Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2021 18(2): 1301-1312. **OPEN ACCESS**

Growth and Yield of *Solanum melongena* L. as influenced by foliar application of yeast extract with different time intervals

Intizar Ahmad[1], Abdul Basit[1*], Neelam Ara[1], Faiza Aman[1], Syed Tanveer Shah[1], Izhar Ullah[2], Yasir Ali[1], Nasrullah Khan[1], Noman Ahmad[1], Ijaz Ahmad Khan[1], Mubashir Ahmad[3], Kaleemullah[3], Iftikhar Ali[4]

[1]Department of Horticulture, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar, 25120, **Pakistan**

[2]Department of Horticulture, Ondokuz Mayis University, 55200, Samsun, **Turkey**

[3]Department of Agricultural Mechanization, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar, **Pakistan**

[4]Department of Soil and Environmental Sciences, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar, **Pakistan**

***Correspondence:** abdulbasithort97@gmail.com; mashalhort97@aup.edu.pk **Received 15-02-2021, Revised: 08-04-2021, Accepted: 17-04-2021 e-Published: 18-04-2021**

Continuous use of inorganic fertilizers has negative effects on human health and the environment itself. Yeast is a natural bio-substance that has useful stimulatory, nutritional and protective functions during stress conditions due to its content of hormones, sugars, amino and nucleic acids, vitamins and minerals. Thereby when applied to plants, it may induce stress tolerance due to its role in the synthesis of protein and nucleic acids, and in minimizing their degradation. Following the role of yeast, an experiment on *Solanum melongena* L., locally known as brinjal (cv. Neelam) was carried out in Randomized Complete Block Design (RCBD) having two factors, i.e. yeast extract concentrations (Y_0=Control, Y_1=2, Y_2=4 and Y_3=6 g.L^{-1}) and time of application (T_1= 15, T_2= 30 and T_3= 45 days after transplantation) at The University of Agriculture, Peshawar, Pakistan. The experimental results showed that both yeast extract concentration @ 6 g.L^{-1} and time of application (15 days after transplantation) significantly affected plant height (cm), number of branches, leaves and fruit plant^{-1}, single fruit weight (gm), leaf chlorophyll content (SPAD), single leaf area (cm^2), yield plant^{-1} (g) and yield tons ha^{-1}. It could be concluded from the study results that yeast extract at the rate of 6 g.L^{-1} could be applied 15 days after transplantation for gaining better growth and yield of brinjal under agro climatic condition of Peshawar, Pakistan.

Keywords: Bio-substance, Eggplant, Growth, Yeast Extract & Application, Yield

INTRODUCTION

Fertilizers are the main inputs which increase the productivity of crops. However, the continuous use of inorganic fertilizers may have negative effects. The use of inorganic fertilizer in long-term has reduced physical, chemical and biological traits, as well as organic matters in the soil and also effected the efficiency of nutrients absorption (Waseem et al. 2013). Excessive application of inorganic fertilizers would contaminate environment and the food yield that may harm human health (Jagatheeswari 2013). Therefore,

some efforts are required to fulfill a part of nutrients and improve their production. The increasing demand of egg plants has gone along with the rapid growth of population and the increasing awareness towards the benefits of vegetables in fulfilling the nutrients level in human body (Jumini and Marliah 2009). Gandhi and Sundari (2012) described that eggplant can be utilized as medicine to reduce cholesterol in blood and it is suitable as diet to regulate hypertension. Owing to high nutrient content of the eggplant, it is presumed that the demand of eggplant will increase, so that the production should be increased as well (Sowinska and Krygier 2013).

Brinjal or eggplant (*Solanum melongena L*.) belongs to the family Solanaceae and originated in India. It is one of the most popular and important vegetable crop grown in almost all parts of India except in higher altitudes. Due to its popularity among all the people it is rightly called the vegetable of the masses. Brinjal contains many macro and micro minerals but low in calories, which are useful for human health. The abundant mineral present in the eggplant is potassium but also a rich source of magnesium, calcium and iron (Arivalagan et al. 2013). In Pakistan, it occupies 9,044 ha area and its production is 88,148 tons (MINNFSR 2016). The fruit is a fleshy berry and found in different colors from shiny purple to white green yellow and black. The brinjal is a shrubby, herbaceous or semi-woody plant with a fibrous root system. The fruit length from 4 to 5 inch, diameter may vary from, 3 to 3.5 cm and weight 0.5 to 1500 g, respectively (Sharma 1995). It is highly prone to many diseases and pests, including the eggplant fruit and shoot borer.

Many studies indicated that yeast is one of the richest sources of high quality protein, namely the essential amino acids like lysine, tryptophan etc. It also contains the essential minerals and trace element namely calcium, cobalt, iron etc. And is the best source of the B-complex vitamins (Amer 2004). The extract is a valuable source of bio-constituents especially, cytokinins, that work as a readily available growth supplement for plants that eventually improve plant production (Ghoname et al. 2009). It is a source of cytokinins and protein that enhance cell division and enlargement (Barnett et al. 1990). Moreover, yeast extracts contain trehalose-6-phosphate synthase (a key enzyme for trehaloes biosynthesis (Mahmoud et al. 2013). Improvement of growth, flowering, total yield and quality of some plants by using foliar application with yeast extract was reported by Kamal and Ghanem (2012). Yeast is used as a kind of biofertilizers in soil fertilization or in foliar application on the shoots of vegetable crops (El-Ghamring et al. 1999). Yeast is a natural bio-substance that have useful stimulatory, nutritional and protective functions when it is applied to vegetable plants during stress conditions due to its content of hormones, sugars, amino and nucleic acids, vitamins and minerals. Thereby, it can induce stress tolerance due to its role in the synthesis of protein and nucleic acids and in minimizing their degradation (Natio et al. 1981). Application of yeast as a foliar spray was found to increase growth, yield and quality of some vegetable crops (Fathy and Farid 2000). This is because of its content of many nutrients and being productive compounds of growth regulator compound like auxins, gibberellins and cytokinins (Glick 1995). Sarhan and Abdullah (2010) also studied that application of yeast suspension significantly increased most of growth and yield related parameters in crops. Keeping in view the role of yeast in plant growth, the present study was designed to test the effect of yeast extract and the best time of application on brinjal crop in agro climatic condition of Peshawar valley.

