Asian Journal of
Science, Technology, Engineering, and Art

e-ISSN: 3025-4507
p-ISSN: 3025-5287
Index: Harvard, Boston, Sydney University, Dimensions, Lens, Scilit, Semantic, Google, etc

https://doi.org/10.58578/AJSTEA.v3i2.5050

Yield and Storability of Onion (*Allium cepa* L.) Ecotypes as Influenced by Irrigation Intervals in Sudan Savanna of Nigeria

Muhammad A. M[1], M. S Na-Allah[2], Muhammad A[3], Mohammed I. U[4], Musa A[5], J. J Adigari[6], Yusuf I. J[7]
Kebbi State University of Science and Technology, Kebbi State, Nigeria
akibu273@gamil.com

Article Info:

Submitted:	Revised:	Accepted:	Published:
Jan 28, 2025	Feb 12, 2025	Feb 24, 2025	Mar 1, 2025

Abstract

Field trials were conducted simultaneously during the 2023/2024 dry seasons at the Kebbi State University of Science and Technology, Aliero University orchard located at Aliero and The second experiment were conducted at Usmanu Danfodio University Sokoto Teaching and research Fadama farm. The area is located at Sokoto State, both locations are in Sudan Savannah agro-ecological zone of Nigeria. The aim was to study the effects of irrigation interval on yield and the storability of twelve onion ecotypes (*Allium cepa* L.). Treatments consisted of three irrigation intervals (3, 6 and 9 days), and twelve onion ecotypes (Ex-Dikwa, Ex-Kaffe, Ex-Bama, Ex-Alieru, Ex-Gothege, Ex-Gada, Ex-Wurno, Ex-GHM, Ex-Gaya, Ex-Borno, Ex-Lahodu, and Ex-Goronyo). Factorial combinations of irrigation intervals were allocated to the main-plots, while ecotypes were assigned to the sub-plots in a randomized completely block design, replicated three times. The size of each sub-plot was 1x2m (4m2). Result revealed that plant height, number of leaves, above ground biomass, total biomass,fresh bulb weight, cured bulb diameter and bulb diameter were higher with 3 to 6 days irrigation interval, while weight loose and weight loose in (%) were higher in 3 days irrigation interval. Higher percentage

AJSTEA Journal is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License

of rotted bulbs and sprouting were recorded by frequent irrigation of 3 days interval. Plant height, number of leaves especially at early growth stages, and number of leaves throughout the crop cycle were higher at 3 days irrigation, eoctypes Ex-Kaffe and Ex-Dikwa has the highest plant height and leave number at 4, 8 and 12 WAT in the both locations, also total biomass, above ground biomass, fresh bulb weight recorded the highest weight value followed by Ex-Dikwa. Similarly, 3 days irrigated ecotypes has the highest weight value followed by 6 days irrigation interval while 9 days irrigation ecotypes recorded the least weight value. Ex-Borno, Ex-Dikwa and Ex-Kaffe recorded the highest weight value after undergoing curing period in the two locations, while ExGHM, Ex-Lohodu has the least weight value. Likewise in sokoto Ex-Dikwa and Ex-Kaffe has the highest weight value. In terms of bulb diameter (cm) Ex-Dikwa recorded the highest value in Aliero while the least was recorded in Ex-Goronyo, similarly in Sokoto Ex-Dikwa, Ex-Kaffe and Ex-Borno has the highest weight values after curing while Ex-Aliero, Ex-Gothege, Ex-Gada, Ex-GHM, Ex-Lohodu and Ex-Goronyo followed. In terms of weight loose, Ex-Borno loses weight drastically for the whole of the storage period followed by Ex-Gaya and Ex-Goronyo. Equally, Ex-Wurno and Ex-Kaffe recorded less weight loose during the storage period. Based on the result of this study, 3 days irrigation scheduling proved the best for more number of leaves plant height and fresh bulb yield in the study area, ecotypes Ex-Dikwa and Ex-Kaffe could be adopted due to its potential for higher yielding, while 9 days irrigation interval is the best for post-harvest storage and Ex-Goronyo were found superior.

