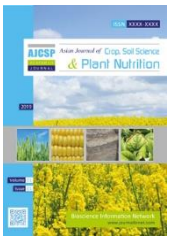
Published with Open Access at Journal BiNET
Vol. 04, Issue 01: 134-140

Asian Journal of Crop, Soil Science and Plant Nutrition

Journal Home: https://www.journalbinet.com/ajcsp-journal.html



Effects of seedling age and potassium fertilizer on growth and yield of summer onion

Fatematuzzohora, Sharmin Sultana and Md. Rezaul Karim

Department of Horticulture, Bangladesh Agricultural University, Mymensingh

✉ Article correspondence: mrkarim1996@yahoo.com (Karim, MR)
Article received: 10.09.2020; Revised: 05.10.2020; First published online: 15 October 2020

ABSTRACT

An experiment was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh to assess the effects of seedling age and potassium fertilizer to improve summer onion production (cv. BARI Piaj-3). The experiment consisted of two factors; Factor A: three seedling age, viz. 35; 40 and 45 days old and Factor B: four different doses of potassium, viz. 0; 40; 80 and 120 kg/ha-1. The experiment was laid out in a randomized complete block design with three replications. The effect of different seedling age and potassium fertilizer and their combined effects showed significant variations in growth and yield of onion. In case of seedling age, the highest plant height (56.58 cm), leaf number (12.37) per plant, leaf length (41.77 cm), yield of bulb per plot (1.96 kg) and yield of bulb (19.64 t/ha) were recorded from 45 day old seedling. In case of different doses of potassium, the highest plant height (58.82 cm), leaf number per plant (13.93), leaf length (43.69 cm), yield of bulb per plot (1.90 kg) and yield of bulb (19.00 t/ha) were recorded from 120 kg K ha-1. Combined effects of seedling age and potassium fertilizer exhibited significant variation on plant height at different days after transplant (DAT), leaf number per plant, leaf length, bulb diameter, pseudostem diameter, fresh weight of bulb, dry weight of bulbs, fresh weight of foliage, dry weight of foliage, yield of bulbs per plot and yield of bulbs (t/ha). The highest bulb yields per plot (2.31 kg) as well as per hectare (23.05 tons) were achieved from the treatment combination of 45 day old seedling and 120 kg K ha-1.

Key Words: *Growth, bulb yield and summer onion*

Cite Article: Fatematuzzohora, Sultana, S. and Karim, M. R. (2020). Effects of seedling age and potassium fertilizer on growth and yield of summer onion. Asian Journal of Crop, Soil Science and Plant Nutrition, 04(01), 134-140.
Crossref: https://doi.org/10.18801/ajcsp.040120.17

I. Introduction

Onion (*Allium cepa* L.) is the most extensively cultivated and broadly consumed spice crops around the globe. It is an herbaceous crop belonging to the family Alliaceae and genus Allium. The crop is grown for consumption in green state and as mature bulbs. The origin of onion is somewhere between western China and deserts lying east of the Caspian Sea (Jones and Mann, 1963). It originated in an area which includes Iran, Pakistan, its northern mountainous region (Purseglove, 1972).

Onion is inseparable from almost all food of our daily diet. The crop, taken into account as condiments

for flavoring foods, makes the food scrumptious. Flavor is the main significant character of onion, which increase the taste of food and also appreciated to increase the taste of various food such as soups, gravies, stew stuffing, meat and fried fishes (Rahim, 1992). Onions have been valued for their medicinal qualities across the world. It promotes the flow of urine, uses against tuberculosis, typhoid fever, venereal disease, chest and lungs problem and also used as a stimulant. In relieving insect bites and sore throat, it is also utilized (Bose and Som, 1990). Onions are a nutrient-dense food, low in calories, high in vitamins, minerals and antioxidants. Some researches revealed that it is used as a diabetic drug in Arabian Folk medicine and reduces blood sugar by 25 percent (Mossa, 1985; Yawalkar, 1985).

