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EFFECT OF POTASSIUM HUMATE AND PHOSPHORUS FERTILIZATION ON FABA BEAN PLANTS OF YIELD AND ITS CONTENT OF NUTRIENTS

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ABSTRACT: A field experiment was carried out in the in winter season of 2015/2016 at sandy soil in El-Sadat city, El Minufia Governorate, 30.3594° N, 30.5327° E, Egypt to evaluate the effect of phosphorus fertilization and potassium humate on the growth and yields of faba bean as well as its content of N, P and K. The experiment factors were phosphorus application at three different levels (0, 10, 15 and 30 P_2O_5 kg kg Fed^{-1}) and potassium humate at rate of 0, 5 and 10 kg fed^{-1}. Also, the phosphorus use efficiency evaluated. The obtained results could be summarized as follows: Growth and yield parameters (plant height, No. of branches, No. of pods plant No. of seed pods) were significantly increased by increasing by increasing rates of added P potassium humate individually and in combination, where the highest values were resulted from their combined treatments especially at high application rates. The combination between phosphorus at 30 kg P_2O_5 $fed^{-1}$and potassium humate at rate of 10 kg fed^{-1} recorded the highest growth and production as well as minerals composition (N, P and K) content compared to the other treatments. On the other hand, potassium humate at high level combined with super phosphate recorded increased in the availability of nitrogen, phosphors and potassium. Concerning, the P-efficiency the results showed that, both agronomic efficiency and apparent recovery efficiency were recorded by the highest values when compared the P fertilizer alone.

Key words: Phosphorus, Potassium humate, Faba bean plant, Growth parameters and Nutrients content.

INTRODUCTION

Reduction of soil fertility is a major limitation for crop production in Egypt. Strategies for increasing agricultural productivity focused on efficient utilization of available nutrient and effectively on sustainable basis for maintaining soil quality. A suitable combination of organic and inorganic sources of nutrients is necessary for sustainable crop yields. the integration of inorganic fertilizers with organic fertilizers such as, organic manures and crop residues has become imperative for sustained crop production and maintenance of soil health Sarwar, et al. (2008). Phosphorus (P) is an essential element for crops with greatly decreased uptake from fixation with mineral ions such as aluminum, iron, calcium and magnesium Feng et al., (2004). Plants can only absorb P as H2PO4-1 or HPO4-2, which are mostly present in very low concentrations in the soil Bhattacharyya and Jha, (2012). P plays a structural role in the nucleus and cell membrane Raghothama and Karthikeyan, (2005). A large percentage of P from chemical phosphate fertilizers is not available to plants because at least 70–90% of P that enters the soil is fixed by Fe, Al, and Ca in soils McBeath et al., (2006). Humic acid

is a commercial product containing many elements which improve the soil fertility and increase the availability of nutrients and consequently increase plant growth and yield. It particularly is used to ameliorate or reduce the negative effect of salt stress. Abdelal et al. (2005) and Erik et al. (2000), on onion plant and Hafez (2003), on squash reported that humic acid applications led to a significant increase in soil organic matter which in turn improves plant growth and crop production. Magdi et al. (2011), with study effects of bio and mineral fertilizers and humic substances on growth and yield of cowpea have reported that, combination of chemical fertilizer with application of humic substances improve growth and yield of cowpea. HA is a suspension, based on potassium-humates, which can be applied successfully in many areas of plant production as a plant growth stimulant or soil conditioner for enhancing natural resistance against plant diseases and pests, stimulation plant growth through increased cell division, as well as optimized uptake of nutrients and water, moreover, HA stimulated the soil microorganisms Chen et al., (2004). Faba bean (*Vicia faba L.*) is one of the most important leguminous crops grown during winter season in Egypt for local consumption and exportation. The pods of faba bean contain a great amount of protein and carbohydrates. So that faba bean is considered as one of the most important sources in human nutrition. Faba bean was main providing food and feed that is rich in protein, supplying N to agro ecosystems by symbiotic N2 fixation with Rhizobium bacteria to increase soil fertility, diversifying the crop system to reduce constraints on growth and yield by the other crops in the rotation and reducing fossil energy consumption for crop production. The faba bean is also grown for green manure and can significantly increase the yields of cereal and other crops.