Keywords: Onion, Ecotypes, Irrigation, Yield, Storability

INTRODUCTION

Onion (*Allium cepa* L.) belongs to family of Alliaceae and is believed to have originated in South West Asia or the Mediterranean (Best, 2000). The crop is the second only to tomatoes in importance among the vegetables in Nigeria and fifth in the world market (Hussaini *et al.*, 2020). It is grown on a wide range of climatic conditions, but thrives best in a mild climate without excessive rainfall or extremes of temperature (Boukary *et al.*, 2012). Onion requires soils with mild acid to neutral reaction (pH 6-7) and high soil moisture content for good yield (Gambo *et al.*, 2008). Onion production covered 215,934 hectares worldwide in 2021, yielding 4,562,530 tons. Onions have considerable economic potential for producing countries (J. S. Sidhu*, et al.*, 2019). The biochemical composition of onions makes them a valuable source of nutrition. (D. I. Leskovar *et al.*, 2012) Onions are rich in

bioactive elements such as flavonoids, phenolic compounds, organosulfur compounds, and polysaccharides, which are essential for human health. (E. Y. Ko*, et al.,* (2015). Onion production requires specific pedoclimatic conditions. Optimal onion vegetative growth requires a temperature range between 15 and 20°C, and bulb development requires a temperature range between 20- 27°C. Onion production requires a soil pH between 6.0-7.0 and requires 350–550 mm of water. Regular irrigation is also necessary to maintain a high soil water content of ensure optimum yields. (V. P. Masson-Delmotte. *et al* 2021). Onions have been used as medicine for purposes ranging from treating wounds and stomach ailments to treating infertility. It also contains a phytochemical called quercetin, which is effective in reducing the risk of cardiovascular disease, an anticancer, and has a promising effect of antioxidant (Smith, 2003).

Average yield of onion obtained by farmers in Nigeria is 14.79 t/ha, which is considered low compared to what is obtained in other countries for example 45 tons/ha in Niger, 39 tons/ha in Egypt and 30 tons /ha in Senegal (Gambo, 2007). This low yield could be attributed to steady depletion of natural soil fertility and also occurrence of multiple nutrient deficiencies in onion field has led to the identification of nutrient management as a key factor limiting sustainable onion production (Sharma *et al*., 2003). Similarly, Harris (2006) and Been *et al.* (2011) reported that constraints to production of onion have been mainly attributed to poor soil fertility as well as use of in-appropriate dose of organic manure which is the main factor affecting crop production in the tropical region, hence, results in low yield. Onion is a seasonal perishable crop and has comparatively low storage ability.

Onion bulbs are usually stored until the harvest of next season crop for steady supply round the year, getting the higher market price and production of true seeds using the bulbs in the next season. Several factors determine the shelf life and storability of onions, such as variety (Genetic trait), growing and harvesting conditions, post-harvest managements, storage conditions & duration (Sekara *et al*., 2017). Storage life of onion is affected by three principal characters such as physiological activity (transpiration, respiration, senescence, sprouting), biochemical activity (enzymatic, softness of tissue) and microbial invasion (fungi, bacteria), as described by Kumar *et al.* (2015). Storage temperature and relative humidity (RH) are two important factors which must be considered for storing the product successfully. Onion is generally stored at two distinct storage temperature and humidity regimes i.e. 0-2 °C & 65-70% RH and 25-30°C & 65-

70% RH which are called ideal conditions for storing onions (Tripathi and Lawande, 2019). The second conditions (25-30 °C & 65-70% RH) prevail in tropical/ subtropical countries which encourage more storage losses. Moreover, onion is normally stored under ambient conditions in most of the tropical countries under different types of structure where the storage losses are very high, as describes by Tripathi and Lawande (2019). Total postharvest losses in onion ranged from 50-90%, 40-60% and 40-50% due to sprouting, physiological loss in weight and rotting, as noted by Toledo *et al.* (1984); Tripathi and Lawanda (2019).