Onion is one of the most important and popular vegetables as well as spice crops in Bangladesh and in the world. In Bangladesh, it is usually grown in the winter season. Annual production of onion in Bangladesh is 1800.0 thousand tons and the annual demand is about 2400 thousand tons (BBS, 2018). Therefore, the prevailing shortage of onion is about 700 thousand tons per year. To meet up this shortage, Bangladesh has to import onion from India and China every year (Hossain and Islam, 2011) at the expense of hard earning foreign currency. Moreover, the demand for onion is increasing day by day with the increasing population. This acute situation could be improved by bringing more land under cultivation or by increasing yield through introducing improved varieties or by adopting improved production technologies or by growing onion in other season i.e. during summer-rainy season.

It is worth mentioning that the land is extremely limited in Bangladesh. Therefore, the horizontal expansion of onion cultivation is very difficult in Bangladesh. At the same time, introduction of high yielding varieties from the temperate regions of the world does not seem to be sound because their climatic requirements cannot be fulfilled under Bangladesh condition. Therefore, growing onion during summer is the only possibility to expand onion production in Bangladesh. Most recently, Bangladesh Agricultural Research Institute (BARI) has developed and released three onion varieties, namely BARI Piaj 2, 3 and 5 which are suitable to grow under summer conditions, but their productivity and improved production technology has not yet been established. Thus, adopting new and improved production technologies would be a major way to increase onion production in this country.

Onion production is greatly influenced by agronomic practices such as planting time, planting density, age of seedling, condition of seedling, judicious fertilization etc. Specially, age of seedling and potassium fertilizer have profound importance in summer onion production. Seedling age is important for better establishment after transplanting, to check transplantation shock. Proper age of seedling can produce a better yield of bulb (Thompson and Kelly, 1957; Singh and Singh, 1974; Maurya et al. 1997; Singh and Chaure, 1999). Potassium is a major plant nutrient, which is needed by the plants in large amounts and is supplied by the fertilizer. It is available to the plants in the form of cation (k+). Potassium is essential for a variety of processes i.e. photosynthesis, fruit formation, winter hardiness and disease resistance (Saud et al. 2013). The beneficial effect of potassium can be found in different traits of agricultural products, such as color, acidity, resistance to shipping, handling and storage, nutritional value and industrial qualities (Malavolta, 2006). Considering the above facts, the experiment was undertaken to investigate the effects of seedling age and potassium fertilizer on the growth and yield of summer onion.

II. Materials and Methods

The experiment was carried out at the Horticultural Farm of Horticulture Department, Bangladesh Agricultural University, Mymensingh during June 2017 to October 2017. Two-factor experiment consisted of three different age of seedlings i.e., A_1: 35 day old seedlings, A_2: 40 day old seedlings and A_3: 45 day old seedlings; and four different doses of potassium fertilizers viz., K_0: 0 kg k/ha, K_1: 40 kg k/ha, K_2: 80 kg k/ha and K_3: 120 kg k/ha. The experiment was laid out in a randomized complete block design with three replications. The seeds of onion variety BARI piaj-3 were collected from Spices Research Sub-center, Bangladesh Agricultural Research Institute (BARI), Lalmonirhat.

Manures and fertilizers were applied at the rate of cowdung 10 t/ha, urea 180 kg/ha, triple super phosphate (TSP) 275 kg/ha, gypsum 110 kg/ha and zinc 3 kg/ha (FRG, 2012). Muriate of potash was

applied as per treatment as the source potassium. The entire amounts of cow dung, TSP, gypsum, zinc sulphate (source of zinc), 1/3rd of muriate of potash were applied during final land preparation. Rest 2/3rd muriate of potash and entire amount of urea were top dressed in three equal installments at 20, 40 and 60 days after transplanting. Seedlings were raised in seedbed in three different times to obtain 35, 40 and 45 days old seedlings. 35, 40 and 45 days old seedlings healthy seedlings were transplanted in 1 m x 1 m plot maintaining a distance of 20 cm x 20 cm keeping plot to plot and block to block distance 50 cm and 100 cm, respectively. Data were collected from five randomly selected plants from each plot and were statistically analyzed to find out the statistical significance of the experimental results. The means for all the treatments were calculated and the analyses of variance for all the characters were performed by F test. The significance of difference between the pairs of means was separated by LSD test at 5% or 1% levels of probability (Gomez and Gomez, 1984).

