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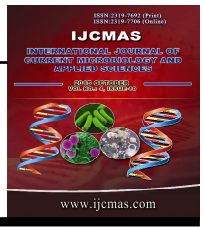

Original Research Article

Effect of different levels of potassium applied with foliar spraying of yeast on growth, yield and root quality of turnip under sandy soil conditions

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Keywords

Turnip, Yeast extract, Potassium fertilizer, Growth, Yield, Chemical root contents

A B S T R A C T

Two field experiments were carried out during two successive seasons; 2012/2013 and 2013/2014 at the experimental station of National Research Centre, Beheira Governorate (North of Egypt) to find out the influence of foliar spraying of yeast extracts at 3 levels (0, 1% and 2 %.) with potassium fertilizer applied at 3 levels (100, 150 and 200 kg/fed.) on plant growth, yield, yield components and root chemical contents of turnip plants cv. "Balady". Three weeks after planting, foliar applications of bio stimulants yeast extract were applied after 21 days at swing and repeated 2 times at 15 days intervals throughout the growing season. These treatments were laid out in split plot design arrangement with three replications. Results indicated that: 1. Foliar application of yeast extract had the highest stimulation effect on turnip plant growth characters i.e. (plant length, number of leaves, chlorophyll content as well as fresh and dry weight of leaves and roots), total root yield and its components as well as content of the percentage of root tissues of nitrogen, protein, P, K and carbohydrate contents compared to the control treatment. 2. Increasing potassium fertilizer levels significantly increased plant growth characters, total root yield and its components as well as the root contents of nitrogen, protein, P, K and total carbohydrate contents. 3. The highest values of plant growth criteria, total roots yield and its components were recorded when sprayed by high level of yeast extract (2%) with high level of potassium soil fertilizer as compared the other interaction treatments. The statistical analysis of the obtained data revealed insignificant differences between the interaction treatments except fresh weight of leaves / plant and the percentage of nitrogen and protein contents in root tissues at second season only.

Introduction

Turnip plants (*Brassica rapa*) is a member of the cruciferous family of vegetables. *Brassica rapa*, commonly known as field mustard or turnip mustard is a plant widely cultivated as a leaf vegetable, a root vegetable, and an oilseed. Plants for a future cannot take any responsibility for any adverse effects from the use of plants. A decoction of the leaves or stems is used in the treatment of cancer (Duke and Ayensu 1985). The powdered seed is said to be a folk remedy for cancer (Duke 1983). The

crushed ripe seeds are used as a poultice on burns (Foster and Duke 1990). The root when boiled with lard is used for breast tumors (Duke 1983). A salve derived from the flowers is said to help skin cancer (Duke 1983). Moreover, turnip extract is also useful for lowering uric acid and extracting renal stones. It increases visual keenness and is used to treat night blindness. Turnips syrup strengthens the memory (Khashayar, 2007). Turnip root peelings contain a natural insecticide Allardice (1993).

Many studies indicated that yeast is one of the richest source of high quality protein, namely the essential amino acids like lysine, tryptophan etc., contains the essential minerals and trace elements, namely calcium, cobalt, iron etc. and the best sources of the B-complex vitamins such as B1, B2, B6 and B12. The extract is a valuable source of bio-constituents especially, cytokinins Amer (2004), that work as a readily available growth supplement for plants that eventually improve plant production Ghoname *et al* (2009)**.** However, it is a source of cytokinins and protein that enhance cell division and enlargement (Barnett *et al*., 1990). Moreover, Yeo *et al*., (2000) found that yeast extracts contain trehalose-6-phosphate syntheses which had a key enzyme for treadles bio synthesis.

