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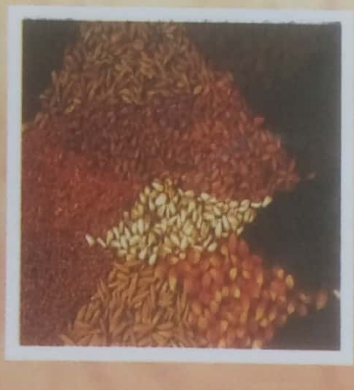

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Effect of fruit maturity stage and hydropriming on seed quality of two cultivars of 'Gboma' eggplant (*Solanum macrocarpon*)

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Abstract
This experiment was undertaken at the laboratory of the Department of Crop Production, Federal University of Technology, Minna, Nigeria to determine the effect of hydropriming on the germination of fresh and aged seeds of two *Solanum macrocarpon* cultivars (FUTMSm-1 and FUTMSm-2) extracted from fruits harvested at different maturity stages (brown and dry-BD, brown and fleshy-BF, yellow-Y and yellowish green-YG). The seeds were stored in screw cap plastic bottles for 14 weeks at ambient temperature of *ca* 29 °C and 60% relative humidity. Germination tests were conducted on the seed lots at two weekly intervals throughout the storage period with and without hydropriming for 24 hours. Seed quality of the different lots was indexed using germination percentages (GP) and germination index (GI). The results revealed that variation existed in the seed quality of the two *Solanum macrocarpon* cultivars, stages of fruit maturity at harvest and response to hydropriming. GI which is an estimation of combination of germination percentage and speed showed that FUTMSm-2 was significantly higher in quality than FUTMSm-1; that seeds extracted from BD fruits were significantly greater than those of other fruit colours and that hydropriming significantly enhanced seed quality compared to the non-hydroprimed seed lots.

Key words: Harvesting stages, cultivars, hydropriming, germination percentage, germination index, *Solanum macrocarpon*

Introduction
'Gboma' eggplant (*Solanum macrocarpon*) is a plant of the family Solanaceae and genus Solanum. It is used all over the world as an edible vegetable (Sharma and Sharma, 2010). The crop is grown in China, India, Turkey, Japan and Philippines majorly with India contributing 6,443,062 metric tonnes to the global production ranking second to China (Thamburaj and Singh, 2003). In Nigeria, it is cultivated for its leaves, fruits or both consumed as vegetable or used in traditional medicine (Bonsu *et al.*, 2008). It is a highly valued constituent of Nigerian food and indigenous medicine that are either eaten raw or cooked especially in the Southern and Western parts of Nigeria (Chinedu *et al.*, 2011).

Seed dormancy in cultivated plant not only cause problems in agricultural production but also complicates assessment of seed quality (Geneve, 1998). *Solanum* species are mainly propagated by seed but have dormancy problem. Buried seeds of *S. nigrum* have been reported to remain dormant for at least 39 years in Britain (Edmond and Chweya, 1997). Abdoulaye (1992) reported that embryo dormancy is a major constraint in African eggplant (*S. athiopicum* L.) and that freshly produced seeds can germinate only after 4 – 5 months under suitable conditions. Yogeesha *et al.* (2006) reported that the germination of two months old seeds of two eggplant varieties cv. ArkaKeshav and ArkaNeelkanth was 0 % and 2%, respectively, revealing the presence of dormancy. The authors reported further that there was gradual decline in the seed dormancy with ageing under ambient conditions and complete breakdown of dormancy occurred after 12 months of storage. Similarly, Daunay *et al.* (2001) reported that storage of eggplant seeds for a few months at ambient conditions, or a few weeks at chilled conditions lessens its dormancy.

Fruit age at harvest has a marked effect on its seed quality and storability. Nerson (2002) observed that watermelon seeds from fruits harvested 28 days after flowering lost the ability to germinate after 4-5 years of storage, whereas mature seeds harvested 42- 49 days after flowering retained full potential to germinate even after 10 years of storage. Mature seeds tend to germinate better than those harvested earlier and seed maturation stage is an influential factor on germination performance (Demir and Oztokat, 2003). Vidigal *et al.* (2009) reported that the vigour of sweet pepper seeds extracted from fruits harvested at 60 or 70 days after anthesis (DAA) was higher than those obtained from fruits harvested at 40 or 50 DAA.