III. Results and Discussion

Plant height

The main effect of seedling age on plant height was found to be statistically significant at different days after transplanting. In general, the plant height increased gradually with the advancement of time. The highest plant height (56.58 cm) was obtained at 75 days after transplanting (DAT) from the plants when they were transplanted at 45 days old seedling followed by the plants at 40 days old seedlings (54.65 cm) and the lowest (51.44 cm) was recorded when plants were grown with 35 days old seedlings (Table 01). The plant height was significantly influenced by the application of different doses of potassium at different stages of growth. Plant height was found to be increased with the increase in potassium dose, and the maximum plant height (58.82 cm) at 75 DAT was obtained from K_3 and the minimum plant height (49.55 cm) at control treatment (K_0). Plant height increased gradually with time up to 75 DAT (Table 02). Combined effect of seedling age and potassium on plant height at different days after transplanting was found to be statistically significant at different DAT. Maximum plant height (61.15 cm) was obtained from 45 days old seedlings with 120 kg K ha^{-1} and minimum (46.62 cm) from 35 days old seedlings with control treatment (Table 03). The result is in agreement with (Bohni, 2015) who reported that higher level of potassium increased plant height.

Table 01. Effects of seedling age on growth, yield and yield contributing characters of summer onion

Age of seedlings	Plant height at 75 DAT	No. of leaves at 75 DAT	Pseudostem diameter (cm)	Bulb diameter (cm)	Fresh weight of bulb (g)	Dry weight of bulb (g)	Bulb yield (kg/plot)	Bulb yield (t/ha)
A_1	51.44	10.18	1.62	4.19	28.37	4.25	1.42	14.18
A_2	54.65	10.97	2.21	5.47	30.37	4.77	1.52	15.18
A_3	56.58	12.37	2.52	5.85	39.28	6.32	1.96	19.64
LSD (0.05)	0.38	0.27	0.04	0.08	0.40	0.08	0.03	0.20
Level of sig.	*	*	*	*	*	*	*	*

A_1, A_2 and A_3 indicate 35, 40 and 45 days of seedlings, respectively; * indicate significant at 5% level of probability.

Number of leaves per plant

An increased number of leaves indicates good growth and development of onion crop and is directly related to the yield of bulb. The more leaves, the more photosynthetic area and thereby higher yield. Seedling age gave significant variation in respect of leaf number per plant at different DAT. The number of leaves per plant was the highest (12.37) when the plants were transplanted at 45 days old seedling and the lowest number of leaves per plant (10.18) when the plants were transplanted with 35 days old seedlings (Table 01). Potassium had significant influence on number of leaves per plant. Effect of different doses of potassium on the number of leaves per plant increased with the increase in potassium level. Numerically leaf production was increased up to 75 DAT and thereafter decreased due to senescence. At 75 DAT the highest number of leaves (13.93) was obtained from 120 kg K ha^{-1} whereas the control produced the lowest (8.38). Probably, the application of potassium increased with the increased height of plants and ultimately the leaf number was increased due to the influence of this nutrient (Table 02). The number of leaves per plant was significantly influenced by the combined effect of seedling age and potassium. The number of leaves per plant was recorded to be the highest (16.33) from 45 days old seedling with 120 kg K ha^{-1} followed by 45 days old seedling with K_2 (80 kg K ha^{-1}) treatment (13.80) whereas the lowest number (7.80) was found from 35 days old seedlings with

control treatment (Table 03). (Vachhani and Patel, 1993) also observed that the application of potassium increased the number of leaves per plant.

Pseudostem diameter

The influence of seedling age in respect of pseudostem diameter was found to be significant at different days after transplanting. The thickness of pseudostem diameter increased gradually up to 75 DAT, and then it decreased slightly. It was observed that 45 days old seedling produced the thickest (2.52 cm) pseudostem, whereas the thinnest pseudostem (1.62 cm) was obtained from 35 days old seedling (Table 01). Pseudo stem diameter varied significantly due to the effect of different doses of potassium and the average pseudostem diameter was shown in Table 03. Among the treatments, the maximum pseudostem diameter (2.91 cm) was obtained for 120 kg K ha^{-1}. The lowest value (1.52 cm) was observed under control treatment (Table 02). The combined effect of seedling age and potassium in respect of pseudostem diameter was found to be statistically significant. The highest pseudostem diameter (3.50 cm) was produced from 45 days old seedlings with 120 kg K ha^{-1} and the lowest (1.10 cm) was found from 35 days old seedlings with control treatment (Table 03). These results were in agreement with the findings of (Miah et. al., 2020) who reported that pseudostem diameter increased with increased doses of zinc and boron.

