne[3]

[1]Department of Horticulture and Plant Sciences, Jimma University College of Agriculture and Veterinary Medicine(JUCAVM), P.O. Box,307, Jimma, Ethiopia
[2]Haramaya University, P.O.Box, 138, Dire Dawa, Ethiopia
[3] Ethiopian Seed Growers and Processors Association, Addis Ababa, Ethiopia
*

[*] Corresponding author: e-mail: jimang244@gmail.com or jima.nego@yahoo.com

ABSTRACT

Laboratory and field experiments were conducted to study the effects of seed priming using different concentrations of potassium nitrate on bulb yield and seed quality of onion (Allium cepa L var cepa.). In laboratory experiment, factorial combination of four concentrations of KNO_3 salt [(0% (distilled water), 1%, 2% and 3%)] and four priming durations (12 hrs, 24 hrs, 48 hrs and 72 hrs), with one control treatment of un-primed seeds were laid out in RCBD with four replications. Field experiment consisted of the same combinations as set in the laboratory experiment and the experiment was laid out as a RCBD in a factorial arrangement with three replications. Data were collected on marketable bulb yield, unmarketable bulb yield, total bulb yield, standard germination, rate of germination, vigour index-I, vigour index –II, and seedling dry weight. Analysis of the data revealed that effect of concentration was significant at ($p<0.05$) for seed germination, seedling vigour and, onion bulb yield. Similarly, interaction of Concentration of the salt and priming duration were significant at ($p<0.05$) for standard germination, rate of germination, vigour index II, seedling dry weight, and bulb yield. These parameters were significantly increased in response to the priming duration of 12 hrs for standard germination, rate of germination, and vigour index. However, the lowest results on these parameters were recorded for the duration of 72 hrs for priming with the potassium nitrate salt. The treatment combination involving priming seeds with 3% KNO_3 for 72 hrs produced the lowest standard germination, rate of germination, and vigour index. For the field experiment, the highest marketable bulb yield (40.78 tons/ha) and total bulb yield (47.78 tons/ha) were obtained in response to priming the seed with 1% KNO_3 for 12 hrs compared to the yields obtained in the control treatment which was 35.11 tons/ha. In conclusion, priming onion seeds with 1% KNO_3 solution for a period of 12 hrs as well as priming the seeds with distilled water for 72 hrs significantly enhanced onion seedling performance and the yield of marketable bulbs.
.

Key words: Bulb yield, Concentration, Duration, Onion, Potassium nitrate, Priming

INTRODUCTION

Onion is by far the most important of the bulb crops cultivated commercially in nearly most parts of the world (Simon, 1992). Onions are grown for a variety of purposes as fresh shoots for green 'salad' and as bulbs for consumption of uncooked and cooked ones; pickling; use in factory made food; dehydration; seed production and sets. Specific varieties have usually been developed for that purposes. Onion is grown in Ethiopia primarily for its bulb which is used for flavouring the local stew 'wot'. It is also widely cultivated as a source of income by many farmers in many parts of the country. Besides, onion contributes to the national economy through export products like bulbs and cut flowers to different countries of the world. The majority of onion production is found in the Central Rift Valley (CRV) of Ethiopia. In these areas, rainfall is unreliable and insufficient to support onion production.

One of the important field production practices is plant establishment where seed enhancement is the important component. Seed enhancement includes pre-sowing hydration or hydro-priming (uptake of water not sufficient to permit radicle protrusion, but sufficient to initiate early events of germination, followed by drying), seed coating technologies, seed conditioning and various other enhancement techniques (Taylor et al., 1988). Seeds remain incomplete of germination, therefore, are desiccation tolerant and can still be dried for long term storage. Primed seeds germinate faster and more uniformly than non-primed seed, especially in cool soils (Bosland and Votava, 2000). Seed priming made a positive impact on farmers' livelihoods by increasing the rate of seed germination, increasing the rate of crop development, reducing crop duration and raising yields (Bennet *et al.*, 1992). Priming responses were attributed mainly to rapid seedling establishment, higher plant stand and earlier crop maturity allowing escape from end-of-season stresses (Harris, 1996).