MATERIALS AND METHODS

Experimental site and treatments' combination

To assess the effect of yeast extract and its time of application on growth and yield of brinjal (*Solanum melongena* L.), an experiment was conducted at Horticulture Research Fam, The University of Agriculture Peshawar-Pakistan, during the year 2018. The research farm is located at 34.01o N latitude, 71.35o E longitude at an altitude of 350 m above sea level in Peshawar valley with sub-tropical climate (Ahmad et al. 2019). Peshawar is located about 1600 km north of the Indian Ocean. The research farm is irrigated by Warsak canal from river Kabul (Alam et al. 2020). Both the summer and winter weather are extreme (Basit et al. 2019), characterized by severe winter and hot prolonged summer where the average minimum temperature during winter is 5 °C while during summer, the average maximum temperature reaches up to 45 °C (Ahmad et al. 2020). The wettest month (with the highest rainfall) is March (78 mm) and driest month (with the lowest rainfall) is June (7 mm) approximately (Sajid et al. 2020). The experiment was laid out in Randomized Complete Block Design (RCBD) having two factors, i.e. yeast extract concentration (Y_0=Control, Y_1=2, Y_2=4 and Y_3=6gL^{-1}) and its

time of application (T_1= 15, T_2= 30 and T_3= 45 days after transplantation).

Physio-chemical analysis of soil samples

Before sowing of the crop, soil samples were taken from different parts of the field randomly with the help of gauge auger (30 mm diameter) and analyzed. The soil collected from the experimental site was tested at Post graduate Laboratory, Department of Soil and Environmental Sciences, The University of Agriculture Peshawar. The soil samples tested for experimental site found to be loamy with a pH of 7.3, which seemed to be low near the surface layer. This might be due to leaching of bases below the surface layer in subsurface. The soil of Peshawar Valley was used to be alkaline. The electrical conductivity (EC) of the suspension was found 0.29 dS m^{-1} and the soil organic matter ranged from 0.92-1.03 %. The extractable nitrogen ranged 0.02 % and P ranged 0.065 % was marginal. The potassium (K) concentration (0.048 %) in the surface (0-30 cm) soil was marginal.

Procedure for field and yeast extract preparation

The field was ploughed with cultivator, and then ridges were prepared. Unwanted plants, pebbles and stubbles were eliminated from the field. Farm yard manure (FYM) was incorporated in the soil. The recommended doses of nitrogen were used @ 140 kg ha^{-1}, P @ 100kg ha^{-1} and K @ 60kg ha^{-1} were applied. Transplantation of brinjal plant cv. Neelam was done in the morning time. P-P distance was kept 80 cm and R-R distance was 110 cm. During the research all other cultural activities like hoeing, weeding and irrigation were practiced at appropriate time. Dry yeast was obtained and relative amount of yeast was weighed and dissolved in 100 ml of water in a glass beaker. A tea spoon full of sugar was added. The beaker was kept in a dark warm place for 30 minutes. Contents of the beaker were then filtered into a one liter measuring flask and water was added to make one liter final volume.

Parameters studied

For studying various attributes plants were selected randomly in each treatment. For measuring plant height five random plants were selected and measured their height from bottom to the top of plants through measuring tape. Number of branches was counted in each treatment of all replications in the randomly selected plants and then took the average. For number of leaves $plant^{-1}$, five randomly selected plants were tagged for counting number of leaves and then their means were computed. For measuring single leaf area (cm^2), leaves of randomly selected five plants of each treatment were measured with the help of graph paper and the average was then computed. Leaf chlorophyll content (SPAD) was measured with the help of SPAD meter in leaves of five randomly selected plants of each treatment in all replications. The number of fruit $plant^{-1}$ were noted and then their mean was calculated. Data of single fruit weight were quantified in five fruit picked randomly from selected plants of each treatment through digital balance (Shimadzu, model AY220, Japan) reported by Basit et al. (2018) and their average was computed.

Yield $plant^{-1}$ and ha^{-1} (tons)

Plants were selected randomly in each treatment and yield per plant was determined and their average was determined. Yield per ha was calculated with the help of following formula equation

$$\text{Yield}(\text{tons ha} - 1) = \frac{\text{Yield per plot (kg)} \times 10000\ \text{m2}}{\text{Area of plot (m2)} \times 1000\ \text{(kg)}}$$

Statistical analysis

Statistical analysis was done by the average data taken among the experimental units through ANOVA procedure suitable for Randomized Complete Block Design (Gilani et al. 2018) using statistical software package (Statistix 8.1, Inc, Tallahassee FL, USA) Basit et al. (2018). LSD was used for mean comparison of the data (Steel et al. 1997).

RESULTS

Plant height (cm), number of branches and leaves $plant^{-1}$

Growth traits were assessed in terms of plant height, number of branches and leaves $plant^{-1}$ as presented in Table 1. Maximum plant height (77.02 cm), highest number of branches (15) and leaves $plant^{-1}$ (194.89) were recorded in 6 $g.L^{-1}$ yeast extract, followed by plants treated with 4gL^{-1} yeast extract (74.70 cm, 13 and 190.78 respectively).Whereas, minimum plant height (62.07 cm), least number of branches (8) and leaves $plant^{-1}$ (178.00) were noted in control treatment (Figure 1). The data regarding time of application showed that the tallest plants (77.02 cm), maximum number of branches (14) and leaves $plant^{-1}$ (194.56) were noted in plots

sprayed after 15 days of transplantation. While lowest plant height (68.55 cm), lowest number of branches (11) and leaves plant^{-1} (184.44) were recorded in plots sprayed after 45 days of transplantation (Figure 2).

Single leaf area (cm^2), chlorophyll content (SPAD)

The data regarding leaf area and chlorophyll content are presented in Table 1. The mean values pertaining to yeast extract concentration indicated that maximum leaf area (594.11 cm^2) and highest chlorophyll contents (43.52 SPAD) were noted in plants sprayed with 6gL^{-1} yeast extract, followed by plants treated with 4gL^{-1} yeast extract (542.89 cm^2, 41.87 SPAD). Whereas, minimum leaf area (493.67 cm^2) and lowest chlorophyll contents (38.73 SPAD) were recorded in untreated plants (Figure 1). Data regarding time of application revealed that maximum leaf area (580.67 cm^2) and highest leaf chlorophyll contents (43.22 SPAD) were recorded in plants sprayed 15 days after transplantation. While minimum leaf area (522.78 cm^2) and chlorophyll contents (40.48 SPAD) were recorded in plants treated after 45 days of transplantation.