Shehata *et al*. (2012) mentioned that yeast is an enriched source of phytohormones especially cytokinins, vitamins, enzymes, amino acids and minerals as well as has a stimulatory effect on the cell division and enlargement, protein and nucleic acids synthesis, chlorophyll formation and protective role against different stresses. Many investigators reported that spraying plants with yeast extract improved plant growth, yield and potato quality (Yeo *et al.*, 2000; and Gomaa *et al.*, 2005). Moreover, Hussain and Khalaf (2007) reported that spraying yeast solution increased the vegetative growth characters, yield/ plant, tubers dry matter percentage and total soluble solid (TSS). However, Sarhan and Abdulah (2010) found that yeast treatments caused gradual significant increase in potato plant growth, total chlorophyll and shoots dry matter percentage. Recently, Ahmed *et al*. (2011) demonstrated that increasing of foliar application of active dry yeast concentrations increased the vegetative growth characters of potato plants, productivity of potato plants, tubers quality and tubers dry matter percentage. Ramadan and Ragab (2015) found that active dry yeast application resulted in increasing growth characters (Plant height, Number of branches/plant), chemical constituents (N, P, K, Ca, Mg, Fe, Zn and Mn % in shoot and root), total carbohydrates % and also, increased yield characters of caraway plant represented in Number of umbels/plant, yield /plant (g) and yield/ha (ton), Anatomical measurements were also increased and those were reflected on yield potential. In the same respect, Shafeek *et al* (2015) reported that foliar spraying of yeast extract at high levels produced the highest stimulation effect on onion plant growth characters i.e. (plant length and number of leaves as well as fresh and dry weight of leaves, nick and bulb), total bulb yield and its components as well as content of the percentage of bulb tissues of nitrogen, protein and dry matter compared to the control.

Potassium is a major plant nutrient, which is needed by the plants in large amount and is supplied by the fertilizer. It is available to the plants in the form of cation (k+). Actually potassium is essential for a variety of process i.e. photosynthesis, fruit formation, winter hardiness and disease resistance. It stiffens straw and thus reduces lodging, and plays an important role in protein formation especially in grain filling.

Moreover, all the root crops frequently respond to the potassium application. However, Yadav *et al*., (2003) noticed significantly higher onion yield of bulb and fresh weight of bulbs with application of 150 kg K2O/ha over other potassium levels. Increased bulb yield of garlic was obtained with application of 150 kg K2O/ha. Moreover, considering economics of crops balanced use of K2O fertilizers at 50 kg/ha gave the optimum returns (Tiwari *et al*., 2003). Increasing levels of potassium significantly increased the TSS content of onion bulb. Higher TSS (11.99%) content of onion bulb was obtained in the treatment receiving K at 125 kg/ha which was on parallel with K at 150 kg/ha. while the maximum ascorbic acid content (9.93 mg /100g) was recorded with 50 kg K2O/ ha. Many investigators studied the response of onion plant to the potassium rates such as AbdEl-Aal *et al*. (2005). Moreover, AbouEl-Nasr and Ibrahim (2011) reported that the highest potassium fertilization rate (75 kg K2O /fed.) gave the tallest shoot, the highest number of leaves per plant and the highest fresh weight of shoots as well as the highest total yield per fed. Also, the obtained results reported that the root measurements expressed as (root length, root diameter, root weight, TSS and carotenoids content, as well as leaves chemical composition (N, P and K concentrations) were increased with increasing potassium fertilization rate. The favorable effects of the potassium on the growth, total yield and root parameters were obtained when plants fertilized with 75 kg K2O /fed. as potassium sulfate plus foliar application of potassium humate (3 ml/ L). However, Saud *et al* (2013) found that the maximum onion plant height (51.6 cm), number of leaves plant (9.89), bulb diameter (5.93), average bulb weight (64.89 g), leaf width (1.33 cm) and yield (22.91 ton/ ha) were observed with the application of the highest level (120 kg K2O / ha). In the same respect, Shafeek, *et al* (2013) reported that the highest onion plant vegetative growth character (the tallest plant, the highest leaves number, the heaviest fresh, dry weight of whole plant, total bulbs yield per unit area and dimension of bulb as well as its average weight) were detected with using potassium sulfate at the highest rate (300 kg/fed.). Also, the application of potassium fertilizer at the highest rate gained the highest nutritional values of bulb tissues from the percentage of TSS, protein, N, P, K, Fe, Mn, Zn and Cu. In the same times, adding the highest rate of potassium fertilizer (300 kg/fed.) gained the highest bulb values of growth promoting phyto hormones expressed as mg /g fresh weight of gibberellins and IAA and the lowest value of ABA as growth retardant.