Water availability is a major factor limiting the production of onion bulb in the Central Rift Valley of Ethiopia (Harris *et al.*, 2001). Once sown, seed spend significant time just absorbing water from the soil before germination. Despite the lack of formal seed technology related research results for growing such high value crops in Ethiopia, the practice is known to some farmers, especially direct seeding onion for early crop harvest. Soaking has, however, never been done on a regular basis at farmers level and the duration of soaking was highly variable (CACC, 2003). Although direct seeding is more economical than transplants or sets, irregularities and delays in germination result in poor plant establishment and yield, especially due to high or low temperatures. In plant species with small seeds and poor seed establishment, perhaps the most promising method of increasing the rate and uniformity of seedling establishment is seed priming that permits the preliminary process of germination but not the final phase of radicle emergence (Heydecker and Coolbear, 1977; Heydecker and Gibbins, 1978). Limited research has been done on seed priming on seedling vigour of onion (Selvarani and Umarani, 2011). However, Selvarani and Umarani (2011) found that onion could benefited from priming with KNO_3 for 12 hrs,but still there have been no detailed studies carried out to identify the optimum priming duration and concentration of KNO_3 for better seedling performance, yield, and yield related traits of the crop. Therefore, objective of this study was to investigate the effect of KNO_3 concentrations and priming duration with the chemical on seed germination, bulb yield, and quality of onion.

MATERIALS AND METHODS

Field activities and laboratory work were conducted at Melkassa Agricultural Research Center (MARC), to determine the effects of seed priming on seedling performance and bulb yield in onion. Distilled water, and potassium nitrate salts (KNO_3) were used for experiments as priming media. A seed of the onion variety named Bombay Red, which is widely cultivated by farmers in most parts of Ethiopia, was used for this study. This variety has firm bulb, light red colour and thick flat globe shape. The leaves are dark green in colour and are medium type. The cultivar takes 3 months for bulb harvest (Lemma and Shimeles, 2003).

Laboratory Experiment

The treatments consisted of four concentrations of potassium nitrate salt [(0% concentration (distilled water) , 1%, 2% and 3%) and four durations of exposure of the seeds to the chemical (KNO_3) for priming (12 hrs, 24 hrs, 48 hrs and 72 hrs), with one control treatment of un-primed seeds. The experiment was laid out as randomized complete block design

(RCBD) in a factorial arrangement and replicated four times. The un-primed seeds were used as control with four replications alone.

Seed priming and re-drying

Prior to the hydro-priming and KNO_3 priming treatments, the moisture contents of the seeds were determined using oven dry method (ISTA, 1985) and brought to the same constant moisture. Seeds were fully immersed in the priming media (on Petri Dishes) for 12, 24, 48, and 72 hrs. All seeds were removed from the priming media at the same time and then rinsed thoroughly with distilled water and dried at room temperature until they gained their original seed moisture content. The percent solutions were prepared by dissolving 0, 1, 2, and 3 g KNO_3 per 100 ml distilled water correspondingly. Primed seeds were washed out and dried under shade back to the original moisture content prior to sowing and sown in germination Petri Dishes each of which contained 50 seeds. The Petri Dishes were lined with filter paper for placing the seeds in a uniform distribution for germination and all seedlings per plot were used for analysis. Germination test was carried out in the laboratory. The seeds were tested in top of paper substrata keeping at 20 ^{0}C temperature. Data that included standard germination percentage, rate of germination, and vigour test, Seedling heights and root and shoot dry matter weights were measured.

Field experiment

The treatments consisted of the same combinations described for laboratory experiment. The primed and un-primed seeds were sown and seedlings raised in a nursery on seed-beds. The experiment was laid out as a randomized complete block design (RCBD) in factorial arrangement with three replications. The area of single plot, which consisted of 4 double rows of 20 cm apart, was 3 m x 2.2 m with furrows at 40 cm apart. Inter and intra-row spacing of 20 and 5cm respectively were used. Plots and blocks were separated by 1 m and 2 m respectively. Seedlings in the middle two rows were harvested for data collection, leaving aside those at the border rows as well as those at both ends of each row to avoid edge effects.

Nursery bed preparation and Transplanting

Onion seeds were sown on nursery beds in order to raise seedlings for field transplanting. Raised beds of size of 1 m x 5 m with 10 cm inter-row spacing were prepared. About 0.5 m distance was kept between two beds to facilitate watering, weeding, etc. To avoid mortality of seedlings due to damping off, beds were drenched with Bavistin (15-20 g/10 litres of water).At 3 to 4 leaf stage; seedlings were transplanted into the experimental field. The seedlings were hardened by withholding irrigation water for one week before transplanting.

