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Effect of Organic Fertilizer and Dry Bread Yeast on Growth and Yield of Potato *(Solanum tuberosum* L.)

Abdel- monnem Sadalaha Kahlel

Technical Agricultural College / Mosul
Foundation of Technical Education/ Iraq
E-mail : monnem_sadalaha@yahoo.com

Abstract

An experiment was conducted in vegetable crops farm of plant production department in Technical Agricultural College /Mosul/Iraq during spring season 2013 to study the effect of using organic fertilizers (Local poultry manure by two methods scattered and irrigation with fertilizer solution) and dry bread yeast irrigated near the plants roots by three concentrations (0, 4 and 8 g L^{-1}) The study included nine different treatments carried out in the Randomized Complete block design with three replications. The results showed that the addition of poultry manure as irrigation near the plants roots has led to a significant increase in plant height , number of stems per plant , leaf area , fresh and dry weight of plant which reached (33.77 cm and 3.08 stem and 2686 cm^2 and 190.44 gr. and 38.40 gr.) respectively, superior on adding fertilizer by prose and control treatment . The addition of bread yeast near the plants roots , by two concentration 4 and 8 g L^{-1} led to a significant increase in the number of stems and leaf area and fresh and dry weight of the plant compared with the control treatment. And also it found that organic fertilization as irrigation has led to a significant increase in the number of tubers (7.26) , the average weight of tuber (59.15 g) , plant yield (453.8 g) , total yield (18.152 Ton. H) and marketable yield (14.528 Ton. H^{-1}) compared by adding fertilizer by scattered and control treatment .Also the results showed that the treatment of yeast concentration of 8 g led to a significant increase in the number of tubers (7.09) , the average weight of tuber (55.39 g) , plant yield (439.7 g) , total yield of tubers (17.588 Ton. H^{-1}) and marketable yield (13.728 Ton. H^{-1}) superior on 4 g L^{-1} and control treatment . The interaction between the organic fertilizer and yeast significantly affect most vegetative growth and yield characters and the interaction between organic fertilization by irrigation and yeast by 4 and 8 g

Keyword : Potato , Organic fertilizer , Yeast .

Introduction :

The potato (*Solanum tuberosum* L.) belonged to the Solanaceae family is one of the most important vegetable crops in the world and in terms of human consumption it comes in the fourth ranked after wheat, rice, corn and it is riches with carbohydrates , nutrients and amino acids (Hassan ,2003) . Potato production is affected by many factors, including varieties , weather conditions , planting date , plant nutrition and irrigation. Owing to the great interest in the last years about quality production and safety of food from contamination remains of fertilizers and pesticides appear the question of healthy vegetable production free from using any chemical materials by application of organic agriculture (El- Ghamring , *et*. *al*. 1999) and the use of manure organic fertilizers (local and manufactured) to be alternatives to chemicals fertilizer was applied by several researchers (Al- Zahawy 2007, Abdul- Rasol *et*.*al*.2009 , Al- Qassy 2009 ,Mahmoud and Al- Salmany 2010). It has stated that poultry manure contains a high proportion of elemental nitrogen and phosphorus, while cow manure contains high proportion of potassium (Hermanson,1996). Also Al-Zubi *et*. *al*.2007 have been found an increase in the content of soil total nitrogen from 0.154% to 0.212% and available phosphorus from 15.82 to 44.22 mg kg^{-1} and potassium from 164.5 to 312 mg. kg^{-1} and organic matter from 3.02% to 4.51% in the treatment of adding organic and bio-fertilizer comparing with control treatment , this led to an increase in the total yield of the tubers from 13.75 to 21.88 ton H^{-1}. Adding animal manure (remains of sheep, cows and poultry) at a rate of 20% of the weight of the soil for the potato crop has led to a significant increase in the number of aerobic

stems , total yield , marketable yield of tubers and the percentage of dry matter in the tubers (Al-Sahaf and Atti 2007).