MATERIALS AND METHODS

The two field trials were conducted simultaneously; one was conducted at Kebbi State University of Science and Technology, Aliero, University Orchard during 2024 dry season. The area is located in Kebbi State in Sudan Savannah agro-ecological zone of Nigeria. The climate of the area is characterized by annual rainfall range from 550-700mm and temperature average between 27- 30°C during dry season and 27°C and 41°C during the raining season and the relative humidity range from 21 to 47 percentages in the dry season and 51 to 79 percentages during rainy season. The area characterized by long dry season with a cool air during hammatan (November to February), followed by short rainy season may/June to September/October (Anonymous, 2011). The second experiment was conducted at Usmanu Danfodio University Sokoto Teaching and research Fadama farm. The area is located at Sokoto State in Sudan Savannah agro-ecological zone of Nigeria.). The climate of the area is characterized by annual rainfall range from 500-700mm and temperature range from 30^0C during dry season and 27^0C and 41^0C during the rainy season and humidity range from 21-47% in the dry season with cool ai during harmattan (November-February), follow by rainy season May/June to September/October.

Treatment and Experimental Design

The treatment consisted of twelve (12) onion ecotypes namely; Ex-Gada, Ex-Dikwa, Ex-GHM, Ex-Lahodu, Ex-Goronyo, Ex-Gaya, Ex-Wurno, Ex-Aliero, Ex-Kaffe, Ex-Bama, Ex-Gothege and Ex-Borno. Irrigation intervals were three (3, 6 and 9days). The treatments were laid out in a Randomized Complete Block Design (RCBD) replicated three times.

Sources of Onion Ecotypes

The onion ecotypes used for the research was sourced from northern Nigerian- Niger republic borders due to their prominence as onion producing areas.

Cultural Practices

Nursery Management

The plot of 1x2m (4m2) was manually ploughed, the farm yard manure was applied evenly on the prepared plots. The viable onion seeds was broadcast evenly, Mulching and watering two days after while the mulches was removed two weeks after seed emerges.

Transplanting

The vigorous and healthy onion seedlings that attained the height of 7-8 cm was transplanted; the spacing of 8x8cm was maintained.

Irrigation

The irrigation was done using machine, the water will convey from the source to the main plot, two days irrigation intervals will maintain before the treatments were imposed.

Weeding

Weed control was done manually using hand and hoe when the weeds was observed in the plots

Fertilizer Application

Organic Manure, was used at 2WAT while NPK (15:15:15) was subsequently applied at 3 and 5 weeks after transplanting.

Data Collection

Plant Height (cm)

Plant height of tagged plants was measured at 4, 8, and 12WAT. This was achieved by measuring the plant from the bulb level to the tallest growing point of the leave using a measuring tape. The mean was determined and recorded.

Number of Leaves

Five leaves of the tagged plants was measured at 4,8,12 and 16WAT using meter rule and mean was record

Bulb weight (kg)

The weight fresh bulb was obtained by weighing five harvested bulbs using analog weighing balance and weight was recorded.

Cured Bulb weight (kg)

The weight of the cured bulb was obtained by weighing five cured bulb using analogue weighing balance and weight was recorded.

Cured Bulb Diameter (cm)

The diameter of five randomly selected bulbs was measured using Vanier caliper and averages were taken.

Storability assessment

Samples of 10 healthy and marketable size bulbs was drawn per treatment, and was spread out in clean disinfected simple and cost effective technology of aerated thatched bed measuring 30 x 30 x 10 m to store the onion sample for storability assessment in a well-ventilated store under ambient local conditions. The containers were kept in a completely randomized arrangement. The samples were inspected after every 30 days, over a period of 5 months, and observations on mean weight loss, sprouting and rotted bulbs was made at 2 weeks interval.

Data Analysis

Data collected was subjected to the Analysis of Variance (ANOVA) using SAS software package. And means that are significant was separated using Duncan's Multiple Range Tests.