Data collection and analysis

*Germination percentage***:** Four replicates of 50 seeds were placed on filter paper moistened with distilled water in Petri Dishes and kept in germination room for 12 days. The numbers of normal and abnormal seedlings were counted and scored on the 12th day and germination percentage was calculated (ISTA, 1985).

$$\text{Germination percentage G\%} = \frac{\textit{Total number of normal seedlings}}{\textit{Total number of seedling planted}} x100$$

*Rate of germination***:** Four replicates of 50 seeds were sown on Petri Dishes and kept in germination room for 12 days. Each day normal seedlings were counted starting from 6th day at predetermined size until all seeds capable to produce normal seedlings. An index was calculated by dividing the number of seedlings counted each day by the number of days in which they were counted (Maguire, 1962). The seed lot having greater germination index were considered as more vigorous. Thereafter a rate of germination (SPG) was computed by using the following formula:

$$X = \frac{\text{number of normal seedlings}}{\text{Days of first count}} + \text{---} + \frac{\text{number of normal seedlings}}{\text{Days of final count}}$$

Seedling vigour: The lengths of five randomly selected seedlings per Petri Dishes were measured in cm using a ruler. Shoot and root of the seedlings were dried in an oven (at 80^0C for 24 hrs) to constant weight and their dry matter was determined. Seedling vigour was determined by two methods: *Vigour Index I*= Germination Percentage x Seedling Length (cm) (shoots length + root length). *Vigour Index II*= Standard Germinations Percentage x seedling dry weight (mg). *Marketable Bulb yield(ton/ha)*: This refers to the bulb yield of marketable category, which included bulbs weighing greater than 30 gram, being free from diseases and blemishes. This was determined by weighing using a digital balance. *Unmarketable bulb yield(ton/ha):* This refers to the bulb yield of unmarketable category, which included bulbs weighing less than 30 gram or bulbs with diseases and blemishes. This was determined also by weighing using a digital balance.

Total bulb yield (ton/ha): This refers to the total weight of marketable and unmarketable bulbs, and was determined by weighing using a digital balance. Finally, all measured variables were subjected to the analysis of variance for RCBD using SAS software. The least significance difference (LSD) at 5% was used to separate significantly differing treatment means.

RESULTS AND DISCUSSION

Laboratory Experiments

The analysis of variance revealed significant ($p \leq 0.05$) differences in germination percentage due to the main effect of concentration of KNO_3, priming duration, and the interaction of KNO_3 concentration and priming duration (Table 1).

The maximum standard germination (87.5%) was recorded in response to priming the seed with 1% KNO_3 for 12 hrs. However, this maximum value of standard germination was in statistical parity with standard germination values obtained in response to priming the onion seeds with distilled water for 12, 24 and 48 hrs, with 1% KNO_3 for 24 hrs, with 2% and 3% KNO_3 for 12 and 24 hrs as well as with standard germination recorded for the un-primed seeds (control treatment). The lowest standard germination occurred in response to priming the onion seeds at all three concentrations of KNO_3 for 72 hrs. These results indicate that priming onion seeds with potassium nitrate salt or distilled water did not improve standard germination compared to the standard germination of the un-primed seed. Moreover, the results revealed that standard germination declined with increase in both concentration of the salt and duration of priming for both KNO_3 and distilled water. The results further revealed that priming onion seeds at any concentration with the KNO_3 salt for 72 hrs led to drastic reductions in standard germination. The result also revealed that priming onion seeds with distilled water for more than 48 hrs led to lowered standard germination (Table 3). The results indicated that priming seeds for longer durations has negative effect on germination percentage. This could be attributable to over priming of the seeds, oxygen deficiency due to impermeable testa, or build-up of inhibitors during priming as well as salinity (toxic effect) of the chemical (KNO_3). Consistent with the results of this study, it was reported that hydro priming for 16-18 hrs resulted in the highest germination percent of onion (Singh *et al*., 2004 as cited by Selvarani and Umarani, 2011). The author observed that halo-priming with 3% KNO_3 for 3 days (72 hrs) damaged the seed as it deteriorated in terms of final germination percent. Corroborating the results of this study, Haigh and Burlow (1987) reported that solutions were found to be toxic to sorghum seeds and thus not suitable for priming. Consistent with the results of this study, Elkoca *et al* (2007) reported that hydro-priming resulted in the highest germination in seed of chickpea. The analysis of variance for germination rate showed highly significant ($P \leq 0.001$) differences due to priming duration and significant ($P \leq 0.05$) differences due to concentration and the interaction effect of the two treatments (Table 1).

