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EFFECT OF SOURCE AND SYNTHESIS OF ORGANIC FERTILIZER ON GROWTH AND TOTAL YIELD OF POTATOES (*SOLANUM TUBEROSUM* L.)

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Abstract

An experiment was conducted in fall season 2017-2018 in one of the fields college of Agricultural sciences engineering–university of Baghdad–Jadiriyah campus, to know the effect of organic fertilizers (plant residues) and its combination on growth and yield of potato "sphere classes" in sandy clay loam texture, the experiment was designed under seven treatment: M_0 (control), M_1 50 % of fertilization recommendation (120 Kg N + 60 Kg P + 200 Kg K) ha^{-1} and O_2O_3 (15 ton of corn stalks residues + 15 ton of Nile flower) ha^{-1}, O_1O_2 (15 ton sugar cane residues + 15 ton of corn stalks), O_1O_3 (15 ton sugar cane residues+15 ton Nile flower residues) ha^{-1}, $O_1O_2O_3$ (10 ton sugar cane residues +10 ton of corn stalks residues + 10 ton Nile flower residues) ha^{-1} and M_2 (240 Kg N + 120 Kg P + 400 Kg K) ha^{-1}, At maturity the plants heights were measured, main branches were calculated, tuber were harvested and plant yield was determined, one tubers average weight and total yield was measured, results was statistically analyzed, where M_2 was exceeded by giving the highest values of 84 cm, 2.55 stem $plant^{-1}$, 1.11 Kg $plant^{-1}$, 0.11 kg $tuber^{-1}$, 57.03 ton. ha^{-1} of plants heights, main branches number of plant, yield of one plant and total yield of tubers, that were not significantly differ from the $O_1O_2O_3$ organic fertilizers combination treatment gave, where it 76.9 cm, 2.33 stem $plant^{-1}$, 0.95 Kg $plant^{-1}$, 0.11 Kg $tuber^{-1}$ and 53.83 ton ha^{-1}.

Key words: Organic fertilizers, Sugar cans, Corn stalks, Nile flower, Potato

Introduction

Potato (*Solanum tuberosum* L.) is the third (after wheat and rice) most consumed food crop in the world (Visser *et al*., 2009, Champouret, 2010, Verzaux, 2010). Potato is the world's most important tuber crop worldwide, It is grown in more than 125 countries (FAO, 2009) of the world with a total production of 308 million tons (Kumar *et al*., 2010) Potato contains 0.1% fat, 0.8 – 3% protein, 1.1% mineral, 11-23% carbohydrate, 17-29% dry matter and 70-82% water, potato is rich source of vitamin, vitamin b and c, it also contains large amount of essential amino acids like tryptophan, isoleucine and leucine (khurana PSM and Naik PS, 2003), The `quantity produced yearly exceeds 300 million metric tons and more than a billion people worldwide consume potato which rich in carbohydrates, protein, vitamins, dietary fibers, simple sugars and minerals (FAO, 2008, CIP, 2010). Application of fertilizers have important effects on the quality and total yield of potatoes (Leytem and Westermann, 2005), The yield and growth of potato depends on the soil and soil can be improved throughout the use of different fertilizer, Approximately 4% organic matter is essential of any agricultural soil while soil 60% cultivated land contains organic matter blow 1% (Ferdoushi *et al*, 2010). Application of fertilizer is one of the most effective means to increase nutrient uptake in crop plants and improve yields of plants (Kumar, 2012), Organic maturing is an agro technological factor which beneficially affects the chemical composition of potato tubers including their content of micronutrients and macronutrients (Redulla *et al.*, 2005; Wszelak *et al.*, 2005; Griffiths *et al.*, 2012).

The use of organic fertilizer helps in mitigating multiple nutrient deficiencies at the same time it provides better environment for growth and development of plants by improving chemical, physical and biological properties of soil (Avitoli *et al*., 2012), Integrated nutrient management by involving the combination of organic manure and fertilizers is an essential tool for balanced fertilization and sustainability of plants production on long term basis. The objective of this research is to determine the effect of the organic fertilizer mixture on the total yield of potatoes and some indicators of vegetative growth.