RESULTS

Table 1: Total biomass, Average bulb diameter, and Fresh bulb weight of onion ecotypes as influenced by irrigation interval during 2023/24 dry season at Aliero and Sokoto locations

Treatments	Aliero			Sokoto		
	TBMS(kg)	AGBMS	FBW(g)	TBMS(kg)	AGBMS	FBW(g)
Ecotypes						
Ex-Dikwa	22.53a	5.42ab	17.10a	26.31a	5.82a	17.90ab
Ex-Kaffe	23.07a	5.70a	17.05a	26.08ab	5.83a	20.00a
Ex-Bama	20.04bc	4.70c	15.14b	24.11de	5.07b	18.82ab

Ex-Alieru	19.32bc	4.51d	14.52b	23.45ef	4.69c	18.69ab
Ex-Gothege	20.07b	5.05bc	14.94b	23.98de	5.32b	18.33ab
Ex-Gada	19.36bc	4.53d	14.91b	22.40gh	4.21d	17.92ab
Ex-Wurno	20.59b	5.32ab	15.10b	25.16bc	5.32b	19.65a
Ex-GHM	17.17d	4.68cd	12.38b	22.66fg	4.32d	18.20ab
Ex-Gaya	19.33bc	4.51d	14.63c	22.40gh	4.17d	18.05ab
Ex-Borno	22.53a	5.37ab	16.80a	24.80cd	5.20b	19.43ab
Ex-Lahodu	17.15d	4.49d	12.40c	22.45gh	4.41cd	17.78ab
Ex-Goronyo	18.77c	4.50d	14.07b	21.54h	4.23d	17.13b
SE±	**0.517**	**0.065**	**0.380**	**0.321**	**0.042**	**1.631**
Irrigation Interval (days)						
3	22.80a	5.53a	17.27a	27.86a	5.62a	21.43a
6	21.11b	4.94b	15.93b	26.24b	5.02b	20.98b
9	15.98c	4.22c	11.55c	17.24c	4.00c	13.06c
SE±	**0.258**	**0.196**	**0.190**	**0.160**	**0.127**	**0.894**
Interaction						
E x I	Ns	Ns	Ns	Ns	Ns	Ns

Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of significance using DNMRT

Table 2: Cured bulb weight (kg) and bulb diameter (cm) of onion ecotypes as influenced by irrigation interval during 2023/24 dry season at Aliero and Sokoto locations

Treatments	**Aliero**		**Sokoto**	
	CBW(kg)	BDM(cm)	CBW(kg)	BDM(cm)
Ecotypes				
Ex-Dikwa	16.20a	4.09a	19.24a	4.34a
Ex-Kaffe	15.87a	4.02ab	18.97a	4.25a
Ex-Bama	14.36b	3.45de	17.82bc	3.72b
Ex-Alieru	13.58b	3.37de	17.87bc	3.49bc
Ex-Gothege	13.77b	3.37de	17.59c	3.53bc
Ex-Gada	13.93b	3.42de	17.14c	3.49bc
Ex-Wurno	14.24b	3.67cd	18.50ab	3.53bc
Ex-GHM	11.47c	3.20ef	17.33c	3.44bc
Ex-Gaya	13.69b	3.41de	17.26c	3.30c
Ex-Borno	15.90a	3.76bc	18.57ab	4.20a

Ex-Lahodu	11.79c	3.15ef	17.00c	3.43bc
Ex-Goronyo	13.45b	3.11f	16.12d	3.59bc
SE±	**0.389**	**0.031**	**0.216**	**0.043**
Irrigation Interval (days)				
3	16.22a	4.15a	21.00a	4.55a
6	14.95b	3.62b	19.95b	3.91b
9	10.89c	2.72c	12.40c	2.61c
SE±	**0.194**	**0.015**	**0.108**	**0.021**
Interaction				
E x I	Ns	Ns	N Ns	Ns

Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of significance using DNMRT

Table 3: Percentage weight loss (%)of onion ecotypes as influenced by irrigation interval during 2023/24 dry season at Aliero and Sokoto locations