Priming involves exposing seeds to an external water potential low enough to restrict germination and yet permit pre-germinative physiological and biochemical activities (Kaya *et al.*, 2006). In hydropriming, seeds are soaked in water before sowing and may or may not be followed by air-drying of the seeds. Seed imbibe water and go through the first phase of germination in which pre-germination metabolic activities are started while the latter two phases are inhibited (Pill and Necker, 2001). The technique has been successfully demonstrated to improve germination and emergence of many vegetable seeds such as cauliflower (Powell *et al.*, 2000), water melon (Hung *et al.*,2002), pepper and aubergine (Demir and Okcu, 2004) and tomato (Badek *et al.*, 2006).

Seed dormancy in cultivated plants not only causes problems in actual agricultural production but also complicates assessment of seed quality (Geneve, 1998). Dormancy and low germination rates have been described in different species within the genus *Solanum* (Demir *et al.*, 2005). Most farmers extract seeds from *Solanum macrocarpon* fruits that have been left to weather on the field without paying attention to the seed quality. In pepper (Omotosho, 2014); tomato (Lui *et al.*, 1996), *S. melogena* (Yogeesha *et al.*, 2008) and sunflower (Mahesha *et al.*,2001), the best fruit stage that would ensure production of high quality seeds has been established but this information appears to be lacking in *Solanum macrocarpon*. Priming has been found effective in dealing with dormancy problems in some other vegetable crops (Omotosho, 2014) but there seems to be paucity of information in this respect in *Solanum macrocarpon*. This research, therefore, aimed at determining the effect of fruit maturity stage and hydropriming on the seed quality of two cultivars of *Solanum macrocarpon*.

Materials and Methods

The experiment was carried out in the laboratory of Department of Crop Production, Federal University of Technology, Minna, Niger State, Nigeria. Seeds of two cultivars of *Solanum macrocarpon* (FUTMSm-1 and FUTMSm-2) were sourced from the stock of the Department of Crop Production, Federal University of Technology, Minna, Nigeria. The seeds were primed in water for 24 hours and broadcast on raised nursery beds. Seedlings were nursed fo five weeks after which they were transplanted at intra and intra-row spacing of 75 x 50 cm. N.P.K (15:15:15) fertilizer was applied at the rate of 80 kg ha^{-1}. Weeding was done manually twice (3 and 9 weeks after transplanting). Fruits were harvested and sorted into four different groups (brown and dry, brown and fresh, yellow and yellowish-green). Seeds extracted from these fruits were dried at ambient conditions for seven days and packed into plastic bottles and stored at room temperature for 14 weeks. Hydro-priming was done by soaking 10 g of seeds in 50 ml of water for 24 hours as described by Afzal *et al.* (2011). After the soaking, the water was decanted and the seeds were dried back on paper under shade (at 29 °C) before they were tested for germination alongside the non-hydroprimed seeds.

Seed germination was tested at 0, 2, 4, 6, 8, 10, 12, 14 weeks after storage. This was done by counting four replicates of 50 seeds each of the treatment combinations and placed on a water-moistened filter paper in plastic Petri dishes. Germination counts were taken every day for 28 days and the results were expressed in percentages. The germination index (GI) described by Bench Anold *et al.* (1991) which Kader (2005) described as a comprehensive measuring parameter because it combines both germination percentage and speed (spread, duration and high and low events) was also calculated and used to better reveal differences among seed lots thus:

$$GI = (28 \times n1) + (26 \times n2) + \ldots\ldots + (2 \times n28)$$

Where n1, n2......., n28 are the number of seeds that germinated on the first, second and subsequent days until the 28th day, respectively; 28, 26,.........., and 2 are the weight given to the number of seeds that germinated on the first, second and subsequent days, respectively.

Data collected were subjected to analysis of variance using statistical analysis system (SAS) and means were separated using least significant difference (LSD) and Duncan Multiple Range Test (DMRT) for main effect means and the interaction means, respectively. All data in percentage were transformed to arcsin values before statistical analysis. Where second order interaction exists, the first order interaction was discountenanced.