Materials and Methods

In fall season 2017-2018 an experiment was conducted in one of the fields of college of Agricultural engineering university of Baghdad in a sandy clay loam soil classified to Typic Torrifluvent due to USDA soil classification (Soil survey staff, 2006). Soil was perpendicularly plowed, grinded and leveled, than soil samples were collected (0-0.3) m, air dried and passed through 2 mm opening sieve, some physical and chemical properties before planting (table 1). Field was divided to three blocks, each one included seven experiment units with three furrows each one (of 2.5 m furrow length and 0.75 m width) with 2 m in between distances. Experiment was laid out in Randomized Complete Block Design (RCBD) with three replications, experiment was conducted with seven treatments: (M_0) control of no fertilizers application, (M_1) 50 % application of fertilization recommendation (120 kg N, 60 kg P, 200 Kg K) ha^{-1} and O_2O_3 (15 ton ha^{-1} organic fertilizers – corn stalks) + (15 ton ha^{-1} organic fertilizers – Nile grass) and O_1O_2 (15 ton ha^{-1} organic fertilizers – sugar cane residues) + 15 ton ha^{-1} organic fertilizers – corn stalks) and O_1O_3 (15 ton ha^{-1} organic fertilizers – Sagar cane residues + 15 ton ha^{-1} organic fertilizers – Nile grass) and $O_1O_2O_3$ (10 ton ha^{-1} organic fertilizers – Sager cane residues +10 ton ha^{-1} organic fertilizers–corn stalks+10 ton ha^{-1} organic fertilizers–Nile grass), M_2 application of 100% of fertilization recommendation (240 kg N, 120 kg P, 400 kg K) ha^{-1} (mineral fertilization recommendation was due to AL-Fadhly, 2006, organic fertilization was due to AL-Juboori, 2015), table 2 shows characteristics of organic fertilizers. Ten days before planting, organic fertilizers and phosphate were applied to each ridge before burred tuber in top of ridges with 30 cm depth 20 cm width and mixed with soil and covered with its.

Table 1: Some physical and chemical properties of soil of field experiment

Property		Value	Unit	Ref
pH		7.15	-	Richards, 1954
EC		2.13	dSm^{-1}	=
SOM		6.03	g. kg^{-1} soil	Page *et al*, 1982
Gypsum		0.81	g. kg^{-1} soil	Richards, 1954
CEC		21.5	C mol^{+} kg^{-1} soil	FAO, 2007
Soluble ion	Ca^{+2}	13.11	C mol^{+} kg^{-1} soil	Page *et al*, 1982
	Mg^{+2}	6.11		
	Na^{+1}	1.88		
	K^{+1}	2.94		
	So_4^{-2}	6.50		
	Hco_3	1.60		
	Co_3^{-2}	Nill		
Available Nutrients	N	35.00	mg. Kg^{-1} soil	
	P	6.71		
	K	53.30		
Bulk density		1.40	g. cm^{-3}	Black,1965
Particle Size	Clay	363	g. kg^{-1} soil	
	Silt	100		
	Sand	532		
Texture		Sandy clay Loam		

Table 2: Chemical analyses of organic manures used

Unit	Corn stalks	Sugar cane	Nill flower	Parameter
-	7.80	7.20	7.00	pH
ds m-1	5.37	10.00	8.35	EC (1:5)
-	17.14	14.30	17.00	C/N ratio
gm kg-1	240.00	247.00	255.00	Organic C
=	14.00	17.20	15.00	Organic N
	5.20	8.40	4.10	Total P
	4.50	9.40	16.30	Total K

On 23 September 2017, potatoes seeds were planted (severe class) on the tip of furrow at 0.25 m in between distance and 0.10 m depth. All experimental unite s were irrigated with quantity of water. Urea 46% N was used as source of nitrogen + superphosphate 20 % P as source of phosphorus and potassium sulphate 41.5% K as source of potassium, nitrogen and potassium fertilizer were applied in two ever doses due to the specific quantity of each treatment and furrow on 10 November 2017 and the second one on 30 November, 2017 by making a slot 0.1 m down to planting furrow and 0.05 m depth, irrigate after fertilization, on 25 January 2018 after plants reached inoculation time, plants heights were measured, number of branches (random five plants samples with medium ridge were depended), than mean of each treatment was calculated. Vegetative parts were cut from the area tangents to soil surface, January 26, 2018, potato tuber were dinged out using hand machinery and mean total yield of one plant was calculated, mean weight of one tuber, total yield of potato tuber were also calculated. Yield measurer of potato tubers were measured for five randomly chosen tubers from the middle furrow of an experimental unit and then transferred to hater as:

Experiment unit yield = plant yield * plant counts of experimental unit

Total yield = (yield of experimental unit* 10000) / area of experimental unit

After getting result, they were statistical processed using ANOVA in factorial distribution under RCBD to calculates least significant (LSD) difference at p 0.05 using SAS lab (2001).

Results and Discussion

Effect of combination of organic fertilizers and level of mineral fertilizers on:

(1) Some vegetative growth indicators of potatoes:

Plant height and number of plant branches:

Results shown in table 3 confirm that there were no significant differences among treatments in plant counts of potato, but there was as a significant difference among treatments in plant heights where M_2 treatment (total mineral recommendation) was superior to other treatments by giving the highest plant heights 840.00 cm an increases of 22.15 % as compared to least average of height of plants in M_0 (control treatment) that gave 68.77 cm while difference were none significant in plant heights in M_2 and O_1O_2 O_3 that reached up to 76.90 cm and differences were not significant among M_1, O_2 O_3, O_1 O_2, O_1 O_3 as well.