MATERIALS AND METHODS

This study was conducted in El-Sadat city, El Minufia Governorate, 30.3594° N, 30.5327° E, Egypt during the winter growing seasons of 2015/2016, to evaluate the effect of individually and combined application of phosphorus and potassium humate at different levels on yield, yield components and chemical contents of (Vicia faba) Faba bean seeds (cv. Miser 1). The chemical and physical properties of the surface layer (0-30) of experimental soil are determined and the found data presented in Table (1). The studied trial was laid out in a randomized complete block design arranged with split plot arrangement in three replicates.

Table (1). Physical and chemical properties of the experimental soil.

Some chemical properties of soil										
Depth (cm)	EC dSm^{-1}	PH (1:2.5)	Soluble cations (meq/L)				Soluble Anions (meq/L)			
			K^+	Na^+	Mg^{++}	Ca^{++}	CO_3	HCO_3^-	CL^-	SO_4^{--}
0-30	0.34	8.10	0.18	1.64	0.70	0.84	---	0.40	1.49	1.47

Some physical properties of soil									
Sand (%)	Silt (%)	Clay (%)	Texture	F.C. (%)	W.P. (%)	A.W. (%)	Available nutrients (mg/Kg Soil)		
							N	P	K
90.1	5.36	4.54	Sand	13.26	6.24	8.02	22.65	5.31	91.67

FC.-field capacity WP.-wilting point AV.- available water

The area of each plot was 3m x 3.5m phosphorus treatments are arranged in main plots and potassium humate was arranged within sub plots. Phosphorus was applied at rates of 0, 10, 15 and 30 kg P fed^{-1} as calcium superphosphate (15% P_2O_5) preparing soil. Also potassium humate was applied at rates of 0, 5 and 10 potassium humate kg fed^{-1} at papering soil, as well as with soil preparing nitrogen fertilizer in the form of ammonium nitrate (33.5%N) at a rate of 20 kg N $fed^{-1}$was added in starter dose. Potassium fertilizer in the form of potassium sulphate (48% K_2O) at a rate of 24 kg K_2O fed^{-1} was applied in one dose after 15 days of sowing. Before planting the seeds of Faba bean were inoculated by specific Rhizobium strain. Gum Arabic (16%) was added as an adhesive agent prior to inoculation. The inoculated seeds were planted on the two ridge sides with hills separated 20 cm on 25 November. At harvest, ten guarded plants were taken randomly from central plot estimate: plant height (cm), number of branches and pods/plant, weight of 100-seed (g), seed yield plant (g), seed and straw yields fed (ton), and straw and seed yields. Seed samples were taken from each experimental plot weighted and oven dried at 70^0C until constant; weights and ground for determine its content, of N, P and K as described by Sherif M. I. and M.A. and Ali (2018). Also, after harvest soil samples of each plot to determine its content of available N, P and K, which was taken were determined as described by Black (1965) and Jackson (1967). Phosphorus recovery and phosphorus use efficiency by faba bean crop were conducted using the formulae: Agronomic efficiency (kg kg^{-1}) It is defined as the economic production obtained per unit of phosphorus applied and was calculated as: AE (kg kg^{-1})-Gf (kg)−Gu(kg) Pa(kg) where AE stands for agronomic efficiency, Gf and Gu for grain yield in fertilized and unfertilized plots, respectively, and Pa for quantity of fertilizer applied. Apparent fertilizer P recovery efficiency (%) It indicates the quantity of nutrient uptake per unit of nutrient applied and was calculated as: the equation of ARE (%)= Pf−Pu /Pa × 100 where Pf is the total P uptake of the fertilized plot (kg), Pu is the total P uptake of unfertilized plot (kg) and Pa is the quantity of P applied (kg). Agro-physiological efficiency (APE) (kg kg^{-1}) was determined as Gf (kg) -Gu(kg) - Pf (kg) -Pu (kg) where Gf and Gu stand for grain yield in fertilized and unfertilized plots, respectively, Pf is the total P uptake of the fertilized plot (kg) and Pu is the total P uptake of unfertilized plot (kg). The analysis of variance was carried out according to Gomez and Gomez (1984) using MSTAT computer software, after testing the homogeneity of the error according to Bartlett's test. Means of the different treatments were compared using the least significant difference (LSD) test at $P<0.05$.

