J. Sylhet Agril. Univ. 1(2):193-198, 2014 **Research Article** **ISSN: 2308-1597**

EXPLORING THE YIELD POTENTIALS OF SOME EXOTIC ONION LINES UNDER THE CLIMATIC CONDITIONS OF BANGLADESH

K M D Hossain[1], M A S Hossain*[2], A F M S Islam[3], M M Islam[3] and D Saha[4]

[1]Department of Environmental Science and Technology, Jessore University of Science and Technology, Jessore-7408, Bangladesh
[2]Soil Resource Development Institute, Dhaka-1215, Bangladesh
[3]Department of Crop Botany and Tea Production Technology, Sylhet Agricultural University Sylhet-3100, Bangladesh
[4]Sylhet Agricultural University Research System, Sylhet Agricultural University, Sylhet-3100, Bangladesh

Abstract

A field experiment was conducted at the experimental farm of Bangladesh Institute of Nuclear Agriculture, Mymensingh during October 2007 to March 2008 to investigate the morpho-physiological characters, yield attributes and yield of ten exotic and two local onion genotypes viz. AV-15142, AV-17070, AV-21844, AV-21848, J-315, J-368, J-420, JM-315, JM-368, JM-420, BARI Piyaj-2 and BARI Piyaj-3. Among the genotypes BARI Piyaj-2 and BARI Piyaj-3 were the recommended varieties for both winter and summer cultivation and the rest of the genotypes were exotic. The experiment was laid out in a Randomized Complete Block Design with three replications. Significant variations were found in all the morpho-physiological and yield contributing characters of onion. Results revealed that higher yield performing genotypes produced taller plants, higher number of leaves plant^{-1}, longer and thicker leaves and thicker pseudostem except J-420. The exotic line J-420 showed superiority in plant height, leaf number, leaf length, leaf breadth and pseudostem diameter with intermediate yield. Investigation showed that low yield performing genotypes produced shorter plants, lower number of leaves and shorter leaves which resulted in lower bulb yield. Similarly, high yield performing genotypes produced thicker and larger bulb which resulted in higher bulb yield. The bulb of JM-315 matured earlier but showed lower performance in bulb yield. The genotypes AV-21844 and AV-21848 showed superiority in yield contributing characters. The genotype AV-21844 showed best performance in respect to storage quality, unsplitted bulb production, days to maturity of the bulb and bulb yield.

Keywords: Splitted bulb, exotic genotype, pseudostem ratio, chlorophyll

Introduction

Onion (*Allium cepa* L.) is a monocotyledonous plant under the family Liliaceae. It is a cross-pollinated and biennial short type vegetable as well as an important spice crop throughout the world. The main edible portion of onion plant is bulb, which is a modified stem and constituted by the thickened fleshy leaf sheaths and stem plate (Purseglove, 1988). It is used in almost all food preparation and is an integral part of Bangladeshi diet (Hossain and Islam, 1994).

In Bangladesh, onion occupies an area of 193 thousand hectares of land with total production of 1701 thousand metric tons of bulb during 2013-14 (MOA, 2014). The average yield hectare^{-1} in Bangladesh is about 8.81 tons, which is very low compared to that of Korean Republic (66.67 MT ha^{-1}), USA (56.56 MT ha^{-1}), Spain (53.53 MT ha^{-1}), Netherlands (48.81 MT ha^{-1}), China (22.21 MT ha^{-1}) and India (13.6 MT ha^{-1}) as per FAO (2009). Thus there is a wide gap between the yields of Bangladesh and other developed countries, suggesting the huge scope of increasing the yields in Bangladesh. Adoption of high yielding lines with proper cultural practices at production level may be a tool to increase the yield of onion in the country.