Yield related attributes

Mean data for yield traits are presented in Table 1. The results of this experiment showed that maximum number of fruit plant^{-1} (32.00), fruit weight (39.01 g), highest plant yield (1262.74 g) and total yield (22.74 tons ha^{-1}) were recorded in plants sprayed with 6gL^{-1} yeast extract.The minimal difference for the above given traits as followed by in plants sprayed with 4gL^{-1} yeast extract (25.00, 33.21 g, 856.35 g and 15.42 tons ha^{-1} respectively). However, minimum number of fruit plant^{-1} (19.00), fruit weight (22.73 g), lowest yield plant^{-1} (488.87 g) and total yield (8.80 tons ha^{-1}) were observed in control treatment (Figure 1). Pertaining to time of application, the highest values for number of fruit plant^{-1} (28.00), fruit weight (34.89 g), yield plant^{-1} (1012.24 g) and total yield (18.23 ton ha^{-1}) were recorded in plants treated with yeast extract after 15 days of transplantation. Whereas, the lowest values for number of fruit plant^{-1} (26.00), fruit weight (31.98 g), yield plant^{-1} (885.96 g) and total yield (15.95 ton ha^{-1}) were assessed in plants sprayed after 45 days of transplantation.

Table 1: Means Square value of growth and yield related attributes of brinjal influenced by different yeast concentration and time of application

SOV	DF	Mean Square value (MS)								
		PH	NOBPP	NOLPP	LChlC	SLA	NOFPP	FW	YPP	TY
Rep	2	7.68ns	0.93ns	242.23ns	1.38ns	169.9ns	5.03*	3.45ns	25.32ns	3.56ns
TRT	9	122.24***	5.14***	147.71ns	11.08*	5780.24***	17.51***	100.21***	678.87***	197.8***
Y	-2	280.98***	3.44ns	160.48ns	20.91*	12266.7***	44.59***	275***	1232.13***	666.3***
T	-2	94.8***	10.78***	269.15ns	14.57*	7594.93*	6.26*	19.08*	269.2***	64.78***
Y x T	-4	14.23ns	0.06ns	8.59ns	0.18ns	686.54ns	0.43	1.76ns	35.79ns	2.32ns
Control vs rest	-1	291.66***	17.63***	435.74ns	28.03*	9552.73*	54.23***	306.71***	2963.98***	308.7***
Error	18	15.14	0.93	865.2	3.87	1278.94	1.07	2.67	26.05	6.03
Total	29									

***:P≤0.001; *:P≤0.001; NS: Non significant; PH: Plant height; NOBPP: Number of branches per plant; NOLPP: Number of leaves plant^{-1}; LChlC: Leaf Chlorophyll content; SLA: Single leaf area; NOFPP: Number of fuit plant^{-1}; FW: Fruit weight; YPP: Yield plant^{-1}; TY: Total yield

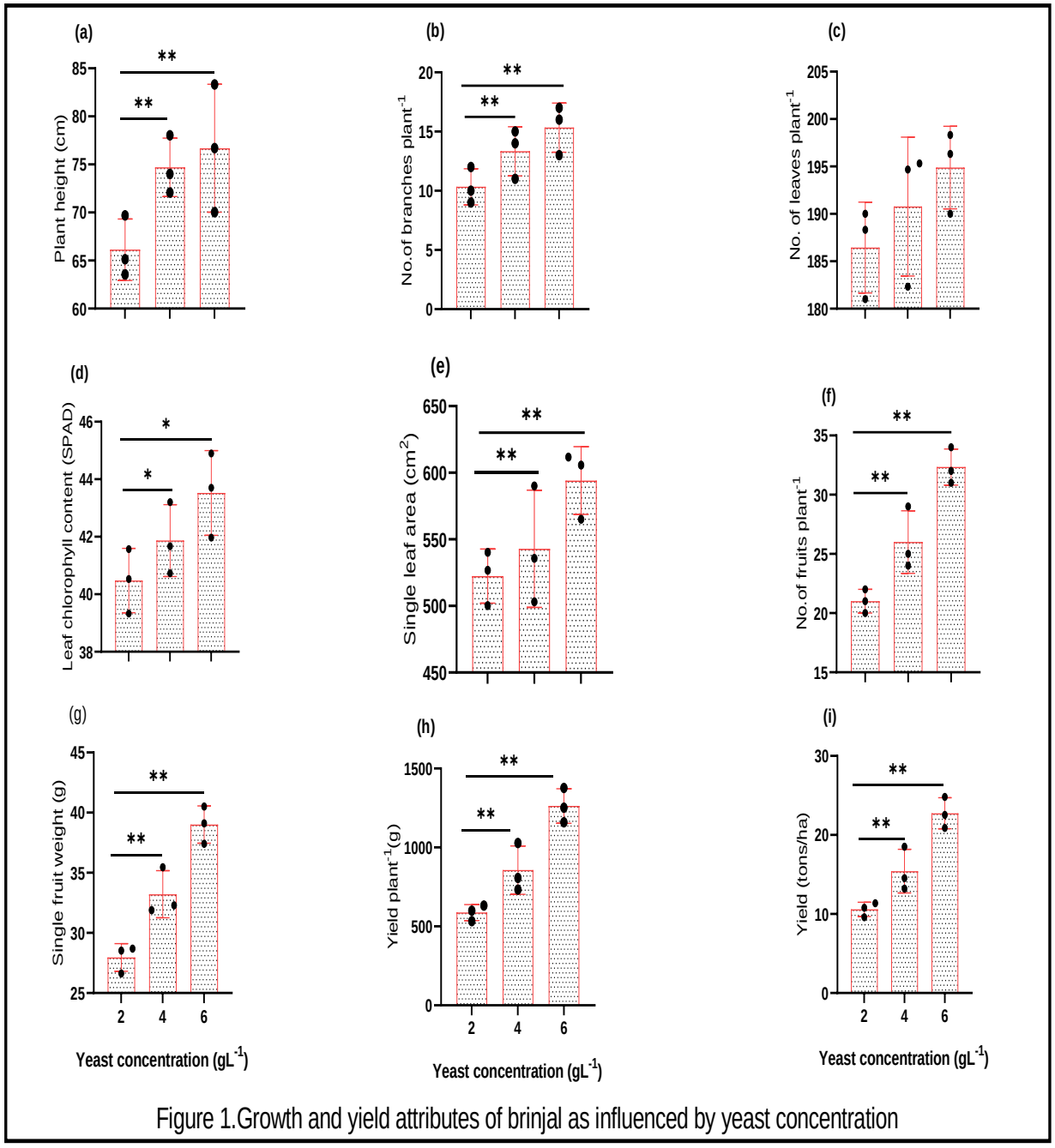

Figure 1.Growth and yield attributes of brinjal as influenced by yeast concentration