The main objective of this study was to investigate the effect of different potassium fertilization rates in addition to foliar spraying of yeast extract on the vegetative growth parameters, total roots yield and its physical and chemical constituents of turnip plants.

Materials and Methods

Two field experiments were carried out at the experimental station of National Research Centre at Nubaria, Behira Governorate, Egypt during the two growing seasons of 2013 and 2014 in order to study the effect of the addition of different levels (100, 150 and 200 kg/fed.) of potassium fertilizer with various concentrations of yeast extracts (0, 1% and 2 %) on vegetative growth, root yield characters and root quality of turnip plants (*Brassica rape* L.) cv. Balady. The experimental site had a sandy soil texture with pH of 7.6, Ec of 0.19 and the organic matter was 0.21% with 14.00, 8.90 and 15.60 mg/100g soil of N, P and K respectively. Super phosphate

fertilizer (16.5% P_2O_5) was applied 100 kg/fed. each at the time of soil preparation and Nitrogen fertilizer at the rate of 30 kg N/fed was added as ammonium sulfate (20.6 % N) in three equal doses after 15, 30 and 45 days after sowing. Yeast extract was prepared from brewer's yeast (*Saccharomyces cerevisiae*), dissolved in water followed by adding sugar at a ratio of 1: 1 and kept 24 hours in a warm place for reproduction according to the methods of Morsi *et al* (2008). Chemical analysis of activated yeast is shown in Table (1). Seeds of turnip were obtained from Horticultural Research Institute, Agriculture Research Center and sown on September 20th and 25th in 2013 and 2014, respectively. The area of experimental plot was 10.5 m^2. Every plot consisted of 5 dripper lines 3 m in length and 0.7 m in width. Seeds were sown in hills 10 cm apart on one side of dripper lines and two seeds per hill. The normal agriculture practices of turnip under drip irrigation system were followed according to the recommendations of Agriculture Ministry. The levels for potassium fertilizer was applied the main plots, while the foliar application of yeast extract levels was distributed randomly in the sub plots. This experiment included 9 treatments which included all combinations between the three levels of potassium fertilizers (100, 150 and 200 kg/ fed.) with three foliar spraying of yeast extract levels (0, 1% and 2 %).Yeast extract levels were sprayed three after 21 days from sowing and repeated 2 times at 15 days intervals throughout the growing season.

At the vegetative growth stage, random samples of five plants from each plot were taken 60 days from sowing for determination of plant length (cm), number of leaves per plant as well as, fresh and dry weight (g) of leaves /plant. Also, root organs (fresh and dry weight) and some physical properties of root (diameter and length) were measured. The chemical constituents of root turnip were determined as the percentage of N, P and K according to the methods of Pregl (1945), Troug and Mayer (1939) and Brown and Lilleland (1946) respectively. However, total crude protein % and total carbohydrate % were extracted and determined according to A.O.A.C (1975). All obtained data were subjected to the statistical analysis and means were compared according to LSD at 5% level test described by Gomez and Gomez (1984).

Results and Discussion

Vegetative growth characters

Effect of yeast extracts

Regarding foliar application of yeast extract, Table (2) that, the concentration of 2% was the most favorable for increasing plant growth, expressed as plant length (cm), number of leaves and total chlorophyll content as well as fresh and dry weight (g) of leaves/ plant in both two seasons as compared with the medium level (1%) and control treatments. The statistical analysis of the obtained data reveals that high level of foliar spraying yeast extract 2% was significantly increased all plant growth characters compared medium level (1%) of yeast extract. These findings are in agreement with the results by Kamal and Ghanem (2012), Tarek *et al* (2014) and Marzauk *et al* (2014) who found that the increase level of yeast extract significantly increased plant growth characters on vegetable crops who found that the application of yeast extract increased plant growth characters. The superiority of plants growth in response to the foliar application of yeast extract may be attributed to its contents of different nutrients, i.e. (P, K, Mg, Ca, Fe, Ba, Mn and Zn), higher

percentage of proteins, higher values of free amino acid and vitamins (Table 1) which may play an important role in improving growth and controlling the incidence of fungi diseases (Bevilacqua,*et al.,* 2008).