Results

Germination was only fairly high in the two cultivars (*ca* 66-68%) within the first two weeks of storage dropping to about 38-44% at 4 WAS; there were no significant differences between the two cultivars during this period. Though significant differences were recorded between the two cultivars at some points beyond this period, the trend was inconsistent and the percentages were rather low (2-38%). The effects of fruit maturity stage and hydropriming on the germination percentage of the seeds of the two *Solanum macrocarpon* cultivars are presented on Table 1. Seeds extracted from BD fruits recorded significantly higher germination percentage (*ca* 87-12%) than those extracted from other fruit colours throughout the storage period except at 0 WAS where the percentages were similar (*ca* 87 and 88%) and at 2 WAS when the seeds extracted from BF fruits had a higher germination percentage (*ca* 88%) than that of BD fruits (*ca* 80%). Generally, seeds extracted from YG fruits recorded significantly lower germination percentages than other fruit stages (0-27%) during the storage period. The germination percentage of the different seed lots was not significantly affected by hydropriming. Interaction effect of cultivar, fruit maturity stages and hydropriming on the germination percentages of *Solanum macrocarpon* seeds at 12 and 14 weeks after storage (WAS) is presented on Table 2. At 12 WAS, seeds of FUTMSm-1 extracted from BD fruits germinated significantly higher when non-primed (32%) than when primed; no significant differences were observed among hydroprimed and non-primed (26%) seeds extracted from BF, Y and YG fruits of the same cultivar. Contrary to the above trend, FUTMSm-2 seeds extracted at the BD, Y and YG fruit stages germinated significantly higher when hydroprimed (27%, 14% and 4%, respectively) than when non-primed (19%, 8% and 0%, respectively). At 14 WAS, un-primed and primed seeds of FUTMSm-1 extracted from BD fruits had similar germination percentages (19% and *ca* 17%, respectively) which were significantly higher than those of other treatment combinations irrespective of cultivar. In FUTMSm-2 hydropriming of BD seed resulted in the highest germination percentage (*ca* 7%) which was however, not significantly different from those of non-primed BD (*ca* 4%) and primed and non-primed Y seeds (3% and 4%, respectively).

Table 3 shows the effect of fruit maturity stage and hydropriming on seed germination index of two *Solanum macrocarpon* cultivars. Seeds of cultivar FUTMSm-2 generally recorded significantly higher GI within the first six weeks of storage than those of FUTMSm-1. The reverse was however, the case during the last 10-14 weeks of storage. GI values were significantly greater in BD seeds compared to those of other seed lots except at 4 WAS when the values were statistically similar for both BD and BF (*ca* 621 and 644, respectively). GI values for BF seeds were significantly greater than those of Y and YG seeds from 0-4 WAS. However, from 6 WAS onwards GI values were significantly greater in Y than in BF and YG seeds. Priming generally significantly improved GI within the first 10 WAS.

Interaction effect of cultivar, fruit maturity stages and hydropriming on the germination index of *Solanum macrocarpon* seeds at 6 and 12 WAS is presented on Table 4. At 6 WAS, non-primed BFseeds of FUTMSm-1 and Y

Table 1: Effects of fruit maturity stage and hydropriming on germination percentage of Two *Solanum macrocarpon* cultivars at different storage periods.

Treatment	Storage period (weeks)							
	0	2	4	6	8	10	12	14
Cultivar (C)								
FUTMSm-1	67.25	65.50	43.75	23.50	17.25	10.00	7.25	4.50
FUTMSm-2	67.25	68.25	38.25	37.50	20.00	9.00	5.00	2.00
LSD (0.05)	3.73	6.85	5.21	3.88	2.11	1.38	0.93	1.22
Fruit maturity stages (FMS)								
Brown and dry	87.25	79.50	62.50	46.00	42.00	31.50	21.25	11.50
Brown and fleshy	88.00	87.50	56.00	28.00	9.75	0.00	0.00	0.00
Yellow	71.75	73.75	31.25	32.50	17.25	5.50	3.50	1.75
Yellowish-green	21.75	27.00	14.50	15.75	5.50	0.75	0.00	0.00
LSD (0.05)	5.13	5.02	4.22	4.46	2.98	2.06	1.32	1.73
Hydropriming (H)								
Primed	67.75	65.50	40.25	26.50	18.25	9.25	6.50	3.25
Un-primed	68.75	68.50	41.75	24.75	20.00	10.50	5.75	3.25
LSD (0.05)	3.73	6.85	5.21	3.88	2.11	1.38	0.93	1.22
Interaction								
C x FMS	*	*	*	*	*	*	*	*
C x H	*	N.S	N.S	*	*	*	N.S	N.S
FMS x H	N.S	N.S	*	*	*	N.S	N.S	N.S
C x FMS x H	N.S	N.S	N.S	*	N.S	N.S	*	*