Table 1: Mean square values for seed quality parameters of onion

Source of variation	Df	Seed quality parameters				
		Standard germination	Rate of germination	Vigour index-I	Vigour index-II	Seedling dry weight
Replication	3	45.23ns	1.12ns	22562.90ns	123891.67ns	32.23ns
Concentration (A)	3	470.56**	4.35*	62311.30ns	202575.00ns	29.73ns
Priming duration (B)	3	2599.06***	20.41***	418683.54***	628075.00**	4.73ns
AXB	9	171.56*	2.72*	27667.66ns	560447.22***	59.45*
Error	45	81.94	1.19	28620.12	115936.11	21.34
CV		12.39	17.68	22.47	31.22	30.99

*, ** and *** indicate significant differences at 5%, 1% and 0.1% probability level respectively; ns= non-significant; Df = Degrees of freedom; A x B=Concentration x Priming duration.

Table 2: Mean squares for bulb yield of onion

Source of variation	Df	Yield parameters		
		Marketable bulb yield	Unmarketable yield	Total yield
Replication	2	86.74*	5.79ns	118.15*
Concentration (A)	3	114.77**	23.46ns	35.90ns
Priming duration(B)	3	37.88ns	7.80ns	42.23ns
AxB	9	127.89***	23.19*	84.92*
Error	30	23.78	9.90	32.49
CV		17.11	28.07	14.35

*, ** and *** indicate significant differences at 5%, 1% and 0.1% probability level respectively; ns=non significant; Df = Degrees of freedom; A x B = Concentration x Priming duration.

All values of the germination rate were high and in statistical parity except the germination rates recorded in response to priming with 1% KNO_3 for 72 hrs and in response to priming with 2 and 3% KNO_3 for 72 hrs. The result showed that germination rates of onion seeds decreased with increase in priming durations (Table 3). Moreover, the results indicated that prolonging the duration of hydro-priming and priming with KNO_3 consistently reduced the rate of germination. This might be attributed to the possible negative effect of too long priming on seed germination. Supporting the results of this study, Mekonnen (2005) also reported that beyond the priming duration of 16 hrs, loss of seedling vigour of sorghum

Table 3: Interaction effects of concentration of potassium nitrate and priming duration on seed quality parameters of onion

Treatments		Standard germination	Rate of Germination	Seedling dry weight(mg)	Vigour index II
Concentration	Priming duration				
0%(distilled water)	12 hrs	81.5abc	6.90ab	12.5bc	1015cdefg
	24 hrs	84ab	6.67ab	10c	840efg
	48 hrs	83.5ab	7.57a	17.5ab	1430abc
	72 hrs	73.5bcd	6.60ab	17.5ab	1290abcde
1% KNO_3	12 hrs	87.5a	7.58a	20a	1750a
	24 hrs	76.5abcd	6.52ab	10c	765fg
	48 hrs	70dc	5.85bc	12.5bc	885defg
	72 hrs	53.5e	4.32cd	12.5bc	665g
2% KNO_3	12 hrs	82.5abc	6.49ab	15abc	1230bcdef
	24 hrs	80abcd	6.54ab	20a	1600ab
	48 hrs	74bcd	6.36ab	17.5ab	1285abcde
	72 hrs	51e	3.97d	15abc	775fg
3% KNO_3	12 hrs	85.5ab	7.56a	15abc	1285abcde
	24 hrs	75.5abcd	6.88 ab	17.5ab	1330abcd
	48 hrs	68d	5.63bc	11c	675g
	72 hrs	42e	3.29d	15abc	630g
Un-primed (control)		79.5abcd	7.16a	12.5bc	975cdefg
LSD (Con.* D) (5%)		12.89	1.55	6.58	484.93
CV (%)		12.39	17.68	30.99	31.22

Means within the same column followed by different letter are significantly different at $P \leq 0.05$

began to demonstrate itself for all cultivars as expressed by slower germination rate, which was either equivalent or slower than the germination rate of seeds in the control treatment.

In agreement with the results of this study, Khan (1992) also reported an increase in time to 50% germination (decrease in germination rate) of sorghum seeds due to over priming beyond the optimal priming time. In agreement with the results of this study, Venkatasubramanium and Umarani (2007) revealed that for tomato seeds, hydro priming for 48 hrs was optimum. However, Nirmala and Umarani (2007) found that for beetroot, hydro priming (12 hrs in double the volume of seed) was found to be the best.

Significant differences ($P \leq 0.05$) were observed due to the interaction effect of concentration and priming duration on seedling dry matter weights of onion (Table 1).