Treatments	WL1 (%)	WL2 (%)	WL3 (%)	WL4 (%)	WL5 (%)
Ecotypes					
Ex-Dikwa	4.17bc	10.77a	18.71ab	27.23ab	34.13ab
Ex-Kaffe	5.13ab	13.33a	20.36ab	26.91ab	34.39ab
Ex-Bama	6.64ab	12.58a	18.73ab	24.32ab	30.03ab
Ex-Alieru	8.15a	16.32a	24.81ab	33.21ab	40.88a
Ex-Gothege	10.46a	17.10a	26.99a	33.80a	43.24a
Ex-Gada	5.49ab	10.73a	17.13ab	22.98ab	28.40ab
Ex-Wurno	9.85a	17.48a	25.13ab	35.20a	41.65a
Ex-GHM	6.66ab	12.21a	18.73ab	25.31ab	31.90ab
Ex-Gaya	6.83ab	12.54a	19.18ab	24.32ab	32.17ab
Ex-Borno	6.19ab	12.08a	17.20ab	24.83ab	30.03ab
Ex-Lahodu	9.69a	14.76a	19.61ab	26.41ab	34.44ab
Ex-Goronyo	6.11ab	10.84a	14.99b	18.63b	23.30b
SE±	**11.208**	**18.239**	**36.087**	**61.442**	**79.206**
Irrigation Interval (days)					
3	8.10a	15.46a	23.83a	31.70a	39.81a

6	7.73a	13.79ab	19.31ab	24.45b	31.33b
9	5.50a	10.94b	17.26b	24.29b	30.05b
SE±	**5.602**	**9.119**	**18.043**	**30.721**	**39.601**
Interaction					
E x I	Ns	Ns	Ns	Ns	Ns

Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of significance using DNMRT

DISCUSSION

Ecotypes response

Twelve onion ecotypes namely; Ex-Dikwa, Ex-Kaffe, Ex-Bama, Ex-Alieru, Ex-Gothege, Ex-Gada, Ex-Wurno, Ex-GHM, Ex-Gaya, Ex-Borno, Ex-Lahodu, and Ex-Goronyo influences it overall performance through it leave number, plant height and bulb weight, the result reveals that the shorter interval i.e 3 and 6 days irrigation significantly increases the growth parameters like plant height at 4,8 and 12 weeks after transplanting in the two locations as compares to 9 days. Crop like onion performs better when the irrigation is given on depletion 15-20% soil moisture of the field capacity. The shorter the irrigation interval at 3 and 6 days ensure the moisture in the crop root zone. Frequent irrigation maintain soil physical condition plant growth by maintaining optimum soil water balance around the plant base, probably this may be the for better performance of growth parameters by the treatments with shorter intervals of irrigation compare to 6 and 9 days. Similar result were obtained by Bagali *et al*., (2012) for plant height and leave number, for fresh bulb yield Neeraja *et al*., (2004), total biomass and fresh bulb weight Haque *et al*., (2004).

Response to Irrigation Interval

Water is an essential resource for crop production. It is required for photosynthesis, respiration, transpiration, transport of minerals and photosynthate, turgidity of plant cells, and regulation of leaf temperature (Fernando and Huchinson, 2006). The result of this study revealed values for plant height, number of leaves and bulb formation (8WAT) stages to be higher when irrigated at 3 and 6 days irrigation intervals.

The positive response of these growth characters to frequent irrigation could be due to the soil type, being sandy loam and the windy harmattan weather coupled with the relatively

shallow and fibrous root system of onion. The sandiness of the soil might have favored high infiltration and depletion of soil moisture. This was aggravated by the harmattan wind, which caused rapid drying of soil, thus the need for frequent irrigation.

The frequent irrigation at 3 or 6 days made water available at the root zone and this enhanced uptake of nutrients from the soil, transport these nutrients as well, and translocation of assimilates to shoots. Similar findings were reported by Shock and Feibert (2002), Wang *et al.* (2004) and Islam *et al.* (2009) who independently noted significant increase in dry matter production, plant height, number of leaves and plant height in treatments with frequent irrigation intervals than with wider intervals.