Table 02. Effects of different doses of potassium fertilizer on growth, yield and yield contributing characters of summer onion

Doses of potassium	Plant height at 75 DAT	No. of leaves at 75 DAT	Pseudostem diameter (cm)	Bulb diameter (cm)	Fresh weight of bulb (g)	Dry weight of bulb (g)	Bulb yield (kg/plot)	Bulb yield (t/ha)
K_0	49.55	8.38	1.52	3.34	26.65	4.00	1.33	13.32
K_1	52.26	9.96	1.83	4.35	31.92	4.79	1.60	15.96
K_2	56.26	12.42	2.22	5.64	34.11	5.12	1.71	17.06
K_3	58.82	13.93	2.91	7.36	38.00	6.56	1.90	19.00
LSD (0.05)	0.44	0.31	0.04	0.09	0.46	0.09	0.03	0.23
Level of sig.	*	*	*	*	*	*	*	*

K_0, K_1, K_2 and K_3 indicate 0, 40, 80 and 120 kg ha^{-1} potassium, respectively; * indicate significant at 5% level of probability

Bulb diameter

Diameter of bulb was significantly influenced by seedling age. The highest diameter of bulb (5.85 cm) was attained from 45 days old seedling. It might be due to optimum seedling age. The lowest bulb diameter (4.19 cm) was produced when plants were grown with 35 days old seedling (Table 01). Analysis of variance revealed that the effect of potassium was highly significant in respect of the diameter of bulb. The result showed that potassium level K_3 produced the largest bulb (7.36 cm) and the minimum diameter (3.34 cm) was obtained from the control treatment. Potassium was essential for photosynthesis, which ultimately increased starch formation, and probably due to storage of starch in bulbs its thickness was increased (Table 02). Bulb diameter was significantly influenced by the combined effect of seedling age and potassium. The highest bulb diameter (7.89 cm) was obtained due to the effect of 45 days old seedlings with 120 kg K ha^{-1} and the lowest bulb diameter (1.93 cm) was recorded from 35 days old seedlings with control treatment (Table 03). These results were in agreement with the findings of (Chroboczek, 1936) who reported that bulb size increased with increased doses of potassium.

Fresh weight of individual bulb

A highly significant difference in bulb weight of summer onion was noticed because of the effect of seedling age. The highest fresh weight of individual bulb (39.28 g) was found by transplanting 45 days old seedling which was statistically different from those of other ages of seedling and the lowest individual bulb fresh weight (28.37 g) was recorded by 35 days old seedling (Table 01). The increased fresh weight of bulb resulted from the 45 days old seedlings could also be explained by the fact that the older seedlings were less susceptible to transplantation shock. 45 days old seedlings might have taken less time to recover from the transplanting shock to get established in the field. The result revealed that the single effect of potassium was highly significant in respect of fresh weight bulb. Single mean effect of the different doses of potassium had been shown in Table 02. It was observed from the result that potassium level K_3 produced the highest weight (38.00 g) of bulb and the lowest bulb weight (26.65 g) was obtained with potassium level K_0. Potassium was essential for

photosynthesis, which ultimately increased starch formation, and probably due to the storage of starch in bulbs, its weight was increased (Table 02). The fresh weight of bulb was significantly influenced due to the combined effect of seedling age and potassium. The highest fresh weight of bulb (46.10 g) was recorded from 45 days old seedlings with 120 kg K ha^{-1} and the lowest fresh weight of bulb per plant (22.43 g) was found from 35 days old seedlings with control treatment (Table 03). Nagaich et al. (1999) and Singh et al. (2004) agreed with the present results who reported higher bulb weight from higher doses of potassium. The bulb weight was higher with the treatment containing older seedling and higher doses of potassium. The results were partially in agreement with the findings of many authors (Rahman et al. 1976; Singh et al. 1988).