Many attempts were taken in the recent past to augment the yield and to improve the quality of onion seed. In Bangladesh, short-day length prevails in the growing season of onion (October-November). So, adjusting the planting time of onion cultivation is very important. Mondal (1980) considered the last week of October as the optimum planting time for attaining highest yield and best quality onion seeds. Haque *et al*. (2011) reported that the farmers encountered different problems during onion cultivation such as non-availability of HYV seed at proper time. Most of the farmers in Bangladesh use their own seed material for cultivation, which is not regulated properly for varietal admixture and consists of a heterogeneous material which reduces yield potentiality.

***Corresponding author: M A S Hossain,** *Soil Resource Development Institute, Regional Laboratory, Sylhet, Bangladesh, email: mashossain75@gmail.com*

The annual production of onion in Bangladesh remains far short of demand. Every year, the country has to import a huge amount of onion from neighboring and other countries to meet up its demand. Mosleh Ud-deen (2011) stated that frequently onion prices reached in recent past years. As a result, the high price is mostly pinching the pockets of the country's low-income group populations.

Rahman (1998) reported that many of the exotic cultivars of onion of the temperate origin produced large bulbs in Bangladesh climatic conditions but failed to produce flower due to short winter season. Hussain (1985) suggested that onion scientists should carry out researches on short-day type onion genotypes of the tropical origin. In this regard, the Crop Physiology Division of Bangladesh Institute of Nuclear Agriculture (BINA) collected some exotic lines of onion from AVRDC, Taiwan and Japan which have high yield potentials with short life span. These exotic lines were evaluated for the morphological and physiological characteristics with yield performances and compared the exotic lines with the existing cultivars.

Materials and Methods

The experiment was carried out at the farm of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during October 2007 to March 2008. The experimental field is medium high land belonging to the Sonatola Soil Series of Grey Flood Plain soil under the Agroecological zone of Old Brahmaputra Flood Plain (AEZ-9) (Brammer, 1971). The soil is silty loam in texture characterized by heavy rainfall during monsoon and scanty in winter season.

Ten exotic lines of onion viz. AV-15142, AV-17070, AV-21844, AV-21848, J-315, J-368, J-420, JM-315, JM-368 and JM-420 were collected from AVRDC, Taiwan and Japan. The two local varieties viz. BARI Piyaj-2 and BARI Piyaj-3 were collected from Bangladesh Agricultural Research Institute. The seeds of each onion line were sown in iron tray (50 cm × 60 cm) and covered with light soil. The experiment was laid out in a Randomized Complete Block Design with 3 replications. The unit plot size was 1.2 m × 1.5 m. Plot to plot and block to block distances were 0.5 m and 1.0 m, respectively. Plant to plant and row to row distances were at 10 cm and 30 cm, respectively.

Fertilizer doses used in the experimental plots were urea 130, TSP 180, MoP 200 and gypsum 150 kg ha^{-1} (FRG, 2005). Cowdung was applied @ 8 t ha^{-1}. Total amount of cowdung, TSP, MoP, gypsum and half of urea were applied as basal dose during final land preparation. The rest half of urea was applied as top dress at 31 days after sowing. Forty days old seedlings were uprooted and transplanted to the main field followed by irrigation. After one week of transplanting, gap filling was done where necessary. Irrigation was done at an interval of three weeks. Weeding was done twice at 20 and 60 days after transplanting. Fungicide (Dithane-M 45) was applied at 80 days after transplanting.

The crop was harvested when 80% of leaves were fallen. Before harvesting 10 plants were selected at random from each plot. The bulbs were harvested from each plot separately and tagged. The tops of onion were removed by cutting the leaves 2.5 cm away from bulb. Morpho-physiological characters and yield contributing characters were evaluated. Plant height was taken to the length between the bases of the plant to the tip of the longest leaf. Number of leaves was counted from 10 randomly selected plants and average leaves $plant^{-1}$ was calculated. Leaf length was taken from the base of leaf to the tip of the longest leaf at maximum growth stage. Breadth of the leaf, pseudo-stem and bulb diameter was measured in centimeter along the middle part of the leaf, pseudo-stem and bulb with the slide calipers and average value was taken. Chlorophyll was extracted in 80% acetone from the leaves of the plant and it was determined as described in Yoshida *et al.* (1976).