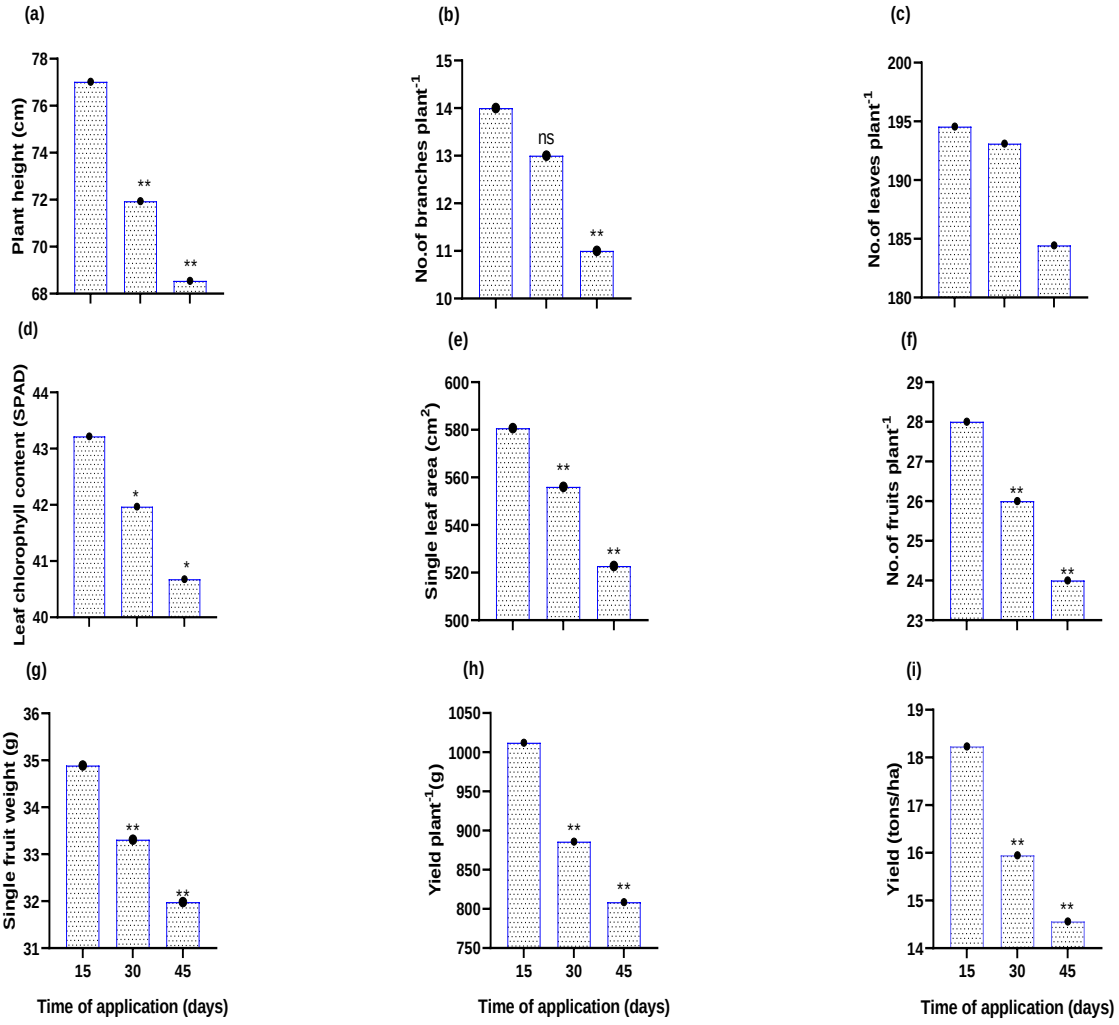

Figure 2.Growth and Yield attributes of brinjal as influenced by time of application of yeast

DISCUSSION

The positive effect of yeast foliar application is considered to be related with the fact that it is a natural source of cytokinins that stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll, hence increase plant height (Kriag and Heber 1980). It also contains sugar, proteins, amino acids and vitamins. Similar results were reported by Fathy and Farid (1996). Recently, Sarhan and Abdullah (2010) reported that the positive effects caused by the addition of yeast suspension increased shoots characteristics that might be due to the presences of wide groups of amino acids and vitamins. The obtained results are in accordance with those reported by Gomaa et al. (2005) in potato Hussain and Khalaf (2007), El-Tohamy et al. (2008) in eggplant and Ghoname et al. (2010) in sweet pepper. Likewise, Sarhan and Abdulah (2010) found that the treatments of yeast suspension caused gradual significant increase in plant height in potato. Foliar application of yeast extract, increased plant growth, i.e. plant height, at 70 and 85 days after sowing, as compared with the other studied foliar application of yeast extract treatments. The present findings are in agreement with the results of El-Tohamy et al. (2008) who indicated that the application of yeast increased eggplant growth. The improvement of plants growth in response to the foliar application of

active dry yeast may be attributed to its contents of different nutrients and higher percentage of protein and some hormones.