The highest seedling dry weights were recorded for seedlings of onion seeds primed with distilled water for 48 and 72 hrs, with 1% KNO_3 for the duration of 12 hrs, with 2% KNO_3 for all durations, and with 3% KNO_3 for the durations of 12, 24, and 72 hrs. The lowest seedling dry weights, on the other hand, were obtained from seedlings raised from seeds primed with distilled water for 12 and 24 hrs, with 1% KNO_3 for the durations of 24, 48, and 72 hrs, with 3% KNO_3 for the durations of 48 hrs, as well as from seedling raised from un-primed seeds. In general, seedling dry weights did not show clear and consistent trends of increase or decrease in response to increased concentration of KNO_3 as well as duration of priming. It appeared that priming onion seeds with distilled water for longer durations (48 and 72 hrs), with 1% KNO_3 for the shorter duration of 12 hrs, with 2% KNO_3 for all durations of priming, as well as priming with 3% KNO_3 for 12, 24, and 72 hrs led to the production of higher seedling dry weights (Table 3).

Vigour index II was significantly influenced by both the main effect of priming duration as well as its interaction with concentration of the priming salt (KNO_3) (Tables 1). Increasing the concentration of the potassium nitrate salt as well as the priming duration resulted in significantly decreasing trend in vigour Index II. Thus, the highest vigour index II was recorded for seedlings raised from seeds primed with distilled water for 48 and 72 hrs, seeds with 1% KNO_3 for only 12 hrs, with 2% KNO_3 for 24 and 48 hrs and with 3% for 12 and 24 hrs. The lowest values of vigour Index II were recorded for seedlings raised from seeds primed with distilled water for only 12 and 24 hrs, with 1% KNO_3 for 24, 48, and 72 hrs, with 2% KNO_3 for 72 hrs, with 3% KNO_3 for 48 and 72, as well as for seedlings raised from un-primed seeds (Table 1). Vigour index II was reduced as priming durations were increased. This could be ascribed to the negative effect of priming seeds for longer periods than necessary, which may result in the development of inhibitors and salinity (toxic) effects of the chemical (KNO_3). In agreement to this result Selvarani and Umarani (2011) reported that the results on halo priming with KNO3 for a range of five durations of soaking proved that onion seeds could benefit from halo priming for 12 hrs with 3% KNO_3 concentration.

Priming duration significantly ($P \leq 0.01$) affected vigour index I. The highest value of vigour index I (936.91) was obtained for the priming duration of 12 hrs. Increasing the priming duration consistently decreased the value of vigour index I. However, the value of vigour index I of seedlings raised from seeds primed for 12 hrs was in

Table 4: Main effects of concentration and priming duration on vigour index I of onion.

Treatment	Vigour index-I
Concentration	
0% (distilled water)	844.40
1% KNO3	718.88
2% KNO3	740.75
3% KNO3	708.11
Un-primed (Control)	848.65
Significant Level	ns
LSD (5%)	--
Priming duration	
12 hrs	936.91a
24 hrs	785.89b
48 hrs	744.99b
72 hrs	544.35c
Un-primed(control)	848.65ab
Significant Level	***
LSD (5%)	120.47
CV (%)	22.47

CV indicates Coefficient of variation; ***= highly significant difference at 0.1% probability level, and ns= non-significant.

statistical parity with the value of seedling vigour index I of un-primed seeds. On the other hand, the lowest value of vigour index I (544.35) was obtained for the priming duration of 72 hrs. Vigour index I was reduced as priming durations were increased (Table 4).

Field Experiments

Bulb yields

The main effect of concentration of the KNO_3 salt significantly ($P \leq 0.01$) affected only marketable bulb yield. The main effect of priming duration did not affect any of the yield parameters. The main effects of both KNO_3 concentration and priming duration did not influence non-marketable and total bulb yields. However, the analysis of variance revealed that KNO_3 concentration and duration of priming interacted to significantly influence marketable bulb yield (($P \leq 0.01$)), non-marketable bulb yield ($P \leq 0.05$), and total bulb yields ($P \leq 0.05$) (Table 2).