Percent rotten bulb was calculated at two months after harvesting. It was calculated by dividing the number of rotten bulb to the total number of bulb by multiplying with 100 and expressed in percentage. Percent splitted bulb was calculated by dividing the number of splitted bulb to the total number of bulb by multiplying with 100 and expressed in percentage. Days to maturity was counted from transplanting to 85-90 % leaves fall down. Number of bulblets $bulb^{-1}$ was counted from 10 randomly selected plants of each plot and average bulblets $plant^{-1}$ was calculated. Bulb pseudo-stem ratio was calculated by dividing bulb diameter to pseudostem diameter. Fifty clean sun dried bulbs were counted from the bulb stock obtained from the sample plants and weighed by using electronic balance and divided by 50 for getting single bulb weight. Bulb was separated from pseudo-stem manually and then air dried under shade and weighed plot wise and then converted to t ha^{-1}.

All the collected data were statistically analyzed through ANOVA technique and the mean differences were adjusted with Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) under MSTAT-C program (Russel, 1986).

Results and Discussion

Plant height of twelve genotypes showed significant variations (Fig.1). The highest plant height was found in J-420 followed by J-368 and JM-420. The plant heights of AV-15142, AV-21844, AV-21848 and AV-17070 were statistically similar. There was no significant difference in the plant height of JM-368 and BARI Piyaj-3. The shortest plant height was found in JM-315.