Table 2. Interaction effect of cultivar, fruit maturity stage and hydropriming on the germination percentage of *Solanum macrocarpon* seeds

Treatment			Storage period (weeks)	
Cultivar	Fruit maturity stages	Hydropriming	12	14
FUTMSm-1	Brown and dry	Hydroprimed	26.00b	16.50a
		Non-primed	32.00a	19.00a
	Brown and fleshy	Hydroprimed	0.00g	0.00d
		Non- primed	0.00g	0.00d
	Yellow	Hydroprimed	0.00g	0.00d
		Non-primed	0.00g	0.00d
	Yellowish-green	Hydroprimed	0.00g	0.00d
		Non-primed	0.00g	0.00d
FUTMSm-2	Brown and dry	Hydroprimed	27.00b	6.50b
		Non- primed	18.50c	3.50bc
	Brown and fleshy	Hydroprimed	0.00g	0.00d
		Non-primed	0.00g	0.00d
	Yellow	Hydroprimed	13.50d	3.00cd
		Non- primed	8.00e	4.00bc
	Yellowish-green	Hydroprimed	3.50f	0.00d
		Non-primed	0.00g	0.00d

Means followed by different alphabets are significantly different at P=0.05 according to DMRT

Table 3: Effects of cultivar, fruit harvesting stages and priming on the germination index of *Solanum macrocarpon* seeds.

Treatment	Storage period (weeks)							
	0	2	4	6	8	10	12	14
Cultivar (C)								
FUTMSm-1	649.00	707.56	489.75	258.50	162.69	90.75	58.38	36.5
FUTMSm-2	762.88	786.75	443.50	421.81	176.63	65.25	40.94	19.38
LSD (0.05)	52.75	48.96	48.63	42.28	23.99	11.80	11.04	7.22
Fruit Maturity stages (FMS)								
Brown and dry	998.79	1008.25	621.23	537.00	380.25	260.63	167.75	94.63
Brown and fleshy	923.00	921.88	643.75	276.50	93.38	0.00	0.00	0.00
Yellow	764.63	763.88	429.13	386.00	153.25	43.88	30.88	17.13
Yellowish-green	227.38	295.13	172.38	161.13	51.75	7.50	0.00	0.00
LSD (0.05)	74.60	63.25	98.93	59.81	33.93	16.69	15.61	10.20
Priming (P)								
Un-primed	693.88	649.94	469.44	401.69	151.88	60.06	56.38	28.50
Primed	763.00	799.38	463.81	278.63	187.44	95.94	42.94	27.38
LSD (0.05)	57.75	48.96	46.63	42.29	23.99	11.8	11.04	7.22
Interaction								
C x MS	*	*	*	*	*	*	*	*
C x P	N.S	N.S	N.S	*	*	NS	NS	NS
MS x P	N.S	N.S	*	*	N.S	S	NS	NS
C x MS x P	N.S	NS	NS	*	N.S	NS	*	NS

Table 4: **Interaction effect of cultivar, fruit maturity stages and hydropriming on the germination index of *Solanum macrocarpon* seeds**

Treatment			Storage period (weeks)	
Cultivar	**Fruit maturity stages**	**Hydropriming**	**6**	**12**
FUTMSm-1	Brown and dry	Hydroprimed	771.50b	185.50b
		Non-primed	694.00b	281.50a
	Brown and fleshy	Hydroprimed	66.00e	0.00f
		Non- primed	398.00c	0.00f
	Yellow	Hydroprimed	62.00e	0.00f
		Non-primed	2.00e	0.00f
	Yellowish-green	Hydroprimed	37.50e	0.00f
		Non-primed	37.00e	0.00f
FUTMSm-2	Brown and dry	Hydroprimed	379.00cd	112.50c
		Non- primed	303.50cd	91.5cd
	Brown and fleshy	Hydroprimed	274.50d	0.00f
		Non-primed	367.50cd	0.00f
	Yellow	Hydroprimed	366.00cd	45.50e
		Non- primed	1114.00a	78.00e
	Yellowish-green	Hydroprimed	272.50d	0.00f
		Non-primed	297.50cd	0.00f

Means followed by different alphabets are significantly different at P=0.05 according to DMRT

fruits of FUTMSm-2 had higher GI (398 and 1114, respectively) compared to the primed seeds of the same fruit colour (66 and 366, respectively). No significant GI differences were recorded between primed and non-primed seeds of the other fruit maturation stages in each cultivar. At 12 WAS, the highest GI of 281.5 obtained in non-primed FUTMSm-1 seeds extracted from BD fruits was significantly greater than that of primed seeds. Priming had no significant effect on GI values of other fruit stages in this cultivar and of all fruit stages in FUTMSm-2.