The highest marketable bulb yields were obtained in response to priming the onion seeds with distilled water for 72 hrs, and with KNO_3 salt at the concentrations of 1% for 12 hrs and at the concentration of 2% for 24 and 72 hrs, respectively. The entire marketable bulb yields obtained in response to the above combined treatments were in statistical parity. The lowest marketable bulb yields were obtained from onion seeds primed with distilled water for 12 hrs, and with KNO_3 salt at the concentration of 1% for 48 hrs, at the concentration of 3% for 12 and 72 hrs as well as from the control treatment (un-primed seeds), all these values were in statistical parity (Table 5). The results revealed that priming onion seeds with KNO_3 at the relatively lower concentration of 1% for a relatively shorter duration of twelve hrs or priming onion seeds with distilled water for a relatively longer duration of 72 hrs increased onion bulb yield remarkably. For example, seedlings raised from seeds primed with distilled water for 72 hrs and seedlings raised from seeds primed with KNO_3 at the concentration 1% for just 12 hrs resulted in additional bulb yield increments of 50 and 84% respectively, compared to the bulb yield obtained from seedlings raised from un-primed seeds (Table 5). The results further showed that the marketable onion bulb yield markedly increased in response to increased duration of priming with distilled water whereas it decreased in response to increased concentration as well as duration of priming with the potassium nitrate salt. Thus, the marketable bulb yield obtained from seeds primed with distilled water for 72 hrs significantly exceeded the bulb yield obtained from seeds primed with distilled water for only 12 hrs by additional increment of 58% (Table 5). Similarly, increasing the concentration of potassium nitrate from 1% to 3% and priming the seed reduced marketable bulb yield by about 100%. Likewise, increasing the duration of priming onion seed with 1% potassium nitrate salt from 12 hrs to 72 hrs reduce bulb yield by about 55%. This signifies that priming onion seeds with distilled water for a few days' time and with KNO_3 at lower concentrations for about a half or less number of days may equally enhance onion bulb yields. In agreement with this result, Muhammad *et al*., (2008) reported that grain yield decreased with the extended seed priming durations. The authors found that the seed primed for 6 hrs produced the highest grain yield of soybean as compared to seed primed for 12 hrs and 18 hrs. The highest total bulb yields were obtained in response to planting seedlings raised from seeds primed with distilled water for 48 and 72 hrs, 1% KNO_3 for 12 and 24 hrs, 2% KNO_3 for 12, 24, and 72 hrs, and 3% KNO_3 for 24 and 48 hrs. In general, the lowest total bulb yields were obtained from seedlings raised from seeds primed with distilled water for only 12 and 24 hrs as well as seedlings raised from seeds primed with higher concentrations of KNO_3 for

Table 5: Interaction effects of concentration of potassium nitrate and priming duration on bulb yields of onion

Treatment		Parameters		
Concentration	Priming duration	Marketable bulb yield (ton/ha)	Non-marketable bulb yield (ton/ha)	Total yield bulb (ton/ha)
0%(distilled water)	12 hrs	21.06def	13.78ab	34.84cd
	24 hrs	29.44bc	8.43cde	37.87bcd
	48 hrs	28bcde	12.22abcd	40.22abc
	72 hrs	33.33ab	10.08abcde	43.41abc
1% KNO_3	12 hrs	40.78a	6.94e	47.72a
	24 hrs	29.33bc	13.61abc	42.94abc
	48 hrs	24.17cdef	12.66abc	36.83bcd
	72 hrs	26.39bcde	9.50abcde	35.89bcd
2% KNO_3	12 hrs	30.22bc	14.20a	44.42ab
	24 hrs	34ab	9.44abcde	43.44abc
	48 hrs	28.56bcd	6.98de	35.54bcd
	72 hrs	33.11ab	8.89bcde	42abc
3% KNO_3	12 hrs	20.39ef	14.61a	35bcd
	24 hrs	31.67bc	11.92abcde	43.59abc
	48 hrs	29.33bc	12.33abc	41.66abc
	72 hrs	16.22f	13.78ab	30d
Un-primed(control)		22.22def	12.89abc	35.11bcd
LSD (5%)		8.13	5.25	9.50
CV (%)		17.11	28.07	14.35

Means within the same column followed by different letter are significantly different at $P \leq 0.05$

longer durations (72) hrs (Table 5). These results also indicate that priming onion seeds with distilled water for 72 and with KNO_3 salt at relatively lower concentration of 1% for about 12 hrs markedly increased total onion bulb yields. The highest unmarketable bulb yields were obtained in response to priming the onion seeds with 1% KNO_3 for 24, 48 and 72 hrs, 2% KNO_3 for 12 and 24 hrs, 3% KNO_3 for all durations of priming as well as with distilled water for 12, 48, and 72 hrs. On the other hand, the lowest unmarketable yield was obtained in response to priming onion seeds with 1% KNO_3 for 12 hrs. These results indicate that increasing the concentration of KNO_3 and duration of priming with the potassium nitrate salt indeed led to significant increases in unmarketable bulb yield, which is consistent with the inverse relationship that would exist with the decrease observed in both marketable and total bulb yields.