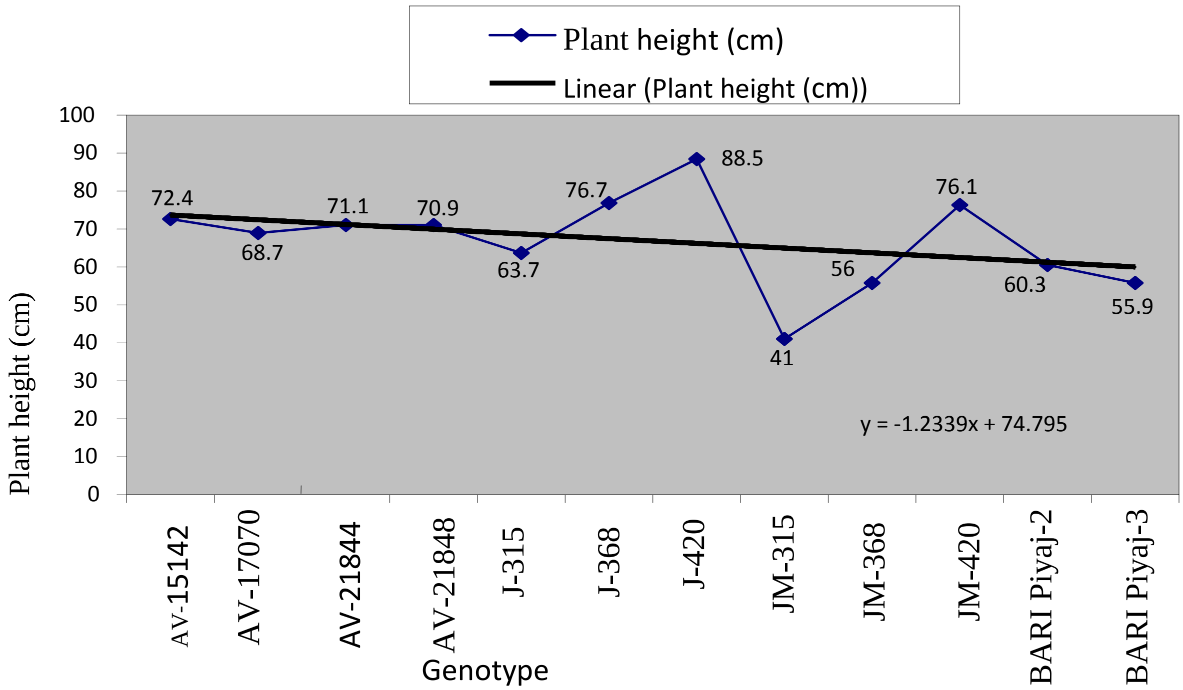

Fig.1. Effect of genotypes on the plant height of onion

The highest number of leaves plant^{-1} was found in the genotype J-420, which was similar to that of BARI Piyaj-2 followed by JM-420 (Table 1). No significant differences were found in the genotypes AV-21844, AV-21848, J-315 and J-368 in respect to leaf number. AV-17070, AV-15142 and BARI Piyaj-3 produced similar number of leaves plant^{-1}. The lowest number of leaves plant^{-1} was found in JM-368.

Table 1. Leaf characteristics of ten exotic and two local genotypes of onion

Genotypes	Number of leaves plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Chlorophyll (mg g^{-1}fw)	Pseudo-stem diameter (cm)
AV-15142	8.73 c	55.3 bc	1.57 a	1.87 bc	1.99 bc
AV-17070	9.00 c	52.1 d	1.32 bcd	1.77 c	1.78 c
AV-21844	9.80 bc	56.4 b	1.18 cd	2.14 a	1.92 bc
AV-21848	9.73 bc	56.3 b	1.33 bcd	2.16 a	1.90 bc
J-315	9.53 bc	43.8 e	1.39 abc	1.66 c	1.82 bc
J-368	9.47 bc	56.8 b	1.27 bcd	1.85 bc	1.99 bc
J-420	13.3 a	61.1 a	1.38 a-d	1.80 c	2.33 a
JM-315	8.07 d	29.0 g	0.87 f	1.66 c	1.15 d
JM-368	6.83 e	39.2 f	0.95 ef	1.82 c	1.22 d
JM-420	10.8 b	52.9 cd	1.43 ab	1.78 c	1.78 c
BARI Piyaj-2	12.9 a	41.2 ef	1.19 cd	1.93 ab	2.15 ab
BARI Piyaj-3	8.87 c	44.0 e	1.15 de	2.09 ab	1.89 bc
F test	**	**	**	**	**
CV(%)	9.76	3.25	9.74	7.47	9.41

*In a column, figure(s) having the same letter(s) do not differ significantly at p≤ 0.05, ** indicates significant at 1% level of probability.*

The highest length (61.1cm) of leaf was found in J-420 line followed by AV-21844, AV-21848, J-368 and AV-15142 (Table 1). The leaf lengths of JM-420 and AV-17070 were more or less identical. BARI Piyaj-3 and BARI Piyaj-2 produced the same length of leaf followed by JM-368. The shortest leaf height (29 cm) was found in JM-315.

The broad leaf was produced by the genotype AV-15142 followed by JM-420, J-315 and J-420 (Table 1). The leaf breaths of AV-21848, AV-17070 and J-368 were statistically identical. The Leaf breath of BARI Piyaj-2 was statistically similar to that of AV-21844 followed by BARI Piyaj-3. The narrow leaf was found in JM-315. The leaf of JM-368 was little broad compared to JM-315.

The influence of genotypes on chlorophyll content showed significant variations. The highest chlorophyll content was recorded in AV-21848 and AV-21844 genotypes closely followed by BARI Piyaj-3, BARI Piyaj-2. The chlorophyll content of AV-15142 and J-368 were statistically identical. The lowest and statistically similar amount of chlorophyll content was recorded in J-315, JM-315, AV-17070, JM-420, J-420 and JM-368 lines.

The longest pseudostem was produced by J-420 closely followed by BARI Piyaj-2. There was no significant difference found among the genotypes AV-15142, J-368, AV-21844, AV-21848, BARI Piyaj-3 and J-315. The onion lines JM-420 and AV-17070 produced statistically similar length of pseudostem. The shortest and statistically identically pseudostem was found in JM-315 and by JM-368.