These results could be due to the fact that yeast extract contains growth factors especially, cytokinins and calcium, cobalt, iron etc. and is the best source of the B-complex vitamins and a relatively larger proportion of free amino acids and short peptides of two or three amino acids (Bevilacqua et al. 2008). The number of branches was significantly increased with the increase of yeast extract concentration. The results are in agreement with those of Sharaf-El- Deen and Manaf (2009) in faba bean and El-Tohamy et al. (2008) in eggplant who observed that yeast extract increased number of branches per plant. The foliar spray with different concentrations of active yeast extract significantly increased number of branches plant^{-1} in Kidney bean with increase in concentrations of active yeast extract. Likewise, improving vegetative growth characters of certain vegetable crops by application of active yeast extract were previously recorded by Amer (2004) and El-Tohamy and El- Greadly (2007) in beans and Fathy et al. (2000) in tomatoes and Tartoura (2001).

Foliar application of yeast extract concentrations had significantly increased all studied parameters of vegetative growth. In this connection, plants sprayed with yeast extractwere generally stockiest and healthiest in appearance than untreated plants. These results could be attributed to the role of yeast in stimulating the cell division, elongation, enlargement, protein and nucleic acid synthesis and chlorophyll formation which ultimately increased number of leaves reported by Kriag and Haber (1980). The obtained results are in harmony with those reported by Tartoura and El-Saei (2006) and Abd El-Mageed et al. (2009). They mentioned that plant growth was enhanced with spraying yeast. Similarly, Abdel-Aziz (1997) in eggplant and El-Tohamy et al. (2008) reported that foliar application of yeast increased all growth parameters including plant height and number of leaves. Fawzy et al. (2010) stated that application of dry yeast compound as a foliar spray lead to improve number of leaves. Nassar et al. (2011) in *Phaseolus vulgaris* L. found that increasing concentration of foliar application of yeast induced significant promotive effects on all investigated morphological characters. Foliar application with yeast extract increased the absolute growth rate of number of leaves plant^{-1} between 70-85 days after transplantation. Plants sprayed with the highest concentrations of yeast extract exhibited the highest values in comparison with those sprayed with the low concentrations. The results are in harmony with those reported by Marschner (1995) and Wanas (2002).

The yeast extract had promotive effect on vegetative growth characters (plant height, number of lateral branches plant^{-1} and number of leaves plant^{-1} and leaf area as reported by El-Gamal and Sabah (2005) in Sweet Basil. The positive effect of yeast extract on vegetative growth was also recorded in other medicinal and aromatic plants. For instance, Eid (2001) in *Coriandrum sativum*, and Nagiub and Khalil (2002) in black cumin reported an improved quality and yield with the application of yeast extract. The positive effects of dry yeast application were attributed to the fact that it is considered as a natural source of cytokinins that stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll (Fathy and Farid 1996). It also contains sugar, proteins, amino acids and vitamins (Shady 1978). The improvement of vegetative growth characters in response to the foliar application of active dry yeast may be attributed to its content of different nutrients, higher percentage of proteins, higher values of vitamins, especially B which may play an important role in improving growth. Sarhan and Abdulah (2010) in potato found that the treatments of yeast suspension caused gradual significant increase in plant height, number of aerial stem per plant and leaves area.

The yeast extract increased chlorophylls and carotenoids content that may lead to enhanced photosynthesis efficiency in faba bean as reported by Mady (2009). Moreover, Fathy and Farid (2000) reported that the application of yeast to tomato plants resulted in an increase in nitrogen contents of leaves, hence chlorophyll content increased. Shalaby and El-Nady (2008) reported that the increase in photosynthetic pigments could be attributed to the role of yeast cytokinins in delaying the aging of leaves by reducing the degradation of chlorophyll. The present results are in agreement with those of El-Tohamy and EL-Greadly (2007), who found that application of yeast extract increased chlorophyll a and b as well as caroteinods in snap bean plants. Fathy et al. (2000) also found that foliar application with yeast extract increased photosynthetic pigments in tomato plants. The increase of chlorophyll and carotenoid contents may enhance the photosynthetic efficiency and consequently

increase plant growth. The improvement of photosynthetic pigments in response to the foliar application of active dry yeast may be attributed to bio regulators which affect the balance between photosynthesis and photorespiration in tomato. Olaiya (2010) reported that foliar application with yeast extract gave the best value of total carbohydrates and crude protein content in leaves of tomato plants at 75 days after transplanting. This might be attributed to the large photosynthetic area and high content of photosynthetic pigments. The results are also in harmony with the findings of Fathy et al. (2000) in tomato.

The application of yeast extract increased number of fruit plant^{-1}. Yeast extract treatments were suggested to play beneficial role during vegetative and reproductive growths through improving flower formation and their set in some plants due to its high auxins and cytokinins contents and its beneficial effect on carbohydrate accumulation as reported by Mahmoud et al. (2013) in pea plants. The present study is supported by Kamal and Ghanem (2012) who reported that spraying yeast solution treatments significantly increased number of fruit per plant. The number of fruit were increased with increasing the foliar application of yeast concentrations. Shehata et al. (2012) in cucumber observed that spraying yeast extract was qualified to its own contents of different nutrients, high percentage of protein, large amount of vitamin B and natural plant growth regulators such as cytokines. Physiological roles of vitamins and amino acids in the yeast extract may increase the metabolic processes role and levels of endogenous hormones that may indorsed the vegetative growth parameters which in turn increased number of fruit. Foliar application of yeast extract increased number of fruit might be attributed to the favorable influence of them on metabolism and biological activity (Wanas 2002), and their stimulating effect on photosynthetic pigments and enzyme activity which in turn encourage number of fruit (El-Sherbeny et al. 2007).

The increase in total yield and improving its components like fruit weight with yeast extract might be ascribed to the fact that yeast contains sugar, proteins and amino acids, as well as several vitamins reported by Eata (2001). The obtained results are in accordance with those of Tartoura and El-Saei (2006) and Abd El-Mageed et al. (2009). Similar findings were reported by Hanafy et al. (2007) in tomato. Yeast extract are the natural components (contains many compounds, i.e. cytokinins and proteins that enhance cell division and enlargement) and increase yield component safely without any pollution (Barnett et al. 1990). Also, it contains the haloes-6-phosphate synthase (a key enzyme for trehalose biosynthesis) which not only affects plant development, but also improves drought tolerance (Yeo et al. 2000). El-Morsy et al. (2011) reported that yeast positively affected the yield components and ultimately fruit weight by yeast extract application that contained growth improving compounds like cytokine which stimulate cell division, protein synthesis and chlorophyll synthesis and hence resulted in significant increase in yield components. Moreover, at 95 days after sowing, vegetative growth decreased, this may be due to foliar application of yeast extract enhanced partitioning of photo assimilates from leaves (source) to flowers and immature fruit (sink) hence fruit weight increased in pea (Hopkins 1995).