The 3 and 6 days irrigation schedules enhanced soil moisture availability, which caused increased solubility and availability of soil nutrients to the crop; and this in turn, increased photosynthesis, thereby causing more tissue formation as well as translocation and distribution of photosynthate to stems, leaves. This also increased crop vigour, through increased leaf number and size, thereby influencing rate of growth and development of the crop. Ferreira and Carr (2002) reported that frequent irrigation increased crop growth rate and delays maturity. Wolfe *et al* (1983), Pereira *et al.* (1995) and Shock and Feibert (2002) independently reported that frequent irrigation increased crop growth rate and relative growth rate, but caused reduction in storability of onion bulb. Shimshi and Susnoschi (1985) reported a high assimilate partitioning rate with reduced duration of water stress.

The positive response of fresh bulb yield and other yield components such as mean bulb diameter, average bulb weight, fresh bulb weight and cured bulb weight per stand to 3 and 6 days irrigation schedules could be due to adequate availability of soil moisture in root zone. As a result, the moisture enhanced efficient uptake and utilization of nutrients for photosynthesis, leaf formation and consequently production and translocation to bulbs, hence the higher bulb weight, size and yield. Kang *et al.* (2004) and Wang *et al.* (2006)

CONCLUSION

Based on the result of this study, 3 days irrigation scheduling proved the best for more number of leaves, plant height and fresh bulb yield in the study area, ecotypes Ex-Dikwa and Ex-Kaffe could be adopted due to its potential for higher yielding, while 9 days irrigation interval is the best for post-harvest storage and Ex-Goronyo were found superior. The experiment should be conducted in other savannah zones to evaluate the

influence of irrigation scheduling on different onion ecotypes, other method of storage should be adopted in other to assess the storage shelf-life of onion ecotypes in the study area.

REFERENCES

Abbey, L., and Joyce, D. C. (2004). Water deficit stress and soil type effects on spring onion accumulation and partitioning in two potato cultivars. *Journal of Plant Nutrition,* 25, 1621–1630. https://doi.org/10.1300/ J068v10n02_02

Abdelsattar, A., Pascual-Seva,N., Nájera, I., Ángel Domene, M., Baixauli, C., and Pascual, B. (2019). Effect of deficit irrigation on the productive response of drip-irrigated onion (*Allium cepa* L.) in Mediterranean conditions. *The Horticulture Journal,* 88(4), 488–498. https://doi.org/10.2503/hortj.UTD-081

Abubakar, L. (2005) Vpremilary characterization and evaluation of onion (Allium cepaL)VGermplasm of Northwestern Nigeria proceeding of the 30th *Genetic society of Nigeria conference, university of Nigeria* Nsuka,5th=8th sept,2005.pp 240-241.

Abubakar, L;S.G.Ado,AASuberu, and M.D, Magaji (2006) screening of onion (Allium *cepa* L.) cultivars for resistance to purples Blotch(Alternaria porri L). *diseases, best journal*, vol3.No,30-36.

Adamicki, F. (2005). Effects of pre-harvest treatments and storage conditions on quality and shelf-life of onions. *Acta Hort.* 2005;688:229-238.

Ali, M. H. (2010). Fundamental of irrigation and on farm water management. Agricultural Engineering Division, Bangladesh Institute of Nuclear Agriculture. https://doi.org/10.1007/978-1-4419-6335-2_2

Al-Moshileh, A. M. (2007). Effect of planting date and irrigation water level on onion (Allium cepa L.) productivity under Central Saudi Arabian conditions. *Scientific Journal of King Faisal University* (Basic and Applied Sciences). C.f. Computer Res.. Ambo Agricultural Research Center (AARC). (2017). *Ambo agricultural research center profile. Ethiopian, Agricultural Research Institute.*

Anbese,A., Seyoum, T., & Hordofa, T. (2020). Effect of irrigation methods and irrigation levels on yield and water productivity of onion at Awash Melkasa, Ethiopia. Octa *Journal of Environmental Research,* 8 (1), 004–016. http://www.seincebeingjournal.co

Anonymous .,(1993). Production Year Book on Onion. Food and Agricultural Organization (FAO), Italy. Pp 33-34.