Table 2. Bulb characteristics of ten exotic and two local genotypes of onion

Genotypes	Rotten bulb (%)	Splitted bulb (%)	Days to maturity	Bulb colour
AV-15142	45.0 c	20.0 e	126 c	Red
AV-17070	63.6 b	10.5 f	126 c	Red
AV-21844	20.0 d	0.00 g	126 c	Yellow
AV-21848	57.9 b	7.90 f	130 abc	Pale yellow
J-315	100.0 a	92.4 a	135 a	Red
J-368	100.0 a	90.7 a	128 bc	Whitish
J-420	100.0 a	18.3 e	129 bc	Red
JM-315	100.0 a	0.00 g	112 d	Red
JM-368	100.0 a	40.0 d	116 d	Red
JM-420	100.0 a	92.1 a	132 ab	Red
BARI Piyaj-2	100.0 a	56.2 b	115 d	Red
BARI Piyaj-3	100.0 a	46.7 c	115 d	Red
F test	**	**	**	**
CV(%)	4.99	7.95	2.57	7.95

*In a column, figure(s) having the same letter(s) do not differ significantly at $p \leq 0.05$, ** indicates significant at 1% level of probability.*

Genotypes significantly affected the bulb characteristics (Table 2). The significant effect of genotypes on storage life and bulb quality was observed. Out of twelve genotypes, eight were damaged by 100% at two months after harvest due to fungal infection. It indicates that these genotypes had poor storage quality. The lowest bulb damage was recorded in AV-21844 (20%) which was followed by AV-15142 (45%).

Among the genotypes, three lines viz. J-315, J-368 and JM-420 produced more than 90% of the total splitted bulbs. No splitted bulb was found in the lines AV-21844 and JM-315 which may be desirable ones. The genotypes AV-21848 and AV-17070 produced fewer numbers of splitted bulbs (from 7.9 - 10.5%). BARI (2004) studied some exotic and local cultivars of onion and reported that exotic onion produced more splitted bulbs than local ones.

The maturity of bulbs was significantly influenced by the genotypes. The genotype J-315 took highest days (135) to become maturity followed by JM-420 (132 days). The genotypes J-368, J-420 and AV-21848 took 128 to 130 days for their maturity of bulbs. The genotypes AV-15142, AV-17070 and AV-21844 took 126 days for bulb maturity. The genotype JM-315 became mature early only after 112 days of transplanting followed by JM-368, BARI Piyaj-2 and BARI Piyaj-3. Most of the genotypes produced red colored bulbs except J-368 (whitish), AV-21844 (yellow) and AV-21848 (pale yellow).

Yield contributing characters of 12 genotypes are shown in Table 3. The maximum bulblets plant^{-1} was found in JM-420 (3.66) followed by J-368 (2.45) and JM-368 (2.0), whereas BARI Piyaj-3 (1.30) and BARI Piyaj-2 (1.15) produced statistically similar number of bulblets plant^{-1}. Four genotypes viz., AV-21844, AV-21848, J-315 and JM-315 produced single bulb plant^{-1}.

The results revealed that bulb diameter positively influenced the bulb yield. The highest bulb diameter was recorded in AV-21844 (6.41 cm) closely followed by AV-21848 (6.33 cm), AV-15142 (6.11 cm) and AV-17070 (6.01 cm). BARI Piyaj-2 (5.43 cm) and BARI Piyaj-3 (5.32 cm) produced statistically similar breadth of bulb. The lowest bulb diameter was recorded in JM-315 which was very close to J-315, JM-368 and JM-420.