The application of yeast extract increased plant yield. It has been reported that yeast extract treatments were found to play beneficial role during vegetative and reproductive growths through improving flower formation and their set in some plants due to its high auxins and cytokinins contents and its beneficial effect on carbohydrates accumulation as found by El-Tohamy and El-Greadly (2007). It also contains cryoprotective agents, i.e. sugars and amino acids as well as several vitamins (Shady 1978 and Mahmoued 2001). The positive effects of using yeast applications was attributed to increase availability of different nutrients, high percent of protein, high amounts of vitamin B and natural plant growth regulators such as cytokinins (Fathy and Farid 1996). Vitamins and amino acids in the yeast extract may increase the metabolic processes and levels of endogenous hormones i.e. IAA and GA3 that may indirectly affect yield of plant (Ahmed et al. 2011). Similar results trend were previously reported by El-Greadly (2008) in egg plant. Mahady (1990) reported that foliar application of yeast extract at 50 and 70 days after sowing of faba bean plants for getting the highest yield and seed quality.

Foliar application with yeast extract induced significant increase in yield and yield components by increasing yeast extract concentration in potato as reported by Hussain and Khalaf (2007). Yeasts have been reported to be rich source of phytohormones (especially cytokinins), vitamins, enzymes, amino acids and minerals (Barnett et al.

1990) and (Mahmoud 2001). It was reported that it has stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation and yeast extract have promotive effect on vegetative growth and productivity. Abo-El-Hamd et al. (2015) in faba bean found that the application of yeast extract increased yields and their component. Yeast extract treatments were suggested to play beneficial role during vegetative and reproductive growths through improving flower formation and their set in some plants. This may be due to its high auxins and cytokinins contents and its beneficial effect on carbohydrate accumulation leading to increase in total yield and improving its components than the other treatments. These increases might be ascribed to the fact that yeast contain sugar, proteins and amino acids as well as several vitamins (Eata 2001).

CONCLUSION

On the basis of above research findings, it is concluded that yeast extract application at the rate of 6 $g.L^{-1}$ at 15 days after transplantation could be proved the best for increased growth and yield contributing attributes. The best considered dose (6 $g.L^{-1}$) and days after transplantation (15) could be recommended. For future suggestion, further research may be required to find out the effects of yeast extract concentration beyond 6gL^{-1} could be tested in various cultivars of brinjal as well as other horticultural crops.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

We are thankful to the Faculty of Department of Horticulture for providing space to conduct research, their every support and appreciation throughout our research project.

AUTHOR CONTRIBUTIONS

"Conceptualization, IA and NA; methodology, IA and AB; software, I.U and S.T.S; formal analysis, IA, NK and STS; investigation, IA and AB; resources, YA, KU, MA; writing-original draft preparation, AB; writing-review and editing, AB; supervision, NA; All authors have read and agreed to the final version of the manuscript.

REFERENCES

Abd El-Mageed IYT, Youssef NS, Youssef M (2009) Effect of some anti oxidant sources on growth, yield and storability of garlic. Egypt J Agric Res 87(1): 245-264.

Abdel-Aziz MA (1997) Response of tomato plants to nitrogen fertilizer concentrations and growth regulators. M.Sc. thesis, Dept Vegetable Crops, Faculty of Agric Cairo Univ Egypt Pp; 169-178.

Ahmad M, Khattak MR, Jadoon SA, Rab A, Basit A, Ullah I, Khalid MA, Ullah I, Shair M (2019) Influence of zinc sulphate on flowering and seed production of flax (*Linum usitatissimum* L.): A medicinal flowering plant. Int J Biosci 14: 464-476.

Ahmad N, Ahmad M, Ullah I, Basit A, Khattak AM, Rab A, Sajid M, Nasir S & Hussain Z (2020) Effect of irrigation intervals on growth and production of Roselle (*Hibiscus Sabdariffa*). Biosci Res 17(2): 759-767.

Ahmed AA, El-Baky MA, Zakiand MF, El-Aal FSA (2011) Effect of foliar application of active yeast extract and zinc on growth, yield and quality of potato plant (*Solanum tuberosum* L.). J App Sci Res 7(12): 2479-2488.

Alam M, Hayat K, Ullah I, Sajid M, Ahmad M, Basit A, Ahmad I, Muhammad A, Akbar S, Hussain Z (2020) Improving okra *(abelmoschus esculentus* l.) Growth and yield by mitigating drought through exogenous application of Salicylic acid. Fres Environ Bulle 29: 529-535.

Amer SSA (2004) Growth, green pods yield and seeds yield of common bean (*Phaseolus vulgaris* L) as affected by active dry yeast, salicylic acid and their interaction. J Agric Sci Mansoura Univ 29(3): 1407-1422.

Arivalagan M, Gangopadhyay KK, Kumar G (2013) Determination of steroidal saponins and fixed oil content in fenugreek (*Trigonellafoenu mgraecum* L.) genotypes. Indian J Pharma Sci 75(1): 110.

Barnett JA, Payne RW, Yarrow D (1990) Yeasts

characteristics and identification. Cambridge Univ. Press Publi by the Press Syndicate of the Univ. of Cambridge. Pp; 999.

Basit A, Khan S, Sulaiman, Shah S, Shah AA (2019) Morphological features of various selected tree species on the greater university campus Peshawar, Pakistan. Int J Bot Studies 4: 92-97.

Basit A, Shah K, Rahman MU, Xing L, Zuo X, Han M, Alam N, Khan F, Ahmed I, Khalid MA (2018) Salicylic acid an emerging growth and flower inducing hormone in marigold (*Tagetes* sp. L.). Pure Appl Biol 7(4): 1301-1308. http://dx.doi.org/10.19045/bspab.2018.700151

Bevilacqua A, Corbo MR, Mastromatteo M, Sinigaglia M (2008) Combined effects of pH, yeast extract, carbohydrates and di-ammonium hydrogen citrate on the biomass production and acidifying ability of a probiotic (*Lactobacillus plantarum)*strain, isolated from table olives, in a batch system. World J Microb Biotechnol 24: 1721-1729.