RESULTS AND DISCUSSION

Growth parameters:

Data in Table (2) estimated the growth parameters i.e. plant height, number of branches/plant, number of pods /plant and number of seeds /pod of faba bean plants are remarkable increased as affected as a result of potassium humate applications at different levels of phosphorus fertilization. The applied of P fertilizer significantly increased of estimated growth parameters and recorded the maximum values of plant height (62.40 cm), No. branches (2.84), No. pods plant (14.70), No. seeds pods (3.16) with P fertilizer treatment especially application rates of 30 kg P fed^{-1}., whiles, the minimum of corresponding values were recorded at rate of 10 kg P fed^{-1}. This result was similar those found, Peshawar et al. (2011) who reported that P is important

for plant growth and promotes root development, tilling, and early flowering and performs other functions like metabolic activities, particularly in synthesis of protein. However, the application of potassium humate, the highest values of plant growth parameters, i.e., plant height (cm) No. Branches, No. Pods plant, no. Seeds Pods of plants under potassium humate treatments were (60.35, 2.92, 15.32 and 2.67), respectively at rate of 10 kg fed of Potassium humate. Concerning the interaction between P fertilizer and potassium humate the data revealed that, the maximum growth parameters under interaction between P fertilizer and potassium humate (86.05, 5.87, 21.68 and 4.21 were obtained by P application at rate of 30 kg fed and potassium humate at rate of 10 kg fed^{-1}.

Table (2). Effect of phosphorus and potassium humate application on Plant height

Phosphorus levels kg fed^{-1}	Potassium humate levels kg fed^{-1}			
	0	5	10	
	Plant height (cm)			Mean
0	48.84	57.50	60.35	55.56
10	54.06	70.60	75.38	66.68
15	57.70	73.12	79.38	70.06
30	62.40	78.36	86.05	75.60
Mean	58.05	73.99	80.27	70.77
LSD 0.05	(H,P) = 0.4952	H = 0.327		P =0.286
	No. of Branches			
0	1.92	2.25	2.92	2.36
10	2.54	3.56	4.51	3.53
15	2.80	4.62	5.36	4.26
30	2.84	4.68	5.87	4.46
Mean	2.72	4.31	5.24	4.09
LSD 0.05	(H,P) = 0.04298	H = 0.0322		P =0.0248
	No. of Pods/plant			
0	12.44	13.41	15.32	13.72
10	14.11	14.62	17.36	15.36
15	14.3	16.32	19.45	16.69
30	14.7	17.32	21.68	17.83
Mean	14.40	16.08	19.49	16.32
LSD 0.05	(H,P) = 0.1366	H = 0.1529		P = 0.0789
	No. of Seeds/Pods			
0	2.31	2.54	2.67	2.51
10	2.68	2.83	2.92	2.81
15	3.14	3.24	3.97	3.45
30	3.16	3.87	4.21	3.74
Mean	2.99	3.31	3.70	3.33
LSD 0.05	(H,P) = 0.01179	H = 0.0131		P = 0.0069