Discussion

The significant variation in the response of the two cultivars used in this study is in agreement with the report of Sayed and Naser (2012) which revealed that significant variations exist in seed quality among selected cultivars of *Solanum lycopersicum*. Moghanibashi *et al.*, (2012) also reported that Urfloar cultivar of sunflower recorded higher germination index and germination rate index than Blazar cultivar. The higher GI and germination percentage recorded in FUTMSm-1 at late storage indicates that it was able to retain viability and vigour better than FUTMSm-2. Similar results were obtained in tomato (Sayed and Naser, 2012), pepper (Omotosho, 2014) and sunflower (Ghasemnez had and Honermeie, 2009). Dharwad (2007) stated that pepper varieties may vary greatly in their potential for retaining germinability and vigour of the seed under ambient storage conditions. Oladiran and Kortse

(2002) also reported that pepper seeds of 'rodo' cultivar maintained viability better than 'tatashe' cultivar.

In this study, seeds extracted from BD fruits had the best quality and YG the least. Seed maturation is known to be one of the main factors that determine vegetable seed quality, which is a prerequisite for successful germination and seedling emergence. Progressive improvement in seed quality as fruits mature has been found to be the case in tomato (Rao *et al.,* 2006) and pepper (Vigidal *et al.,* 2009). The report of Demir and Ellis, (1992) and Liu *et al.* (1996) showed that seeds extracted from tomato fruits at 70-75 DAA or when they were firm and red (Valdes and Gray, 1998; Demir and Samit, 2001; Ramirez-Rosales *et al.,* 2004) had the maximum vigour and viability compared to those extracted from fruits at 40 to 60 DAA.

Hydropriming did not significantly improve seed germination percentage in the current study. This is contrary to the report on other vegetables such as cauliflower (Powell *et al.*, 2000), watermelon (Huang *et al.*, 2002), pepper and aubergine (Demir and Okcu, 2004) and tomato (Badek *et al.*, 2006). The hydropriming duration of 24 hours was probably either sub- or supra- optimal as success of seed priming could be influenced by the duration until the optimum is reached; when the optimum duration is exceeded, seeds damage may occur (Farooq, *et al.,* 2005). However, the trend in the current study agrees with the report of Pill and Necker (2001).

It is, however, noteworthy that GI was significantly increased by priming especially within the first 10 weeks of storage. This parameter also made the difference between cultivars and among fruit harvesting stages more prominent. This confirms the assertion of Kader (2005) that GI takes into account in one measurement not only the germination percentage but also in combination with speed (spread, duration and high/low events); that it magnifies the variation among seed lots just has it has done in this study. Vidigal *et al.*, (20011) also stressed that maximum seed quality can be determined by a combination of germination percentage and vigour in pepper.

Conclusions and Recommendation

It is concluded that seeds of FUTMSm-2 cultivar of *Solanum macrocarpon* had higher quality than FUTMSm-1. Also, seed quality was greater when fruits were harvested at the brown and dry stage than at less-mature stages. Furthermore, seed quality was enhanced by 24-hour hydropriming. It is, therefore, recommended that fruits of *Solanum macocarpon*, be harvested when they are brown and dry to obtain seeds of high quality and that hydropriming for 24 hours may be done to enhance vigour.

References

Abdoulaye, S. (1992). Advances in seed research on embryo dormancy in African eggplant (*Solanum aethiopium*, L., spp Kumba). *Internationa Horticultural Congress Senegal, West Africa*, 1620 – 1640.

Afzal I., Basra S. M .A. & Ahmad, N.(2011). Hormonal priming induces salt tolerance in wheat through enhanced antioxidant defense system. *Cereal Research Community,* 39, 334–342.

Ahmed, A. M., Mumtaz, K., Omar, A. & Khamis, A. (2002).Effect of accelerated aging on lipid peroxidation, leakage and seedling vigor in cucumber (*Cucumis sativus* L.) seeds. *Pakistan Journal of Agricultural Science,*39(4), 124-137.