Dry weight of bulb

Dry weight of bulb was found to be significantly influenced by different seedling ages. The highest dry weight of bulb (6.32 g) was obtained from 45 days old seedling (Table 01). Chlorophyll is one of the most important materials for photosynthesis. The rate of photosynthesis increased with the increasing doses of chlorophyll content. As a result, greater amount of dry matter accumulated in the bulb. On the other hand, the minimum dry weight (4.25 g) was obtained from 35 days old seedling. Dry weight of bulb was significantly influenced by the different doses of potassium. Single mean effect of different doses of potassium had been shown in Table 02, and it was observed that potassium level of K_3 produced the maximum dry weight (6.56 g) and the lowest (4.00 g) was obtained from K_0 (Table 02). The combined effect of seedling age and potassium on the dry weight of bulbs was found to be significant. The highest dry weight (8.62 g) of bulb was found at the treatment combination of 45 days old seedlings with 120 kg K ha^{-1} and the lowest (3.36 g) was found at the treatment combination of 35 days old seedlings with control treatment (Table 03). These results were in agreement with the findings of (Miah et. al., 2020) who reported that dry weight of bulb increased with increased doses of zinc and boron.

Table 03. Combined effects of seedling age and different doses of potassium fertilizer on growth, yield and yield contributing characters of summer onion

Treatment combination	Plant height at 75 DAT	No. of leaves at 75 DAT	Pseudostem diameter (cm)	Bulb diameter (cm)	Fresh weight of bulb (g)	Dry weight of bulb (g)	Bulb yield (kg/plot)	Bulb yield (t/ha)
A_1K_0	46.62	7.80	1.10	1.93	22.43	3.36	1.12	11.21
A_1K_1	49.26	9.27	1.53	3.63	27.42	4.11	1.37	13.71
A_1K_2	53.16	10.93	1.81	4.75	30.31	4.55	1.52	15.15
A_1K_3	56.70	12.73	2.05	6.45	33.31	5.00	1.67	16.65
A_2K_0	50.11	8.60	1.49	4.03	25.09	3.76	1.25	12.54
A_2K_1	52.70	10.00	1.78	4.25	29.97	4.50	1.50	14.99
A_2K_2	57.20	12.53	2.39	5.89	31.82	4.77	1.59	15.91
A_2K_3	58.61	12.73	3.18	7.73	34.59	6.05	1.73	17.29
A_3K_0	51.92	8.73	1.96	4.07	32.42	4.86	1.62	16.21
A_3K_1	54.82	10.60	2.17	5.19	38.38	5.76	1.92	19.19
A_3K_2	58.42	13.80	2.45	6.26	40.21	6.03	2.01	20.10
A_3K_3	61.15	16.33	3.50	7.89	46.10	8.62	2.31	23.05
$LSD_{0.05}$	0.76	0.53	0.08	0.15	0.80	0.16	0.05	0.40

A_1, A_2 and A_3 indicate 35, 40 and 45 days of seedlings, respectively; K_0, K_1, K_2 and K_3 indicate 0, 40, 80 and 120 kg ha^{-1} potassium, respectively; * indicate significant at 5% level of probability.

Yield of bulb per plot

The yield of bulbs was significantly influenced by the effect of age of seedlings. The highest yield of bulbs (1.96 kg/plot) was observed with 45 days old seedlings. The lowest yield (1.42 kg/plot) was found in plants grown with 35 days old seedlings (Table 01). The yield of bulb per plot increased significantly by the application of different doses of potassium. The highest yield (1.90 kg/plot) was obtained from K_3 treatment (120 kg ha^{-1}) and the minimum yield (1.33 kg/plot) from K_0 (Table 02). The yield of bulbs was significantly influenced by the combined effect of seedling age and potassium. The highest yield of bulbs (2.31 kg/plot) was found from 45 days old seedlings with 120 kg K ha^{-1}. The lowest yield (1.12 kg/plot) was found from 35 days old seedlings with control treatment (Table 03). This result is in agreement with Singh et al. (2011) who reported that the highest yield was recorded with 45 days old seedlings.