(2) Some yield indicators of potatoes:

(A) Yield of one plant

Results in table. 4 showed the significant superiority of yield per plant in M_2 treatment at 1.11 kg $plant^{-1}$ and an increase rat of 76.19% as compared to M_o treatment (0.63 kg $plant^{-1}$), no significant difference in yield per plant in M_2 and $O_1O_2O_3$ treatment that gave 1.07 kg $plant^{-1}$ that exceeded at 22.99 % at 22.99 % and 30.49 % for both mineral fertilization treatment O_1O_2 and O_2 O_3 that gave 0.87 and

0.82 kg plant^{-1} yield per plant respectively, $O_1O_2O_3$ treatment was significant superior in yield per plant when compared to M_1 treatment at 0.76 kg plant^{-1} and increase rate of 40.79%.

(B) Average weight of one tuber

The results in the same table showed no significant differences between all the treatments in the average weight of the tuber.

(C) Total yield of tubers

Table 4 shows the significant effect of fertilization treatments (organic and mineral) in total yield of potato, M_2 treatment (the whole fertilization recommendation) has exceeded the other treatments by giving total yield 57.03 ton ha^{-1} at an increase rate of 65.53% as compared to least total yield of control treatment (M_0) that gave 34.45 ton ha^{-1}, Where difference was non significant in M_2 treatment and $O_1O_2O_3$ that reached 53.83 ton ha^{-1} at 40.70% increase rate in the total yield of tubers of M_2 treatment as compared to M_1 treatment that gave 40.24 ton ha^{-1}, treatments $O_1O_2O_3$, O_1O_3, O_1O_2 have given total yield of tubers at 53.83, 50.38 and 47.91 ton ha^{-1} in a significant increase of the M_1 treatment (40.24) ton ha^{-1} at 33.74, 25.18 and 19.04 % rats respectively, also Differences were none significant in total yield of O_2O_3 (43.77) ton ha^{-1} as compared to total yield of M_1 treatment.

Results in tables 3, 4 show the effect of fertilization treatments (organic, mineral) parameters of this study as compared to control, M_2 of total fertilized in recommendation was superior in giving the highest in most treatment which they did not differ significantly of parameters that were given by $O_1O_2O_3$ fertilization, combination O_1O_3, O_1O_2, O_2O_3 were significantly superior in most measured parameters when compared to control treatment M_0.

The superiority that total fertilization recommendation has revealed (240 Kg N, 120 kg p, 400 kg K) ha^{-1} is related to the available nutrient quantity of N, P, K in soil solution and ready for uptake by root group and providing plants with needs, once these nutrients been uptake by plant the participate in bio processes of plant which positively affected this study parameters shown in table 3,4. That was parallel to finding of (Al-Fadly, 2011, Al-Kadimi, 2017, Yoda, 2018).

Organic fertilization combination have affected study parameters (table 3,4) this highest superiority was in $O_1O_2O_3$ followed by O_1O_3, then O_1O_2 and O_2O_3, where all of them have exceeded the half fertilization recommendation M_1 and that is related to the role of organic fertilizers' in providing plants with the available nutrients to be uptake by plant roots, in addition to the role of organic fertilizers in improvement the physical, chemical and biological properties that reflected in a way positively. the activity of plant and eventually an increase in studied parameters that was corresponded to (Al-Fadlly, 2011; Al- Kadimy, 2017; Yoda, 2018) where the addition of organic fertilizers to potato plants has a positive effect on most of parameters of plant growth and total yield where it gave semi results of total mineral fertilization recommendation.

Conclusion of this study are that the addition of 30 ton ha^{-1} organic fertilization (1/3 reeds + 1/3 Nile flower + 1/3 stalks) have given closer results to the total mineral fertilization treatment (240 Kg N, 120 kg p, 400 kg K) ha^{-1} with not differ significantly between these treatments.

Table 3: Effect of organic fertilizer source and combination in some vegetative growth indicators of potatoes

Treatment	Main branches number of plant Branches plant^{-1}	Plant height cm
M_0	1.99	68.77
M_1	2.10	71.55
O_2O_3	1.84	74.33
O_1O_2	2.22	74.55
O_1O_3	2.22	75.22
$O_1O_2O_3$	2.33	76.90
M_2	2.55	84.00
L.S.D (0.05)	0.73	8.62

Table 4 : Effect of organic fertilizer source and combination in some indices of potato yields

Treatment	Average yield of one plant Kg plant^{-1}	Average tuber weight Kg tuber^{-1}	Total yield of tuber Ton ha^{-1}
M_0	0.650	0.10	34.45
M_1	0.76	0.10	40.25
O_2O_3	0.82	0.10	43.73
O_1O_2	0.87	0.10	47.91
O_1O_3	0.95	0.11	50.38
$O_1O_2O_3$	1.07	0.11	53.83
M_2	1.11	0.11	57.03
L.S.D (0.05)	0.14	0.03	6.59

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