Amjad, M. & Anjum, M. A. (2002). Principles and humidity and ageing period on the quality of onion. Procedures of Statistics. McGraw- Hill, *New York Seed International Journal of Agriculture and Biology,* 4 (2), 291-296.

Ashraf, M. & Foolad, M. R. (2005). Pre-sowing seed treatment – A shotgun approach to improve germination, plant growth, and crop yield under saline and non-saline conditions. *Advances in Agronomy*, 88, 223–271.

Badek, B., Van Duijn, B. & Grzesik, M. (2006). Effects of water supply methods and seed moisture content on germination of China aster (*Callistephus chinensis*) and tomato (*Lycopersicon esculentum* Mill.) seeds. *European Journal of Agronomy*, (24), 45-51.

Bench, A. R., Fenner, M. and Edwards, P. (1991). Changes in germinability, ABA content and ABA embryonic sensitivity in developing seeds of *Sorghum bicolor*(L.) Moench induced by water stress during grain filling. *New phytologist*, 118:339-347

Bonsu, K. O., Fontem, D. A., Nkansah, G. O., Iroume, R. N., Owusu, E. O. & Schippers, R. R., **(2002).**Diversity within the Gboma eggplant (*Solanum macrocarpon*), an indigenous vegetable from West Africa. *Ghana Journal of Horticulture,* **1**,50-58.

Chinedu, S. N., Olasumbo, A. C., Eboji, O. K., Emiloju, O. C., Arinola, O. K. & Dania, D. I. (2011). Proximate and phytochemical analysis of *Solanum aethiopicum* L and *Solanum macrocarpon* L. fruits. *Research Journal of Chemical Sciences,* 1, 63-71.

Daunay, M. C., Lester, R. N & Laterrot, H. (2001). The usè wild species for the genetic improvement of brinjal (*Solanum melogeana*) and tomato (*Lycopersicon esculentum*). In: *Solanaceae* III: Taxonomy, Chemistry, Evolution (eds Hawkes, J.G. ., Lester, R. N., Nee, M and Erstrader, N.), *Royal Botanic Garden, Kew, Richmond, UK*, 380-412.

Demir, I. & Okcu, G. (2004). Aerated hydration treatment for improved germination and seedling growth in aubergine (*Solanum melongena*) and pepper (*Capsicum annuum*). *Annals of Applied Biology*, 144, 121-123.

Demir, I. & Oztokat, C. (2003). Effect of salt priming on germination and seedling growth at low temperatures in watermelon seeds during development. *Seed Science Technology*, 31, 765–770.

Demir, I., Ennis, S., Okyu, G. & Matthews, S. (2005). Vigour tests for predicting seedling emergence of aubergine (*Solanum melongena* L.) seed lots. *Seed Science Technology,* 2, 481-484.

Dharwad, (2007). Seed Quality enhancement and storability studies in chilli pepper (*Capsicum annum*).*Seed Science Technology*,4(18),122-126.

Edmond, J. M. & Chweya, J.A. (1997). Black Nightshades (*Solanum nigrum* L.) and Related Species. *International Plant Genetic Resources Institute (IPGRI)-Rome*,113.

Farooq, M., Basra, S. M. A, Hafeez, K. & Ahmad N. (2005). Thermal hardening: a new seed vigour enhancement tool in rice. *Journal of Integrated Plant Biology*,47,187-193.

Geneve , R. L. (1998). Seed dormancy in commercial vegetable and flower species. *In:*D.M. TeKrony (ed.). *Seed Technology*,2,20.

Ghasemnezhad, A. & Honermeier, B. (2009). Influence of storage conditions on quality and viability of high and low oleic sunflower seeds. *International Journal of Plant Production*,3,39-48.

Huang, R., Sukprakarn, S., Thongket, T. & Juntakool, S. (2002). Effect of hydropriming and redrying on the germination of triploid watermelon seeds. *Kasetsart Journal* (*Natural Science*), 36,219-224.

Kader, M. A. (2005).*A comparison of seed germination calculation formulae and the associated interpretation of resulting data. Journal and Proceeding of the Royal Society of New South Wales, 138, 65-75.*

Kaya, M. D., Okcu, G., Atak,M., Cikili, Y. & Kolsarici, O. (2006). Seed treatments to overcome salt and drought stress during germination in sunflower (*Helianthus annuus* L.) *European Journal of Agronomy*,24, 291-295.