Effect of potassium fertilizer

Data presented in Table (2) show that the highest level of potassium soil fertilizer (200 kg/fed.) had a significant effect on plant growth parameters, *i.e.*, plant height, number of leaves per plant, total chlorophyll content, fresh and dry weight of leaves compared to medium fertilizer (150 kg/fed.) or low level (100 kg/fed.) treatments. These findings were true in both seasons. These results may be due to the role of potassium element in metabolism and many processes needed to sustain and promote plant vegetative growth and development. Moreover, K plays a major role in many physiological and biochemical processes such as cell division and elongation and metabolism of carbohydrates and protein compounds (Marschner, 1995). The obtained results are in a good accordance with those recorded by Abd El-Aal *et al*. (2005), Brintha, and Seran, (2009), AbouEl-Nasr and Ibrahim (2011), Saud *et al* (2013), Salami and Saadat (2013) and Shafeek, *et al* (2013) who found that increasing potassium fertilizer levels increased plant growth characters.

Effect of the combination of yeast extract with potassium fertilizer

Regarding with the interaction of both factors data in Table (2) found that, vegetative growth characters of turnip plants was not significant effect except fresh weight of leaves in both seasons. Generally, the obtained data indicated that, the highest values of plant growth criteria expressed as (plant length, number of leaves, total chlorophyll content as well as fresh and dry weight of leaves, plant) were recorded when sprayed by high level of yeast extract (2%) with high level of potassium soil fertilizer as compared the other interaction treatments.

Total root yield and its components

Effect of yeast extracts

Data in Table (3) indicated that productivity of turnip plants were significantly influenced by using of different yeast concentrations as foliar spray. Whereas, their productivity was increased with increasing the different concentrations of yeast extract which consequently reflected on the total roots yield as ton/fed. in both experimental seasons. The highest values of yield were observed with the highest yeast concentrations which it was 9.106 and 9.416 ton/fed in the first and second seasons, respectively.

On the other hand, the lowest values were recorded with corresponding untreated plants which it was 8.459 and 8.942 ton/fed. for the first and second seasons, respectively. Likewise, marketable roots characters expressed as (fresh and dry weight as well as root length and diameter) were also influenced by different yeast concentrations and showed the same trend of yield as mentioned before. These increases might be attributed to increase the vegetative growth (Table 2). Also, might be due to the direct or indirect effect of its ability to change the environment of the root system to form a fine network of polysaccharide that behaves symbiotically with the rhizome, or because the development of the yeast after its saturation with groups of amino acids and vitamins. These results were in harmony with those reported by Amer (2004), Ahmed *et al*. (2011), Shehata *et al*. (2012), Ramadan and Ragab (2015) and Shafeek *et al* (2015).

Effect of potassium fertilizer

The mean data for potash revealed that maximum total yield (9.416 and 9.776 ton/ fed.) for 1st and 2nd seasons, respectively with addition soil potassium fertilizer at rate of 200 kg as potassium sulfate per fed. (Table 3) followed by (8.343 and 9.327 ton / fed.) with application at 150 kg K2O \ fed. while the minimum yield (8.170 and 8.431 ton /fed.) was recorded in low fertilizer level (100kg/fed.). The response of fresh and root weight as g and root dimension (length and diameter) followed the same pattern of change like that mentioned above. It could be concluded that, the heaviest roots yield and its component it might be attributed to the best vigor of plant growth characters which obtained by addition of 200 kg of potassium sulfate per fed. Also, potassium element is very important in overall metabolism of plant enzymes activity, it was found to serve a vital role in photosynthesis by direct increasing in growth and total root yield. Also, potassium has a beneficial effect on water consumption (Mansour, 2006). The same result was also concluded by Ghafoor *et al*. (2003), Khan *et al.* (2003), Pervez *et al.* (2004), Ali *et al.* (2007) who stated that as potash level increases up to optimum levels the yield (ton / fed.) and its components increases.