It was also found by Al-Kafagy 2009 that fertilization potato plant with local poultry fertilizer at rate of 5 and 10 ton H^{-1}. resulted in a significant increase in plant height and number of tubers and total yield . Also Al-Qassy 2009 pointed that adding of poultry manure at 16 ton H^{-1} with chemical fertilizer NPK led to a significant increase in fresh and dry weight , leaf area per plant , number of fruits and total yield in watermelon plants . At 2012 Al-Bayaty *et.al*. noticed a significant increase in the number of fruits , total yield , marketable yield of cucumber grown in the greenhouse when using manufacture poultry manure (Italbollina) at a rate 200 $Kg.500m^{2-1}$.

One kind of fertilizers used in organic farming is bio-fertilizers and since yeast is organisms (fungi) it has been used as a fertilizer because it contains many nutrients (Al-Kafagy 1990) , as well as the yeast produces some plant growth regulators such as Auxin and Gibberellin (Sarhan and Sharif 1988) , also it has the ability to produce a group of enzymes that help in converting of mono-saccharids into alcohol and CO_2 which is essential to the process of photosynthesis in plants (Dinha and Khazragy 1900). Bread yeast contains free IAA by 85.04 concentration and associated IAA with a concentration of 112.60 micrograms ml^{-1} at 280 nm wavelength and free GA_3 by 382 concentration and associated GA_3 with a concentration of 417 micrograms ml^{-1} at 254 nm wavelength (Twfig 2010). So dry bread yeast has been used in improving growth and productivity in some vegetable crops(Fathy and farid 1996 ,Fathy et.al.2000 ,Mohammed et.al.1999 ,Omar 2003 , Sarhan 2008). It has been found by Hussein and Kalaf 2008 that spraying potato plants in the autumn by five concentrations of dry bread yeast (0, 2, 4, 6, 8 g. L^{-1}) , there is a significant increase in plant height and number of branches and dry matter in the shoot and the number of tubers per plant and the rate of tuber weight and plant yield. It also found by Sarhan 2008 that spraying potato plants with bread yeast produced a significant increase in some vegetative growth parameters and yield traits . Also Sarhan *et.al*. 2011 noticed a significant increase in plant height , number of fruits per plant , average weight of the fruit , plant yield , early yield and total yield of cucumber when spraying plants with dry bread yeast at 6 $g.L^{-1}$ concentration .

The aim of this study was to use organic fertilizers of animal origin (local poultry manure) and bio-fertilizers (dry bread yeast) to improve growth and productivity of potatoes under the condition of Ninavah city

Materials and Methods

A field experiment was conducted in a vegetable field of the Department of Plant Production in Agricultural Technical College / Mosul , during the spring season 2013 to study the effect of the application of organic fertilizers and dry bread yeast in the growth and yield of potato. The local poultry manure has been used at rate of 40 tons H^{-1} in two methods first by scatting on the soil before sowing and second by irrigated the fertilizer solution near the plants roots system in two times after the germination of tubers and during tubers formation in addition to the control treatment (without fertilizer) , the dry bread yeast (its components illustrated in Table 1 form Tartoura 2001) applied as a solution near the plants roots system at three concentrations (0, 4 and 8 g. L^{-1}.) were added in two times after the germination of tubers and the second at tubers formation , and thus the study included nine treatments subjected in factorial experiment in Randomized Complete Block Design with three replications. Potatoes seeds var. Riviera class E imported from the Netherlands sowing in 22 Feb. on furrows width 75 cm and the distance between tubers 30 cm under the drip irrigation system in loamy soil (Table 2 from Saleh 2013). Tubers were harvested at 4 June for all experimental unite plants and the following measurements were recorded:

A - Vegetative growth measurements : Five plants of each experimental unit were taken one week before harvesting process to record measurements of vegetative growth, namely: -

1. Plant height from the stem connection with the roots to the highest peak of the plant.
2. Number of aerial stems of the plant.
3. Fresh and dry weight of the plant.(gr.)
4. Leaf area of the plant . (cm^2)