Asemanrafat,. M.,and Honar, T. (2017). Effect of water stress and plant density on canopy temperature, yield components and protein concentration of red bean (*Phaseolus vulgaris* L. cv. Akhtar). *International Journal of Plant Production,* 11(2), 1735–6814. https://doi.org/10.22069/ijpp.2017.3422

Bagali, A. N. (2012). Effect of scheduling of drip irrigation on growth,yield and water use efficiency of onion (*Allium cepa* L.). Indian Karnataka. *Journal of Agriculture Science*, 25(1), 116–119.

Baninasab, S. and Rahemi, M. (2006). The effect of high temperature on sprouting and weight loss of two onion cultivars. *Amer. J. Plant Physiol.* 2006;1(2):199-204.

Benkeblia, N., Varoquaux, P. and Gouble, B., Selselet-Atto, G. (2000). Respiratory parameters of onion bulbs (*Allium cepa* L.) during storage. Effects of ionizing radiation and temperature. *J Sci. Food and Agri.* 2000;80(12):1772-1778.

Benkeblia. N, Varoquaux P, Shiomi P. and Sakai., H. (2002). Storage technology of onion bulbs c.v. Rouge Amposta: effects of irradiation, maleic hydrazide and carbamateisopropyi, N-phenyi (CIP) on respiration rate and carbohydrates. Inter. *J Food Sci. Technol* .2002;37(2):169-176.

Berth, M. M., Hankison, T. R., Zhuang, H and Breidt, F. (2009*)* *Microbiological Spoilage of Fruits and Vegetables*. In: Sperber, W.H and Doyle, M.P. (eds.), Compendium of the *Microbiological Spoilage of Foods and Beverages, Food Microbiology and Food* Safety, Springer Science+BusinessMedia. LLC, New York.135-183.

Biswas, S. K., Khair, A., Sarkar, P. K. and Alom, M. S. (2010). Yield and storability of onion (*Allium cepa* L.) as affected by varying levels of irrigation. Bangladesh., *J. Agric. Res.* 2010;35 (2):247-255.

Biswas, S. K., Sarker, P. K., Mazharulislam, A. K., Bhuyan, M. A. and Kundu., B. C. (2003). Effect of irrigation on onion production. *Pakistan Journal of Biological Science*, 6 (20), 1725–1728. https://doi.org/10.3923/pjbs.2003. 1725.1728

Brewster. (2014). Turkey, Iran. Afghanistan, Pakistan, Tajikistan, China, Mongolia and Siberia Brewster (2014)

Brewster, james L. (1994). Onion and other vegetable Allums (1sted.)Wallingfort UK: AB Internations: p. 16. Class Lilopsida onion belongs to the kingdom plantae, Wikipedia (2017).

Brice, J., Currah, L. and Malins, (1997). Bancroft R. Onion Storage in the Tropics: A Practical Guide to Methods of Storage and Their Selection. Chatham*, UK. Natural Resource Institute; c1997.*

David, K., Emmanuel, C., & John, K. (2016). Effects of deficit irrigation on yield and quality of onion crop. *Journal of Agricultural Science*, 8(3), 1916–9752. https://doi.org/http://dx.doi.org/10.5539/jas. v8n3p112

Denton, L.and Ojeifo, I.M. (1990). Onion Production Practices and their Improvement in Nigeria. Onion

Disket, D., Parshant, B., Stanzin, D., Preeti, C., Kiran, K. and Mahender, S. (2017). Effect of deficit irrigation scheduling on yield and quality of Kinnow Mandarin crop. *International Journal of Current Microbiology and Applied Sciences*, 6(7), 261–269. https://doi.org/http://dx.doi.org/10.20546/ijcmas.2016.501.031

Dogondaji, S.D. M. Baba, K. and Mohammed, I. (2006). Marketing analysis of onion in Sokoto and Kebbi State of Nigeria. *Journal of Agriculture* 1(2).

Erin, S. (2010). Influence of pre-harvest factor on post- harvest quality. *Journal of Biochemistry* 2: 133-145.