Effect of the combination of yeast extract with potassium fertilizers

The interaction between potassium fertilizer and foliar application of yeast extract had significant effects on root yield and its components. The highest values were recorded by using 200 kg K2O /fed. with foliar application of yeast extract at high concentration (2%) yielded (9.850 and 9.820 ton/fed.) for 1st and 2nd seasons, respectively followed by low concentration of soil potassium fertilizer (100 kg/fed.) without foliar spraying yeast extract (control treatment) (8.170 and 8.431 ton/fed.) for 1st and 2nd seasons, respectively. These findings were true in both seasons. The statistical analysis of the obtained data recorded a non significant increase in total root yield (ton\fed.) and its components in two experimental seasons.

Chemical roots quality

Effect of yeast extracts

Regarding, the roots quality of turnip in respect to the percentage of (N, Protein, P, K and total carbohydrate) showed observed responses to different yeast concentrations Table (4). Whereas, the highest values of the above mentioned findings were recorded with the highest yeast concentration (2%). However, the highest level of yeast extract (2%) significantly increased all the percentage of chemical root tissues compared low level (1%). Meanwhile, the lowest values were obtained with the corresponding untreated plants by yeast treatment. These findings were true in both seasons. It could be concluded that, the improving of the chemical roots quality by increasing the level of yeast extract application may be due to that, yeast extracts are natural components contain many of the nutrient elements and cytokininis, which are safe and non-pollutant. Their results supported the obtained data (Shehata *et al*.(2012), Ramadan and Ragab (2015) and Shafeek *et al* (2015) they reported that, the root quality was increased by increasing the concentration of yeast extract in spraying solution.

Effect of potassium fertilizer

Data of N, protein, P and K content as well as total carbohydrate were significantly increased by increased K fertilization over two seasons. The statistical analysis of the obtained data reveals that, the differences

within different potassium soil fertilizer were great enough to be significant. It could be concluded that, increasing the levels of potassium soil fertilizer raised the availability of nutrient elements which favored to enhancement their absorption and hence increased its concentration in turnip roots.

Table.1 Chemical analysis of activated yeast (mg/ 100g dry weight)

Minerals		Amino acids		Vitamins	
Total N	7.23	Arginine	1.99	Thiamin	2.71
P2O5	51.68	Histidine	2.63	Riboflavin	4.96
K2O	34.39	Isoleiucine	2.31	Nicotinic acid	39.88
MgO	5.76	Leucine	3.09	Pantothenic acid	19.56
CaO	3.05	Lysine	2.95	Biotin	0.09
SiO2	1.55	Methionine	0.72	Pyridoxine	2.90
SO2	0.49	Phrnylalanine	2.01	Folic acid	4.36
NaCl	0.30	Theronine	2.09	Cobalamin	153ug
Fe	0.92	Tryptophan	0.45	Enzymes	
Ba	157.6	Valine	2.19	Oxidase	0.350
Co	67.8	Glutamic acid	2.00	Peroxidase	0.290
Pd	438.6	Serine	1.59	Catalase	0.063
Mn	81.3	Aspartic acid	1.33	Carbohydrates 23.20	
Sn	223.9	Praline	1.53		
Zn	335.6	Tyrosine	1.49		

An increase in root yields might be due to the role of K in nutrients uptake and nutritional balance, which increase the biosynthesis of photosynthesis Milford *et al*, (2000), Attia, (2004) Salami and Saadat (2013). The trends of obtained results are in good accordance to the previous investigators such as (Abd El-Aal *et al*. 2005, Brintha, and Seran, 2009, AbouEl-Nasr and Ibrahim 2011, Saud *et al* 2013, Salami and Saadat 2013 and Shafeek, *et al* 2013).

Effect of the combination of yeast extract with potassium fertilizer

Data presented in chemical content of turnip root tissues i.e. (N, Protein, P, K and total carbohydrate) were responded to the interaction treatments between yeast extract and potassium fertilizer. Whereas, the highest chemical contents was recorded with that plants which were sprayed with yeast extract at 2% along with potassium fertilizer treatment at 200 kg\fed. in both seasons. On the other hand, the lowest values were detected with the corresponding untreated plants on yeast extract with low level of potassium fertilizer (100 kg\fed.) These results were true in both seasons. The statistical analysis of the obtained data revealed insignificant differences between the interaction treatments except the percentage of nitrogen and protein contents in root tissues at second season only.

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