B – Yield and qualitative measurements including : -

1- Number of tubers per plant.
2- Average weight of the tuber. (gr.).
3- Plant yield (kg. $plant^{-1}$).
4- Total yield of tubers per unit area. (Ton. H^{-1}) and its calculated by the following equation :

$$\text{Total yield} = \frac{\text{Yield of experiment unit}}{\text{Area of experiment unit}} \times \text{hectare}$$

5- Marketable yield of tubers per unit area (Ton. H^{-1}) and its calculated by the following equation :

$$\text{Marketable yield} = \frac{\text{Marketable yield of experiment unit}}{\text{Area of experiment unit}} \times \text{hectare}$$

6-The percentage of dry matter in the tubers.

7- Percentage of total soluble solids in the tubers were measured by Hand- Refractometer.

8- Tubers hardness was measured by Pressure Tester. (Kg. cm^2).

The results were analyzed statistically according to the SAS system (SAS 1998) and comparison among the average was done by Duncan Mutable Test at 5% level (Al-Rawy and Kalaf 2000).

Table 1 : The continent of dry bread yeast

Nutrient Element	%	Nutrient Element	%
N	1.2	Cu	0.04
P	0.13	B	0.016
K	1.2	Mo	0.0003
Mn	0.013	Total Protein	5.3
Ca	0.02	Carbohydrate	4.7
Na	0.01	Auxin IAA	0.5
Mg	0.07	Gibberellin	0.03
Zn	0.04		

Table 2 : Some physical and chemical properties of soil of the field experiment .

Properties	**Value**
PH	7.3
Organic Matter g. Kg^{-1}.	21
E.C. ds m^{-1}	3.380
Cation Exchange Capacity Meq.100 $g.soil^{-1}$	14.87
available N (ppm)	42
available P (ppm)	0.89
soluble K (ppm)	141
CaCO3 g. Kg^{-1}.	225
Particle Size g. Kg^{-1}.	
Sand	493.5
Clay	161.8
Silt	344.7
Texture Class	Lomey

Results and discussion:

Table (3) exhibited the effect of organic fertilizers and bread yeast on vegetative growth of potatoes plants , it obviously noticed that addition of poultry manure by irrigation near the plants roots has led to a significant increase in plant height , number of stems per plant , leaf area , fresh and dry weight of plant , which reached (33.77 cm , 3.08 stem , 2686 cm2 , 190.44 gr. and 38.40 gr.) respectively, superior over the scattered adding fertilizer method and control treatment . Also the scattering fertilization treatment significantly superior over control treatment in leaf area and dry weight of plant. The same table shows that addition of bread yeast near the plants roots , with concentration of 4 and 8 g. L.-1 led to a significant increase in the number of stems per plant , leaf area , fresh and dry weight of the plant as compared with the control treatment. Thus the table shows a significant effect of the interaction treatments between organic fertilization and yeast in vegetative growth parameters , the highest length of the plant (34.55 cm) produced from the interaction treatment between fertilization by scattered method and yeast at 4 and 8 g. L.-1 conc., and the largest number of stems per plant (3.42) and the largest leaf area of plant (2873 cm2) and fresh weight (204.86 g) and dry weight of the plant (41.36 g) resulted from the interaction treatment between organic fertilizers by irrigation and yeast concentration with 8 g. L -1 which is the greatest over the other treatments.

Table 3: The effect of organic fertilizer and dry bread yeast and there interaction in vegetative growth characters of the potato plant.