Yield of bulb per hectare (t/ha)

The yield of bulbs was also significantly influenced by the effect of age of seedlings. The highest yield of bulbs (19.64 t/ha) was observed from 45 days old seedlings followed by 40 days old seedlings (15.18 t/ha). The lowest yield (14.18 t/ha) was found in plants from 35 days old seedlings (Table 01). The yield of bulb per hectare increased significantly by the application of different doses of potassium. The highest yield (19.00 t/ha) was obtained from K_3 and the minimum yield (13.32 t/ha) from K_0 (Table 02). The yield of bulbs was also significantly influenced by the combined effect of seedling age and potassium. The highest yield of bulbs (23.05 t/ha) was found from 45 days old seedlings with 120 kg K ha^{-1}. The lowest yield (11.21 t/ha) was found from 35 days old seedlings with control treatment seedlings (Table 03). This result is in agreement with (Singh et al., 2011) who reported that the highest yield was recorded with 45 days old seedlings.

IV. Conclusion

Augmenting the yield of onion is being felt necessary as Bangladesh is facing a great deficit of this spice crop. Among the factors for which yield of onion are greatly influenced, seedling age and potassium fertilizer can be considered as major of them. Therefore, an investigation was carried out to find out an optimum seedling age and potassium fertilizer dose to maximize onion yield and production. From this study, it may be concluded that effect of seedling age on growth and yield performance of onion was significant. The results showed that 45-day old seedlings gave the highest growth and yield performance compared to 35- and 40-day old seedlings. In this experiment maximum plant height and better yield were achieved from 45 days old seedlings due to quicker establishment and favorable condition. So, it may be recommended that 45 days old seedlings are good for maximum growth, development and yield performance to improve onion production. It may also be concluded that based on growth, development and yield performance 120 kg K ha^{-1} showed a good result among all fertilizer doses. 120 kg K ha^{-1} showed maximum growth and yield. The result of the experiment revealed that seedling age and potassium fertilizer had significant effects on the growth and yield of onion with maximum vegetative growth and higher yield. The highest value of plant height, bulb weight etc. were recorded on the effect of the combination of 45-day old seedling with 120 kg K ha^{-1} may be used to maximize the production of onion through the bulb planting method. As per hectare production of onion obtained from this experiment is very high, so it was economically benefited. Therefore, from the yield as well as an economic point of view a combination of 45-day old seedlings with 120 kg K ha^{-1} may be recommended for maximizing the production of onion.

Acknowledgement

We thank the Spices Research Sub-center, Bangladesh Agricultural Research Institute (BARI), Lalmonirhat for providing onion seeds. The work was partly supported by the Ministry of Science and Technology, Government of the People's Republic of Bangladesh through the Special Allocation for Science and Technology under the project entitled "**Upscaling of Summer Onion Production through Improved Management Practices"** (2017-2018/BS-106) to M. R. Karim.

References

[1]. BBS, (2018). Bangladesh Bureau of Statistics, Ministry of Planning, Government of Peoplés Republic of Bangladesh. pp 58.
[2]. Bohni, N. F. (2015). Effect of potassium and sulphur on growth and yield of summer onion, MS Thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh. pp.18.
[3]. Bose, T. K. and Som, M. G. (1990). Vegetable crops in India. Nayaprokash, Calcutta 6, pp. 545-582.
[4]. Chroboczek, E. (1936). Study of some problems connected with growing and storage of onion. Annals of Horticulture Science 3, 57-137.
[5]. FRG, (2005). Fertilizer Recommendation Guide-2005. Bangladesh Agricultural Research Council, Farmgate, New Airport Road, Dhaka. pp. 117.
[6]. Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. (2nd Ed.). John Wiley and Sons, New York. pp. 28-192.
[7]. Hossain, A. K. M. A. and Islam, J. (2011). Status of Allium production in Bangladesh. Acta Hort. 358, 33-36.