Bulb pseudostem ratio of the genotypes AV-17070, AV-21844 and AV-21848 were higher and statistically similar to each other and followed by AV-15142, JM-368 and JM-315 which were also identical to each other. The lowest bulb pseudostem ratio was found in J-420. It was found that bulb pseudostem ratio was higher in high yield performing genotypes compared to those of low yield performing ones. Perhaps it is possible that assimilates transferred from pseudostem to bulb for bulb growth and development in high yield performing genotypes.

Table 3. Yield contributing characters of ten exotic and two local genotypes of onion

Genotypes	Bulblets plant^{-1}	Bulb diameter (cm)	Bulb-pseudostem ratio	Single bulb weight (g)
AV-15142	0.40 ef	6.11 a	3.07 b	74.2 bc
AV-17070	0.20 fg	6.01 a	3.38 a	78.2 b
AV-21844	0.00 g	6.41 a	3.34 a	103.2 a
AV-21848	0.00 g	6.33 a	3.33 a	99.7 a
J-315	0.00 g	3.63 d	1.99 d	38.4 f
J-368	2.45 b	4.37 c	2.20 d	67.1 d
J-420	0.45 e	3.87 cd	1.66 e	49.6 e
JM-315	0.00 g	3.42 d	2.97 b	20.0 g
JM-368	2.00 c	3.70 d	3.03 b	43.0 f
JM-420	3.66 a	3.71 d	2.08 d	53.8 e
BARI Piyaj-2	1.15 d	5.43 b	2.53 c	70.0 cd
BARI Piyaj-3	1.30 d	5.32 b	2.81 b	54.0 e
F test	**	**	**	**
CV(%)	12.51	6.51	3.35	5.47

*In a column figure(s) having the same letter(s) do not differ significantly at p≤ 0.05, ** indicates significant at 1% level of probability.*

Single bulb weight showed significant variations among the genotypes and directly influenced the bulb yield (Table 3). The highest single bulb weight was found in AV-21844 and AV-21848 mainly due to having higher bulb diameter and bulb pseudostem ratio. The second higher single bulb weight was recorded by the genotype AV-17070 followed by AV-15142, which were also having higher bulb diameter and bulb pseudostem ratio. Single bulb weight of BARI Piyaj-2 followed by J-368 was also a contribution of the bulb diameter and bulb pseudostem ratio. The lowest single bulb weight was produced by JM-315. Single bulb weight was mainly influenced by bulb diameter.

It was found that the yield of onion bulb was influenced by the genotypes significantly (Fig. 2). The highest bulb yield was obtained from AV-21844 (34.1 t ha^{-1}) which was statistically similar to that of AV-21848 (32.7 t ha^{-1}).