Characters / Treatments		Plant height (cm)	Aerial Stems number	Plant Leaf Area (cm^2)	Plant Fresh Weight (gr.)	Plant Dry Weight (gr.)
Organic fertilizer treatments						
Without Fertilizer		24.44 b	2.25 b	2260 c	150.48 c	29.93 c
Scattered Fertilize		28.44 ab	2.47 b	2519 b	168.88 b	34.19 b
Irrigation Fertilizer		33.77 a	3.08 a	2686 a	190.44 a	38.40 a
Bread yeast treatments						
Zero		28.00 a	2.32 b	2325 c	156.22 b	33.56 b
4 g. L^{-1}.		28.22 a	2.70 a	2525 b	174.04 a	34.99 a
8 g. L^{-1}.		30.44 a	2.79 a	2615 a	179.56 a	35.97 a
Interaction treatments between fertilizer and yeast						
Without Fertilizer	Zero	26.33 ab	2.02 f	2180 g	147.33 d	29.44 c
	4g..L^{-1}.	21.66 b	2.51 cde	2280 f	154.52 d	30.83 c
	8g. L^{-1}.	25.33 ab	2.23 def	2320 f	149.61 d	29.53 c
Scattered Fertilizer	Zero	32.66 ab	2.13 ef	2365 ef	152.84 d	31.63 bc
	4g.L^{-1}.	34.55 a	2.56 cd	2540 d	169.28 c	33.92 bc
	8g.L^{-1}.	34.55 a	2.73 bc	2654 c	184.52 b	37.02 ab
Irrigation Fertilizer	Zero	25.00 ab	2.81 bc	2432 e	168.43 c	33.63 bc
	4g. L^{-1}.	28.66 ab	3.03 bc	2754 b	198.34 a	40.23 a
	8g..L^{-1}.	31.66 ab	3.42 a	2873 a	204.86 a	41.36 a

Mean within a column , row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels .

The increase in vegetative growth parameters as a result of adding organic manure (poultry manure) with irrigation near the plants roots might be due to the role of organic fertilizer to improve soil characteristics,(physical, chemical, biological) and increase its ability to retain water (the soil of the experiment field is homey texture and the sand is 493.5 g. Kg^{-1}.) and increased its content of nutrients elements especially nitrogen, phosphorus and potassium (Al-Zubi et.al.2007 and Al-Sahaf and Atti 2007) . Also Ali and Jutheri 2011 stated that addition of organic fertilizer (Organo Fert.) lead to increase phosphorus availability in the soil by 50% comparing with control treatment and this might stimulated dormant buds on the tubers to sprouting and increase the number of aerial stems of plant. The increase in the availability of nutrients in the soil increased the efficiency of elements absorption by the plant roots, which was reflected on raising the efficiency of biological processes especially photosynthesis which will positively reflect on vegetative growth and significantly increased leaf area per plant and therefore increased the fresh and dry weight of the plant. These results are in agreement with what has been found by (Al-Zahawy 2007 , Abdul-Rasol *et. al.* ,Al-Qassy 2009 ,Mahmued and Al-Salmany 2010 ,Al-Sahaf and Atti 2007 , Al-Kafagy 2009 ,and Al-Bayaty *et.al*. 2012) In the other hand the superiority of adding organic fertilizer by irrigation near the plant roots might be due to the availability of nutrient elements in the water solution as compared with the dry fertilizer which need a longer period to dissolved and to be ready for absorption by plant roots

The role of bread yeast in increasing the vegetative growth parameters (number of stems per plant , leaf area , fresh and dry weight of plant) it may be due to the content of yeast to many important nutrients

elements necessary for plant growth (Al-Khafaji 1990 and Tartoura, 2001) in addition to the production of yeast for some growth regulators such as Auxin and Gibberellin and cytokinin (Sahan and Shrife 1988 and Twfig 2010) which will stimulate biological processes in plants and led to an increase in the vegetative growth of the plant. These results are in agreement with what has been found by (Omar 2003 ,Sarhan 2008 , Hussrin and Kalaf 2008 ,and Sarhan *et.al*.2011).