It could be concluded that, the increasing plant growth characters by increasing levels of potassium humate, of faba bean plant due to an increase of the nutritional elements in rooting zone, and also due to increased availability of nutrients especially N, P, K, Zn, Fe and Mn even from the early stage of crop growth. Consequently the more nutrients were absorbed so more and enhancement of plant growth characters. Also, it was reported that, the application of humic acid increased the synthesis and activity of IAA, which played a significant role in promoting the plant growth and application of potassium humate like organic fertilizers which mobilized, solubilized, fixed and retained P in the soil. El-Bassiony et al. (2010) stated that germination growth of green bean such as leaf, branch, plant wet and dry weight, height, pods' green yield and their quality such as length and weight of pod, and content of green leaf chlorophyll of green bean was increased due to the application of humic acid. Mohammadipour et al. (2012) showed that, the application of humic acid improved the plant growth parameters. Dileep Kumar et al. (2013) there is no better way to enhance the economics of farming, than to build soil humus and enhance the natural processes, such as microbial activity, which can be sustained over a long period of life. Potassium humates derived from lignite brown coal are alkaline, rich in carboxylic and phenolic groups, aromatic in nature and provide favorable conditions for biological activity, chemical reactions and physical improvement of soil. Accumulation level of natural humic acids like potassium humate has shown to reduce the need for commercial fertilizers because it improves fertilizer efficiency. Sahar S. Taha and Ashraf Sh. Osman (2018) The obtained results indicated that addition of KH increased all of the studied growth parameters, i.e. plant height, number of leaves, leaf area, stem diameter and canopy dry weight. Moreover addition of KH significantly increased membrane permeability measurements. KH significantly increased chemical composition related to salt tolerant either inorganic e.g. N, P, K, and decreased Na and Cl contents of leaves or organic components e.g. chlorophyll a b, carotenoids, anthocyanin total phenolics, total flavonoids and proline. DPPH radical-scavenging activity and yield and its components were increased. Patil et al. (2011) reported that yield characters of soya bean plants were significantly affected by application of potassium humate. Dileep et al. (2014) found that addition of 10 mg kg potassium humate along with 100% NPK fertilizers caused significant increase in plant growth parameters of rice plant i.e., height number of tillers, panicle height, panicle length, test weight, straw yield and yield of rice as compared to 100 and 75% NPK alone.

Straw, seeds, biological yields and harvest index of faba bean crop:

Data in Table (3) Showed that the effect of potassium humate and P applications on straw yield, seed yield, biological yield and harvest index were increasing significantly. Concerning, the P application, the highest values of straw yield, seed yield, biological yield and harvest index were with P application at rate of 3344.75 kg fed^{-1}., 1097.75kg fed^{-1}., 4442.50 kg fed^{-1}. And 24.71%, respectively with P application at rate of use 30 kg P fed^{-1}. On the other hand the lowest values of straw yield, seed yield, biological yield and harvest index were 2053.00 kg fed^{-1} (429.85 kg fed^{-1}., 2482.85 kg fed^{-1}., and 17.31 %) which recorded from the control treatment. The increases in straw yield, seed yield biological yield and harvest index due to P application may be attributable to the fact that P is known to help in the development of more extensive root system and nodulation, and thus enables plants to

absorb more water and nutrients from depth of the soil. This in turn could enhance the plant's ability to produce more assimilates which were reflected in the high dry weight. Similar results have been reported by El- Habbasha et al. (2005). El- Gizawy and Mehasen (2009) found that adding (30 kg P_2O_5 fed^{-1}) mixed with phosphate dissolving bacteria markedly increased plant height, number of branches and pods plant, 100-seed weight (seed index), seed yield plant^{-1} and seed and straw yield fed^{-1}. In the case of potassium humate applied at different levels, the maximum amount of straw yield, seed yield, biological yield and harvest index were (3605.52 kg fed^{-1}, 1028.86 kg fed^{-1}., 4634.80 kg fed^{-1}. and 22.19%), respectively which obtained at rate of (10 kg fed^{-1}) of potassium humate. The interaction effect of P fertilizer and potassium humate on the above-mentioned parameters recorded in Table (3) showed that, the application of potassium humate at (10 kg fed^{-1}). with 30 kg P recorded the highest values of straw yield, seed yield, biological yield and harvest index (4947.85 kg fed^{-1}., 2982.40 kg fed^{-1}., 7930.25 kg fed^{-1}., and 37.60%), respectively. This performance in the plant growth most probably was due to enhance in moisture retention and the improvement of nutrients supply in the root zone Yusuff, et al. (2009).

Table (3). Effect of phosphorus fertilizer and potassium humate on straw, Seeds, biological yields and harvest index of faba bean crop