Eata AM (2001) Response of some tomato cultivars to natural soil salinity and use of some treatments to reduce salt injury. Ph.D Thesis, Fac. Agric. Mansoura Univ. Mansoura, Egypt. Pp; 263-279.

Eid MI (2001) Response of coriander plant to foliar spray with active dry yeast and phosphorus fertilization. J Agri Sci Mansoura Univ 26(12): 7869-7878.

El-Gamal, Sabah MA (2005) Physiological response of sweet basil plants grown under stress conditions as affected by yeast extract ascorbic acid and potassium. Minufiy J Agric Res 30(1): 25-50.

El-Ghamriny EA, Arisha HME, Nour KA (1999) Studies in tomato flowering fruit set,yield and quality in summer seasons. 1- Spraying with thiamine, ascorbic acid and yeast. Zagazig J Agric Rec 26(5): 1345-1364.

El-Tohamy WA, El-Greadly NHM (2007) Physiological responses, growth, yield and quality of snap bean in response to foliar application of yeast, vitamin E and zinc under sandy soil conditions. Australian J Basic and Appl Sci 1(3): 294-299.

El-Tohamy WAH, El-Abagy M, El-Greadly NHM (2008) Studies on the effect of putrescine, yeast and vitamin C on growth, yield and physiological responses of eggplant (*Solanum melongena* L.) under sandy soil conditions. Australian J Basic and Appl Sci 2(2): 296-300.

Fathy EL, Farid S, El-Desouky SA (2000) Induce cold tolerance of outdoor tomato during early summer seasons by using adenosine tri phosphate (ATP), yeast, other natural and chemical treatments to improve their fruiting and yield. J Agric Sci Mansura Univ 5(1): 377-401.

Fathy El-S L, Farid S (1996) The possibility of using vitamin B and yeast to delay senescence and improve growth and yield of common beans (*Phaseolus vulgaris* L.). J Agric Sci Mansoura Univ 21(4): 1415-1423.

Fathy SL, Farid S (2000) Effect of some chemical treatments, yeast preparation and Royal Jelly on some vegetable crops growing in late summer season to induce their ability towards better thermal tolerance. J Agric Sci Mansoura Univ 25(4): 2215-2249.

Fawzy ZF, El-Bassiony AM, Behairy AG, Helmy YI (2010) Effect of foliar spraying by some bio and organic compounds on growth, yield and chemical composition of Snap bean plants. J App Sci Res 6(12): 2269-2274.

Gandhi, Sundari US (2012) Effect of vermin compost prepared from aquatic weeds on growth and yield of eggplant (*Solanum melongena* L.). J Bio Fert Biopesticide 3 (5): 1-4.

Ghoname AA, El-Nemr MA, Abdel-Mawgoud AMR, El-Tohamy WA (2010) Enhancement of sweet pepper Crop growth and production by application of Biological. J App Sci Res 6(12): 2269-2274.

Ghoname AA, Mona G, Dawood GS, Riad, El-Tohamy WA (2009) Effect of nitrogen forms and bio stimulants foliar application on the growth, yield and chemical composition of hot pepper grown under sandy soil conditions. Res J Agri Bio Sci 5(5): 840-852.

Gilani SAQ, Shah K, Ahmed I, Basit A, Sajid M, Bano AS, Ara G, Shahid U (2018) Influence of indole butyric acid (IBA) concentrations on air layerage in guava (*Psidium guajava* L.) cv. Sufeda. Pure Appl Biol 8(1): 355-362. http://dx.doi.org/10.19045/bspab.2018.700194

Glick BR (1995). The enhancement of plant growth by free living bacteria. Cand J Microbiol 41: 109-117.

Gomaa AM, Moawad SS, Ebadah IMA, Salim H (2005) Application of bio-organic farming and its influence on certain pests infestation, growth and productivity of potato plants. J App Sci Res 1(2): 205-211.

Hanafy AAH, Khalil MK, Metwally AM, Abdel-Aziz MA (2007) Effect of biomagic, yeast, acadian sea plants, foliar feed trial compound putrescine and silicon treatments on growth, yield and chemical composition of tomato plants grown under early and late summer seasons. J Agric Sci Mansoura Univ 32 (2): 913-949 .

Hopkins WG (1995) Carbon assimilation and productivity.In introduction to plant physiology. John Wiley & Sons Inc ed Pp: 251-261.

Hussain W, Khalaf L (2007) Effect of foliar spraying with yeast solution on growth and yield of potato plant cv. desiree. Retrieved from www. tropentage.de/ 2007/ abstracts/ links/khalaf.FPRAXY 90.

Jagatheeswari D (2013) Effect of vermicompost on growth and yield of eggplant (*Solanum melongena* L.). Indian Streams Res J 3(4): 1-6.

Jumini, Marliah A (2009) Growth and yield of eggplant due to application of leaf fertilizer Gandasil D and Harmonik growth regulators (in Indonesian). J Floratek 4(1):73-80.

Kamal AM, Ghanem KM (2012) Impact of some bio-stimulants on organically cultivated snap bean plants. Egyt J App Sci 27(2): 89-104.

Kriag E, Haber JE (1980) Messenger ribonucleic acid and protein metabolism during sporulation of *Saccharomyces cerevisiae.* J Bacteria 144: 1098-1112.

Mady MA (2009) Effect of foliar application with yeast extract and Zinc on fruit setting and yield of faba bean (*Viciafaba* L.). J Biol Chem Environ Sci 4(2): 109-127.

Mahmoud R, Asmaa, EL-Desuki M, Mona M, Abdel-Mouty, Ali H (2013) Effect of compost levels and yeast extract application on the pea plant growth, pod yield and quality. J App Sci Res 9(1): 149-155.

Marschner H (1995) Mineral nutrition of higher plants. 2nd ed., Acadimic press. Pub. New York (USA). Pp 907

Marschner H (1995) Mineral Nutrition of Higher Plants. 2nd Edn. Academic Press, London. Pp 889

Marzauk N, Safeek M, Helmy Y, Ahmed A, Shalaby M (2014) Effect of vitamin E and yeast extract foliar application on growth, pod yield and both green pod and seed yield of broad bean (*Viciafaba* L). Mid East J Appli Sci 4(1): 61-67.