[8]. Jones, H. A. and Mann, L. K. (1963). Onion and their Allies. Leonard Hill (books) Ltd. London. pp. 32.
[9]. Malavolta, E. (2006). Manual de nutrição mineral de plantas. São Paulo, Agronômica Ceres. 638p.
[10]. Maurya, K. R., Singh, V. K. and Singh, R. (1997). Effect of age of seedlings on growth and yield of onion. Journal of Applied Biological Sciences, 7(1-2), 55-57.
[11]. Miah, M. S., Taheri, R. H., Rabbani, M. G. and Karim, M. R. (2020). Effects of different application methods of zinc and boron on growth and yield of onion. International Journal of Biosciences 17(4), 126-133.
[12]. Mossa, J. S. (1985). Onion: a diabetic drug. International Journal of Crude Drug, 23(3), 137-145. https://doi.org/10.3109/13880208509069018
[13]. Nagaich, K. N. Trivedi, S K. Rajesh, L. and Lekhi R. (1999). Effect of sulphur and potassium fertilization in onion (*Allium cepa* L.). Horticultural Journal, 12 (3), 25- 31.
[14]. Purseglove, J. W. (1972). Tropical Crops: Monocotyledons 1 and 2. Longman Group Ltd., London. pp. 32-50.
[15]. Rahim, M. A. (1992). Spices and plantation crops in National Economic. Proceeding of the sixth National Horticultural Convention and Symposium, held at Bangladesh Agricultural University, Mymensingh. pp. 24-29.
[16]. Rahman, S., Talukder, M. R. and Miah, A. M. (1976). Effect of nitrogen, phosphoric acid and potash on the bulb size and yield of onion. Bangladesh Horticulture, 4(1), 7-11.
[17]. Saud, S., Yajun, C., Razaq, M., Luqman, M., Fahad, S., Abdullah, M. and Sadiq, A. (2013). Effect of potash levels and row spacings on onion yield. Journal of Biology, Agriculture and Healthcare, 3(16), 13-20.
[18]. Singh, D. P. and Singh, R. P. (1974). Studies on the effect of time of sowing and age of seedlings on growth and yield of onion (*Allium cepa* L.). Indian Journal of Horticulture, 31(1), 69-73.
[19]. Singh, G., Saini, S. P. and Sidhu, A. S. (2011). Effect of age of seedlings and irrigation on mortality, bolting, bulb weight and yield of onion (*Allium cepa* L.). Journal of Krishi Vigyan, 2, 10-13.
[20]. Singh, J. and Chaure, N. K. (1999). Effect of age of seedlings and nitrogen levels on growth and yield of onion (*Allium cepa* L.). Advance Horticultural Science, 6, 73-77.
[21]. Singh, J., Dhankhar S. B. and Ram, V. (1988). Effect of nitrogen, potash on growth, yield and quality of onion. Vegetable Science, 16(2), 136-14.
[22]. Singh, S., Yadav, P. K. and Singh, B. (2004). Effect of nitrogen and potassium on growth and yield of onion (*Allium cepa* L.) cv. Pusa Red. Haryana Journal of Horticultural Sciences, 33(3/4), 308-309.
[23]. Thompson, C. H. and Kelly, C. W. (1957). Vegetables crops. McGraw Hill Book Company Inc. New York. pp. 354-355. https://doi.org/10.2307/1292320
[24]. Vachhani, M. U. and Patel, Z. G. (1988). Studies on growth and yield of onion as affected by seedling age at transplanting. Progressive Horticulture, 20 (3-4), 297-298.
[25]. Yawalkar K. S. (1985). Vegetables crops of India. Agriculture-Horticultural Publishing House, Nagpur. pp. 288-304.

HOW TO CITE THIS ARTICLE?

MLA
Fatematuzzohora et al. "Effects of seedling age and potassium fertilizer on growth and yield of summer onion". Asian Journal of Crop, Soil Science and Plant Nutrition, 04(01), (2020): 134-140.

APA
Fatematuzzohora, Sultana, S. and Karim, M. R. (2020). Effects of seedling age and potassium fertilizer on growth and yield of summer onion. *Asian Journal of Crop, Soil Science and Plant Nutrition*, 04(01), 134-140.

Chicago
Fatematuzzohora, Sultana, S. and Karim, M. R. "Effects of seedling age and potassium fertilizer on growth and yield of summer onion". Asian Journal of Crop, Soil Science and Plant Nutrition, 04(01), (2020): 134-140.

Harvard
Fatematuzzohora, Sultana, S. and Karim, M. R. 2020. Effects of seedling age and potassium fertilizer on growth and yield of summer onion. Asian Journal of Crop, Soil Science and Plant Nutrition, 04(01), pp. 134-140.

Vancouver
Fatematuzzohora, Sultana, S and Karim, MR. Effects of seedling age and potassium fertilizer on growth and yield of summer onion. Asian Journal of Crop, Soil Science and Plant Nutrition, October 2020 04(01), 134-140.