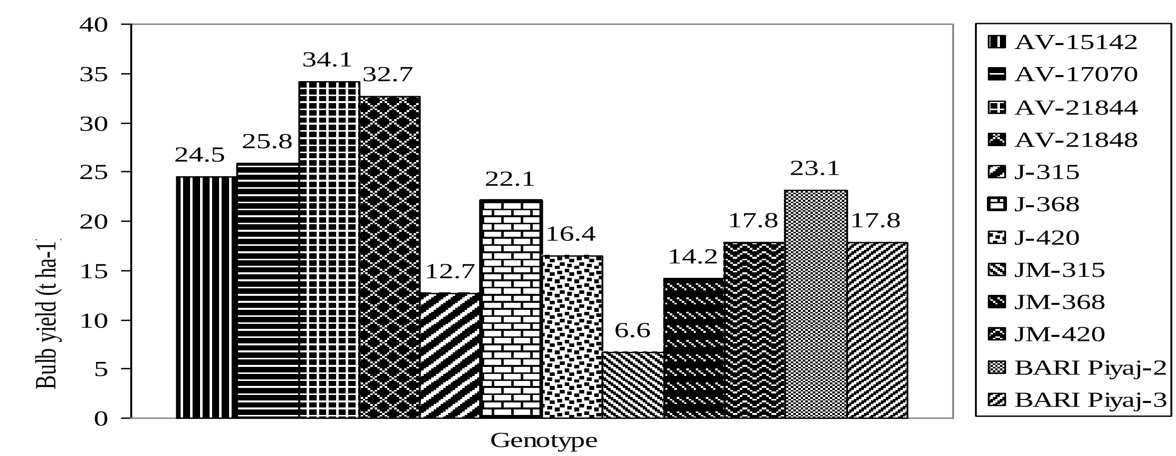

Fig.2. Bulb yield of twelve genotypes of onion

It happened perhaps due to the production of larger size of bulbs, higher bulb pseudostem ratio, individual bulb weight and chlorophyll content in leaves. The bulb yields of AV-17070 and AV-15142 were comparatively higher. The yields of BARI Piyaj-2 and J-368 were statistically similar followed by BARI Piyaj-3 and J-420. JM-315 showed the worst performance in bulb production. The results revealed that the AVRDC genotypes performed better with respect to yield, storage quality and unique bulb production than other genotypes. The storage quality of non AVRDC exotic genotypes was very poor. The bulb of genotype JM-315 became mature early like local varieties and J-315 became mature in late. Among the genotypes, only J-368 had distinct bulb color which could easily be separated from the others.

In the study it could be concluded that the genotype AV-21844 showed best performance in respect to storage quality, higher unique bulb production and relatively early maturity of the bulb.

References

FRG (Fertilizer Recommendation Guide). 2005. Bangladesh Agricultural Research Council, Farm Gate, Dhaka-1215. Publication No.45. pp.216-217.

Brammer H. 1971. Soil Resources, Soil Survey Project, Bangladesh. AGL. St. Pak. 6. Technical Reports. UNDP/FAO.

FAO (Food and Agriculture Organization). 2009. FAO Quarterly Bulletin of Statistics. Food and Agriculture Organization of the United Nations, Rome Italy. 12:3-4.

Gomez K A and Gomez A A. 1984. Statistical Procedures for Agricultural Research. Inter'l Rice Research Institute, John Wiley and Sons.

Hossain A K M and Jamiul Islam M. 1994. Status of Allium Production in Bangladesh. In: Inter'l Symposium on Alliums for the Tropics 358:33-36.

Haque M A, Miah M A M, Hossain S, Rahman M S and Monuruzzaman. 2011. Profitability of onion cultivation areas of Bangladesh. Bangladesh J. Agril. Res. 36(3):27-435.

Hussain A. 1985. Final Report on the Improvement and Storage of Onion. Department of Horticulture, Bangladesh Agricultural University, Mymensingh. 24p.

Mallik M S A. 2011. The methods of seed production from seed to seed, bulb to seed, seed to bulblet to seed and seed to bulblet to bulb to seed (Seed Production of Summer Onion Varieties). Spices Research Centre, Bangladesh Agricultural Research Institute (BARI), Sibgonj, Bogra during May 2009 to May 2011.

MOA (Ministry of Agriculture). 2013. National Information Cell, Govt. of the People's epub. of Bangladesh. www. infokosh.bangladesh.gov.bd.

Mondal M F, Chowdhury M S H. 1980. Effect of size of mother bulb on seed yield of onion. Bangladesh Hort. 8(2):22-25.

Mosleh Ud-deen. 2011. Onion Research and Development in Bangladesh. Dept. of Crop Science and Technology, University of Rajshahi, Rajshahi-6205, Bangladesh.

Purseglove J W. 1988. Tropical Crops (Monocotyledons). Longman Scientific and Technical, New York. 41p.

Rahim M A. 1999. Onion Situation in Bangladesh: Problems, Research and Prospects. Allium Improvement Newsletter (USA) 1:1-10.

Russel D F. 1986. MSTAT-C Package Programm. Dept. of Crop and Soil Science, Michigan State University, USA.

Yoshida S, Forno D A, Cock J A and Gomes K A. 1976. Laboratory Manual for Physiological Studies of Rice. 3rd ed., IRRI, Loss Banos, Philippines.