MINNFSR (2016) Fruit, vegetables and condiments statistics of Pakistan. Ministry of National Food Security and Research Economic wing Islamabad. Pp: 21-32.

Mohamed AN (2015) Influence of Foliar Spray with Yeast Extract on Vegetative Growth, Yield of Fresh Herb, Anatomical Structure, Composition of Volatile Oil and Seed Yield Components of Basil Plant (*Ocimumbasilicum L*.). Inter J Adv Res 3(10): 978-993.

Mona M, Kabeel SMA, Fayza MA (2005) Effect of organic and biofertilizer on growth, yield and fruit quality of cucumber grown under clear polyethelene low tunnels. J Agric Sci Mansoura Univ 30(5): 2827-2840.

Naguib NY, Khalil (2002) Studies on the effect of dry yeast, thiamin and biotin on the growth and chemical constituents of black cumin (*Nigella stavia* L.). Arab Univ J Agric Sci 10(3): 919-937.

Nassar RMA, Ahmed MY, Nassar DMA (2011) Effect of foliar spray with active yeast extract on morphological, anatomical and yield characteristics of kidney bean (*Phaseolus vulgaris* L.). Aust J Basic and Appl Sci 5(5): 1071-1079.

Natio KS, Nagamo K, Susuki H (1981) Effect of benzyl adenine on KNA and protein synthesis in bean leaves at various stages of ageing. Phys Plant 52: 343-348.

Olaiya CO (2010) Presowingbioregulator seed treatments increase the seedling growth and yield of Tomato (*Lycopersicon esculentum* L.). J Plant Growth Reg 29:349-356.

Sajid M, Basit A, Ullah Z, Shah ST, Ullah I, Mohamed HI, Ullah I (2020) Chitosan-based foliar application modulated the yield and biochemical attributes of peach (*Prunus persica* L.) cv. Early Grand. Bull Nat Res Centre 44:150. https://doi.org/10.1186/s42269-020-00405-w

Sakr MM, Abd–El-Mottaleb HM, Ali EA (1996) Effect of spraying iron and zinc on botanical, chemical characters, yield and its components of *Vicia faba* L. Ann Agric Sci Moshtohor 4(4): 1457-1477.

Salama MA (2016) Influence of foliar application with some Bio-Stimulants on growth, yield, anatomical structure and chemical composition of Stevia plant (*Stevia rebaudianaBertoni*) Mid East J Agric Res 05(1): 50-60.

Sarhan T, Abdullah OK (2010) Effect of Azotobacter Inoculation, dry bread yeast suspension and varying levels of urea on growth of Potato Cv. Desiree.

html/www.tropentage.de/2010/abstracts/full/628. September 12, 2018.

Shady MA (1978) The yeasts, Adv. Cour for Post Grand. St. In Microbiol Agric Bot Dept, Fac Agri Mansoura Univ Pp: 146-247.

Shafeek, Olaiya CO (2015) Use of some Bio-stimulants for improving the growth, yield and bulb quality of Onion plants *(Allium cepa L*.) under Sandy Soil Conditions. Mid East J App Sci 5: 68-75.

Shalaby ME, El-Nady MF (2008) Application of Saccharomyces cerevisiae as a biocontrol agent against Fusarium infection of sugar beet plants. Act Bio Szegediensis. 52(2): 271-275.

Sharaf EHAM, Manaf HH (2009) Effect of some plant growth regulators on shedding physiology, antioxidant enzymes, growth and yield of faba bean. J Biol Chem Env Sci 4(3): 21-46.

Sharma P, Swarup A (1995) Microbial oxidation of pyrites in relation to its efficiency in alkali soil reclamation. Environmental impact of soil component interactions—natural and anthropogenic organics 1: 97-104.

Shehata SA, Fawzy ZF, El-Ramady HR (2012) Response of cucumber plants to foliar application of chitosan and yeast under green- house conditions. Aus J Basic and App Sci 6(4): 63-71.

Sowinska KA, Krygier M (2013) Yield and quality of field cultivated and the degree of fruit maturity. Acta Sci Pol Holturum Cultus 12(2): 13-23.

Spencer TFT, Dorothy SM, Smith ARW (1983) Yeast genetics fundamental and applied aspects. Springer-Verlag, New York USA. Pp: 16-18.

Steel RGD, Torrie JH (1980) Principles and procedures of ststistics. A biometrical approach. 2nd edition. McGraw-Hill, New Yark, USA. Pp: 20-90.

Tarek FAA (2003). The effect of some organic and inorganic fertilizers on plant growth and fruit quality of cucumber plant under plastic houses. M.Sc. Thesis, Faculty of Agric Ain Shams Univ Pp: 66.

Tartoura EAA (2001) Response of pea plants to yeast extract and two sources of N-fertilizers. J Agric Sci Mansoura Univ 26(12): 7887-7901.

Tartoura EAA, El-Saei MA (2006) Effect of compost tea, yeast extract and their mixture on yield and storability period in garlic. J Agric Sci Mansoura Univ 31(7): 4801-4811.

Ullah MS, Islam MS, Islam MA, Haque T (2008) Effects of organic manures and chemical fertilizers on the yield of brinjal and soil properties. J Bangla Agric Univ 6(2): 271-276.

Wanas AL (2002) Resonance of faba bean (*Vicia faba* L.) plants to seed soaking application with natural yeast and carrot extracts. Annals Agric Sci Moshtohor 40(1): 259-278.

Wanas AL (2006) Trails for improving growth and productivity of tomato plants grown in winter. Annals Agric Sci Moshtohor 44(3): 466-471.

Waseem K, Hussain A, Jilani MS, Kiran M, Ghazanfarullah, Javeria S, Hamid A (2013) Nutritional management in brinjal (*Solanum melongena* L.) using different growing media. Pak J of Sci 65(1): 21-25.

Yeo E, HawkBin K, SangEun H, JoonTak L, JinChang R, MyungOk B, Yeo ET, Kwon HB, Han SE, Lee JT, Ryu JC, Byun MO (2000) Genetic engineering of drought resistant potato plants by introduction of the trehalose-6-phosphate synthase (TPSI) gene from *Saccharomyces cerevisiae*. Molecules and Cells 10(3): 263-268.