Liu, Q., Hilhorst, H. W. M., Groot, S. P. C. & Bino, R. J. (1997). Amounts of nuclear DNA and internal morphology of gibberellin- and abscisic acid-deficient tomato (Lycopersiconesculentum Mill.) seeds during maturation, imbibition and germination. *Annals of Botany*, (79), 161-168.

Mahesha, C. R., Channaveeraswami, A. S., Kurdikeri,M. B., Shekhargouda, M. & Merwade, M. N. (2001). Storability of sunflower seeds harvested at different maturity dates. *Seed Research*,**29**(1), 98-102.

Moghanibashi, M., Karimmojeni, H., Nikneshan, P. & Delavar, B. (2012). Effect of hydropriming on seed germination indices of sunflower (*Helianthus annuus* L.) under salt and drought conditions. *Plant Knowledge Journal, Southern Cross Publishing Group*, 1(1),10-15.

Nerson, H. (2002). Effects of seed maturity, extraction practices and storage du ration on germinability in watermelon. *Scientia Horticulturae*,**93**,245-256.

Oladiran, J. A. & Kortse, P. A. (2002). Variations in germination and longevity of pepper (*Capsicum annum* L.) seeds harvested at different stages of maturation. *Acta Agronomica Hungarica*,50(2),157-162.

Omotosho, O. R. (2014). Enhancement of seed germination, emergence and seedling vigour in three pepper*species*by hydro-priming. *Journal of Agricultural and Biological Science*,6(1),39-43.

Patil, K. N. & Nagaraja, A. (2000). Germination of chilli seeds varieties Byadagi kadi and Dyavanood local as influenced by aging and storage period. *Kamataka Journal of Agricultural Science*, 12(4), 189-190.

Pill, W. G & Necker, A. D. (2001). The effects of seed treatments on germination and establishment of Kentucky bluegrass (*Poapratense* L.). *Seed Science and Technology*, 29, 65-72.

Powell, A.A., Yule, L.J., Jing, H., Groot, S.P.C., Bino, R.J. & Pritchard, H. W. (2000). The influence of aerated hydration seed treatment on seed longevity as assessed by the viability. *New York press*, 605.

Pukacka, S. (1998). Changes in membrane fatty acid composition during desiccation of seeds of silver maple. *Seed Science and Technology*, 26, 535-540.

Ramirez-Rosales, G., Bennett, G., McDonald, M. & Francis, D. (2004). Fruit Maturity Effects and Dormancy Breaking Treatments in High lycopene and Normal Tomato Seed. *Trade, Production and Technology, 2(7), 134 – 153.*

Rao, R.G.S., Singh., P. M. & Rai, M. (2006). Storability of onion seeds and effects of packaging and storage conditions on viability and vigour, *Scientia Horticulturae*, 110, 1-6.

Seyed, M. Z. & Naser A. A. (2012). Comparison in Quantity Characters (Flowering and Fruit Set) of Ten Selected Tomato (*Solanum lycopersicum* L.) Genotypes under Subtropical Climate Conditions (Ahvaz). *American-Eurasian Journal of Agriculture and Environmental Science*, 12 (11), 1437-144.

Szafirowska, A., Grzesik, M., Habdas, H. & Staniaszek, M. (2002). Improving germination and vigour of aged and stored onion seeds by matriconditioning. *Acta Physiologiae Plantarum*, 24, 167-171.

Valdes, V. M. & Gray, D. (1998). The influence of stage of fruit maturation on seed quality in tomato (*Lycopersicon lycopersicum* L.) *Seed Science and Technology*, 26, 309-318.

Vidigal, D.S., Dias, D.S., Von Pinho, E. R. V. & Dias, L. A. S. (2009). Sweet pepper seed quality and leaf- protein activity in relation to fruit maturation and post-harvest storage. *Seed Science and Technology*, **37**, 192-201.

Walker-Simmons, M. K. (1987). ABA levels and sensitivity in developing wheat embryos of sprouting resistant and susceptible cultivars. *Plant Physiology*, 84, 61-66.

Yogeesha, H.S., Singh, T. H. & Naik, L. B., (2008). Seed germination in relation to seed development in eggplant (*Solanum melongena*). *Indian Journal of Agricultural Science*, 78, 1010-1012.

Yogeesha, H. S., Upreti, K.K., Padmini,K., Bhanuprakash, K. & Murti, G. S. R. (2006). Mechanism of seed dormancy in eggplant (*Solanum melongena* L.). *Seed Science and Technology*, 34(2), 319-325.