The maximum marketable and total bulb yields as well as minimum non-marketable bulb yields were obtained when seeds were primed with 1% KNO_3 concentration for 12 hrs as compared to the other treatments. Although it resulted also in a high unmarketable bulb yield, priming onion seeds with distilled water for 72 hrs also led to the production of significantly higher marketable and total bulb yields (Table 5). The improvement in bulb yield of primed seed may be due to early, uniform and improved emergence, and vigour stand establishment, which are the results of improved yield contributing factors i.e. higher plant population, weight of marketable bulb, and higher nutrient uptake of seedlings raised from seeds primed with lower concentration of KNO_3 but sufficient to afford the necessary nutrient in the priming treatments that ultimately resulted in the higher yield. Similar findings were reported by Harris et al. (1999), and Harris *et al*. (2000). The authors reported that the resulting improved stand establishment due to priming increased drought tolerance reduced pest damage and increased crop yield. The increase in yield of primed seed may be due to the fact that primed seed emerged faster and more uniformly and seedlings grew more vigorously, leading to a wider range of phenological and yield related benefits (Harris et al., 2000). Harris et al., (1999) further reported that primed crops did produce higher yields than non-primed crops.

On the other hand, priming seeds with KNO_3 salt for longer durations led to increased unmarketable bulb yield possibly due to the production of inhibitors and toxic effect of the chemical on seedlings established from higher concentration of KNO_3. However, priming seeds with distilled water for longer durations increased yield. This could be because distilled water may be able to enhance seedling emergence, seedling vigour and establishment of uniform stand when priming is done with it for sufficient time that is enough to trigger seed germination and seedling development. Moreover, it can be concluded that primed seed germinated faster and more vigorously, leading to better crop stands, faster development and increased yield. In agreement with this study, Byrum and Copeland (1995) reported that more vigorously growing crops from primed seeds were able to capture more nitrogen than crops grown from non-primed seeds, perhaps before the nitrogen became unavailable due to leaching or volatilization. The results obtained in this study corroborate also the results obtained by other workers. Accordingly, Adugna (2008) reported that priming hot pepper seed with sodium chloride (NaCl) increased marketable yield by about 6% compared to the un-primed seeds. Taylor and Harman (1990) found that in the low external input system like fertilizers, in Bihar and West Bengal of India, primed plots of chickpeas out-yielded non-primed plots in 41 trials with an average yield increase of about 13%. Mubshar et al. (2006) also concluded that seed priming with 0.5% KON_3 could enhance seedling establishment, yield, and quality of hybrid sunflower.

CONCLUSION

Results of the present study indicated that yield and seed quality parameters were significantly affected by the treatments or their interaction effects. Accordingly, priming onion seeds with KNO_3 at the relatively lower concentration of 1% for a relatively shorter duration of twelve remarkably increased standard germination, germination rate, vigour index, seedling dry weight and both marketable and total onion bulb yields whereas seedling performance and bulb yield of onion was poor with regard to standard germination, germination rate, vigour index, and both marketable and total onion bulb yields when onion seed is primed with higher concentration of 3 % for long duration of 72 hrs.

ACKNOWLEDGEMENTS

The authors would like to thank Haramaya University for funding the research and providing all the necessary facilities required for the research and Bedo Hamda for his support in providing laptop during write up. We want to thank also Melkasa Agricultural Research Center (MARC) for permitting us research field and laboratory.

REFERENCES

Zeleke, A. 2008. Effects of seed priming, planting method and fertilizers on yield and yield components of fresh Hot pepper (*Capsicum annuum* L.) in Northwest Ethiopia. (unpublished M.Sc. thesis) Haramaya University.

Bennett, M.A., Fritz, A.V. and Callan N.W. 1992. Impact of seed treatments on crop stand establishment. *Journal of Seed Technology*, 2: 345-356

Bosland, P.W. and Votara, E.J. 2000. Peppers: Vegetable and spice Capsicums. CABI publishing. New York. 198p.

Byrum, J. R. and Copeland, L.O. 1995. Variability in vigour testing of sorghum (*Sorghum bicolor*. L. Moench) seeds. *Journal of Seed Science and Technology,* 23: 543-549.

CACC (Central Agricultural Census Commission), 2003. Agricultural Sample numeration, Addis Ababa, Ethiopia. 374p.