Table (4) revealed that adding organic fertilizers by irrigation near the plant roots has led to a significant increase in the number of tubers (7.26) , average weight of tuber (59.15 gr.) , yield per plant (453.8 gr.) , total tubers yield (18.152 Ton. H^{-1}) and marketable tubers yield (14.528 Ton. H^{-1}.) compared with adding fertilizer by scattered method and control treatment. As in the treatment of yeast, the concentration of 8 g. $L.^{-1}$ gave a significant increase in the number of tubers (7.09) , average weight of tuber (55.39 g) , yield per plant (439.7 gr.) , total tubers yield (17.588 Ton. H^{-1}) and marketable tubers yield (13.728 Ton H^{-1}.) which was superior over the treatment of yeast at concentration of 4 g. $L.^{-1}$ and control treatment . The interaction treatment between the organic fertilization and yeast was significantly affect the yield parameters which increase the number of tubers per plant , average weight of tubers , yield per plant ,total tubers yield , and marketable tubers yield by the interaction treatment between organic fertilizer by irrigation and yeast at concentration 4 and 8 g. $L.^{-1}$.

This increase in yield parameters resulted from organic fertilizer in added by irrigation method may be due back to the above-mentioned role of this fertilizer for improve the properties of the soil (physical and chemical) and the content of nutrients elements , as well as the fertilizer promotes the activity of micro-organisms and increased microbial activity and then increase the activity of microbial enzymes such Nitrogenase ,Urease ,and Dehydragenase (Mohamed *et.al*.1999).Also Atti and Al-Sahaf 2007 mentioned that organic fertilizer(poultry fertilizer by 20%) lead to increase the percentage of mycorrhiza colonies in the roots of potato plants and attributed it to the contain of manure to a number of mycorrhiza spores unspecified type which has contributed to increasing the proportion of infected roots as well as the contain of manure to some fungi such as *Trichoderma* spp.which involved with mycorrhiza in positive interference to stimulate growth. Also Al- Sahaf and Atti 2007 noted that the analyzed of organic fertilizers resulting in some organic and amino acids , and all these play an important role in biological processes in plants and led to increased vegetative growth (Table 3), which was reflected on the characteristics of yield (number of tuber per plant ,yield per plant , total yield and marketable yield) . These results are in agreement with findings of (Al-Zahawy 2007 , Abdul-Rasol *et. al*. ,Al-Qassy 2009 ,Al-Zubi et.al. 2007 ,Mohamed et.al.1999).

Table 4: The effect of organic fertilizer and dry bread yeast and there interaction in qualitative characters of the potato tubers.

Characters / Treatments		Tubers Number Plant^{-1}	Tubers Weight (gr.)	Plant Yield (gr.)	Total Yield (Ton H.$^{-1}$)	Marketable Yield Ton H.$^{-1}$)(
Organic fertilizer treatments						
Without Fertilizer		5.99 c	56.69 a	354.8 c	14.192 c	10.112 c
Scattered Fertilize		6.47 b	55.24 a	397.9 b	15.916 b	12.300 b
Irrigation Fertilizer		7.26 a	59.15 a	453.8 a	18.152 a	14.528 a
Bread yeast treatments						
Zero		6.15 b	59.17 a	361.3 c	14.452 c	10.520 c
4 g. L^{-1}.		6.45 b	56.52 a	405.4 b	16.216 b	12.692 b
8 g. L^{-1}.		7.09 a	55.39 a	439.7 a	17.588 a	13.728 a
Interaction treatments between fertilizer and yeast						
Without Fertilizer	Zero	5.92 c	57.48ab	340.3 e	13.612 c	9.064 f
	4g.L^{-1}.	6.03 c	59.96ab	341.6 e	13.664 c	10.304 ef
	8g.L^{-1}.	6.11 c	52.63ab	382.7 cde	15.308 cde	10.972 de
Scattered Fertilizer	Zero	6.01 c	60.78ab	365.3 de	14.612 de	10.604 de
	4g.L^{-1}.	6.45 bc	52.82ab	405.2 cd	16.208 cd	12.608 bc
	8g.L^{-1}.	6.96 b	52.12 b	432.4 bc	17.296 bc	13.696 b
Irrigation Fertilizer	Zero	6.54 bc	59.25ab	387.5 cde	15.500 cde	11.900 cd
	4g.L^{-1}.	7.03 b	56.79ab	469.6 ab	18.784 ab	15.172 a
	8g.L^{-1}.	8.21 a	61.42 a	504.3 a	20.172 a	16.520 a

Mean within a column , row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels .

The role of bread yeast in improving the growth and increase the number of tubers , yield per plant , total and marketable yield of tubers due to the yeast content of nutrients elements which play an important role in stimulating growth, as well as the production of yeast to the Auxin and Gibberellin (Twfig 2010) and we know the role of Auxin in stimulating division and expansion of cells and activate the functions of cell membranes and the work of enzymes and stimulate the formation of organic acids and proteins in cells (Abdul 1987) as well as the role of Gibberellin stimulating cell division and increase the elasticity of the cell wall which helps in the elongation of the cells (Abdul and Mohamed 1986) which led to activate the vegetative growth, which is reflected in the increase of yield parameters .

Table (5) shows that there is a significant increase in the percentage of dry matter of tubers as a result of organic fertilizer adding by irrigation method (17.38%) compared with adding organic fertilizers by scattered method and control treatment (without fertilization) . While there is non significant effect of organic fertilizer treatments in the total soluble solids and tubers hardness . We also find that bread yeast treatments led to a significant increase in the percentage of dry matter of tubers where the treatment 8 g. L^{-1}. gave (17.75%) and the treatment 4 g. L^{-1} (16.81%) and the control treatment (16.35%). In the other hand , non significant effect was observed for yeast in the total soluble solids and tuber hardness . The interaction between the organic fertilization and yeast was significantly affected the percentage of dry matter in the tubers and the highest percentage (18.43%) was recorded from the interaction treatment between the organic fertilization by irrigation and yeast at concentration of 8 g. L^{-1}. which was superior over the all other treatments where as the lowest percentage (16.02%) resulted from control treatment . There was no significant effect for interaction treatments on total soluble solids and tubers hardness .

Table 4: The effect of organic fertilizer and dry bread yeast and there interaction in yield characters of the potato plant.

Characters / Treatments		% Tuber Dry Weight	Total Soluble Solids (TSS)	Tuber Hardness (Kg. $cm^{2\ -1}$)
Organic fertilizer treatments				
Without Fertilizer		16.35 c	5.27 a	10.94 a
Scattered Fertilizer		16.95 b	5.38 a	11.16 a
Irrigation Fertilizer		17.38 a	5.44 a	11.16 a
Bread yeast treatment				
Zero		16.35 c	5.50 a	10.72 a
4 g. $L.^{-1}$		16.81 b	5.27 a	11.23 a
8 g. L^{-1}.		17.57 a	5.53 a	11.21 a
Interaction treatments between fertilizer and yeast				
Without Fertilizer	Zero	16.02 e	5.16 a	10.01 a
	4g.L^{-1}.	16.22 de	5.16 a	11.55 a
	8g.L^{-1}.	16.83 bcd	5.50 a	11.26 a
Scattered Fertilizer	Zero	16.52 cde	5.33 a	11.60 a
	4g.L^{-1}.	17.01 bc	5.33 a	10.56 a
	8g.L^{-1}.	17.32 a	5.50 a	11.00 a
Irrigation Fertilizer	Zero	16.51 cde	5.50 a	10.56 a
	4g.L^{-1}.	17.21 b	5.33 a	11.60 a
	8g.L^{-1}.	18.43 a	5.50 a	11.33 a

Mean within a column ,row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels .

The increase in the percentage of dry matter in the tubers as a result of adding organic fertilizer and yeast is might be due to the content of fertilizer and yeast of nutrients and plant growth regulators and their

role in stimulating growth and raising the efficiency of photosynthesis which will reflected in addition production of carbohydrate assembling at the storage places in tubers. .

From this study we concluded that the use of organic fertilizers (which is available locally) as well as bio-fertilizers(bread yeast) will increase the productivity and quality traits of the potato crop .

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