Elkoca, E., Haliloğlu K., Eşitken, A. and Ercişli, S. 2007. Hydro and osmopriming improve chickpea germination. *Acta Agriculturae Scandinavica Section B Soil and Plant Science*, 57: 193-200.

Haigh, A.M. and Barlow, E.W.R. 1987. Germination and priming of tomato, carrot, onion, and sorghum seeds in a range of osmotica. *Journal of the American Society for Horticultural Science* 112: 202-208.

Harris, D. 1996. The effects of manure, genotype, seed priming, depth and date of sowing on the emergence and early growth of Sorghum bicolor (L.) Moench in semi-arid Botswana. *Soil and Tillage Research*, 40: 73-88.

Harris, D., Joshi, A., Khan, P.A., Gothkar, P. and Sodhi, P.S. 1999. On-farm seed priming in semi-arid agriculture: development and evaluation in maize, rice and chickpea in India using participatory methods. *Experimental Agriculture, 35*(01), 15-29.

Harris, D., Pathan, A.K., Gothkar P., Joshi, A., Chivasa, W. and Nyamudeza, P. 2001a. On-farm seed priming: using participatory methods to revive and refine a key technology. *Agricultural Systems* 69: 151-164.

Harris, D., Raghuwanshi, B.S., Gangwar, J.S., Singh, S.C., Joshi, K.D., Rashid, A. and Hollington, P.A. 2001b. Participatory evaluation by farmers of 'on-farm' seed priming in wheat in India, Nepal and Pakista*n. Experimental Agriculture,* 37: 403-415.

Harris, D., Tripathi, R.S. and Joshi, A. 2000. Onfarm priming to improve crop establishment and yield in direct seeded rice in IRRI: International Workshop on Dry Seeded Rice Technology, held in Bangkok, 25-28 January 2000. *The International Rice Research Institute. Manila. The Philippines*., and pp.164.

Heydecker, W. and Coolbear, P. 1977. Seed treatments for improved performance: Survey and attempted prognosis. *Journal of Seed Science and Technology,* 5: 353-425.

Heydecker, W. and Gibbins, B.M. 1978. Priming of seeds. *Acta Hort,* 83: 213-223.

ISTA (International Seed Testing Association), 1985. International rules for seed testing. *Seed Science and Technology*, 13: 1299–355.

Dessalegn, L. and Aklilu, Sh. 2003. Research Experience in Onion Production. *Research Report Number, 55*, EARO, Addis Ababa Ethiopia.

Mekonnen, H. 2005. *Effects of Hydro Priming Sorghum [Sorghum Bicolor (L.) Moench] Seeds on Germination, Seedling Emergence and Stand Establishment (*unpublished thesis).p.27.

Hussain, M., Farooq, M., Basra, S. M. and Ahmad, N. 2006. Influence of seed priming techniques on the seedling establishment, yield and quality of hybrid sunflower. *International Journal of Agriculture and Bilogy*,8(1),14-18.

Arif, M., Jan, M.T., Marwat, K.B. and Khan, M.A. 2008. Seed priming improves emergence and yield of soybean. *Pakistan Journal of Botany*, 40:1169-1177.

Nirmala, K. and Umarani, R. 2007. Evaluation of seed priming methods to improve seed vigour of okra (Abelmoschus esculentus) and beetroot (Beta vulgaris). *Seed Science & Technology.36-1 (In Press).*

Selvarani, K. and Umarani, R. 2011. Evaluation of seed priming methods to improve seed vigour of onion (*Allium cepa cv. aggregatum*) and carrot (*Daucus carota*). *Journal of Agricultural Technology* 7: 857-867.

Simon, P.W. 1992. Onion improvement News letter for 1991. *Dept of horticulture, university of Wisconsin, Madison, Wisconsin, USA.*

Taylor, A.G. and Harman, G.E. 1990. Concepts and technologies of selected seed treatments. *Annual Review of Phytopathology*, 28(1), 321-339.

Taylor, A.G., Klein, D.E. and Whitlow, T.H. 1988. Hydro- priming of seeds. *Horticulture Science*, 37: 1-11.

Taylor, A.G., Klein, D.E. and Whitlow, T.H. 1988. SMP: solid matrix priming of seeds. *Scientia Horticulture* 37: 1-12.

Venketasubramanium, A. and Umarani, R. 2007. Evaluation of seed priming methodsto improve seed performance of tomato (*Lycoperison esculentum*), egg plant (*Solanum melongena*) and chilli (*Capsicum annum*). *Seed Science & Technology* .35-2 *(In Press.).*