Phosphorus levels kg fed^{-1}	Potassium humate levels kg fed^{-1}			
	0	5	10	Mean
	Straw yield kg fed^{-1}.			
0	2053.00	2403	3605.52	2687.17
10	2626.35	2892	4048.91	3189.08
15	3038.51	3190	4466.32	3564.94
30	3344.75	3806	4947.85	4032.86
Mean	3687.53	3072.75	4267.15	3368.51
LSD 0.05	(H,P) = 0.9041	H = 0.9816		P = 0.5220
	Seed yield kg fed^{-1}.			
0	429.85	643.51	1028.86	700.74
10	575.90	921.40	1474.24	990.51
15	765.51	1148.26	1837.16	1250.31
30	1097.75	1864.92	2982.40	1981.69
Mean	7172.25	1144.52	1830.66	3382.47
LSD 0.05	(H,P) = 1.371e-12	H = 9.0578e-13		P =ns
	Biological yield (kg fed^{-1}.)			
0	2482.85	3046.51	4634.80	3388.05
10	3202.25	3813.40	5523.15	4179.60
15	3804.02	4338.26	6303.48	4815.23
30	4442.50	5670.92	7930.25	6014.55
Mean	3482.90	4217.27	6097.92	4599.36
LSD 0.05	(H,P) = 1.3370	H = 0.8834		P = 0.7371
	Harvest index (%)			
0	17.31	21.12	22.19	20.20
10	17.98	24.62	26.69	23.09
15	20.12	26.46	29.91	25.49
30	24.71	32.88	37.60	31.73
Mean	20.03	26.27	29.09	25.13
LSD 0.05	(H,P) = 7.4636e-15	H = 4.932e-15		P = 2.257e-7

Results presented in Table (4) showed that all P levels significant increased the content of N, P and K as compared with control. The highest values of N, P and K contents in Faba bean seeds were obtained as a result (30 Kg P_2O_5 fed^{-1}), application compared with the other levels. For the interaction treatments between using the different P fertilizer and potassium humate levels on the macronutrients content and uptake of faba bean seeds are shown in Table (4). The also data shows that, in spite of the no significant response of the percentage of N, P and K but as a general, the addition of high level of P fertilizer (30 kg P fed^{-1}.) Combined with the high level of potassium humate (10 kg fed^{-1}.) caused the highest percentage of N, P and K contents as well as uptake in the faba bean seeds.

Effect of phosphorus fertilizer and potassium humate on the soil contains of available N, P and K:

From the data summarized in (Fig. 1) may be that with the application of potassium humate especially as application rates of (5 and 10 kg $fed.^{-1}$), there was an increase the available nitrogen, phosphorus and potassium in soil as compared to control (without application potassium humate). Corina et al. (2006) conclude that P-fertilization increased growth more than N-fertilization in the three soils used, in the three soils, the extraction of N from the soil increased substantially in P fertilized plants, which accumulated more N even than plants fertilized with N.

Table (4): Effect of phosphorus fertilizer and potassium humate on N, P and K content and uptake (kg $fed.^{-1}$) by seeds of faba bean crop.

Phosphorus levels kg fed^{-1}	Potassium humate levels kg fed^{-1}								
	0			5			10		
	Macronutrients content in seeds of faba bean (%)								
	N	P	K	N	P	K	N	P	K
0	1.53	0.13	0.87	2.22	0.20	1.31	2.42	0.31	1.41
10	3.02	0.19	1.02	3.53	0.24	1.36	3.64	0.34	1.46
15	3.25	0.24	1.12	3.53	0.30	1.43	3.72	0.36	1.52
30	3.38	0.26	1.13	3.69	0.32	1.46	3.81	0.42	1.58
Mean	2.795	0.205	1.035	3.2425	0.265	1.39	3.3975	0.575	1.4925
LSD 0.05	N H =0.3223 * P H=0.0033 * K H= 0.05667 N P = 0.2835 * PP = 0.0029 * K P= 0.0495								
	Macronutrients uptake by seeds of faba bean (kg fed^{-1})								
0	6.56	0.57	3.73	14.31	1.22	8.41	24.90	3.40	14.54
10	17.39	1.09	5.89	32.56	2.18	12.56	53.71	5.06	21.57
15	24.88	1.86	8.55	41.57	3.48	16.42	68.28	6.55	27.92
30	37.07	2.89	12.40	68.75	5.97	27.23	113.62	12.53	47.12
Mean	21.475	1.6025	7.6425	39.297	3.2125	16.155	65.127	6.885	27.787
LSD 0.05	N H = 3.3329 * P H= 0.5471 * K H= 1.027 b N P = 2.983 * PP = 0.5035 * K P= ns								

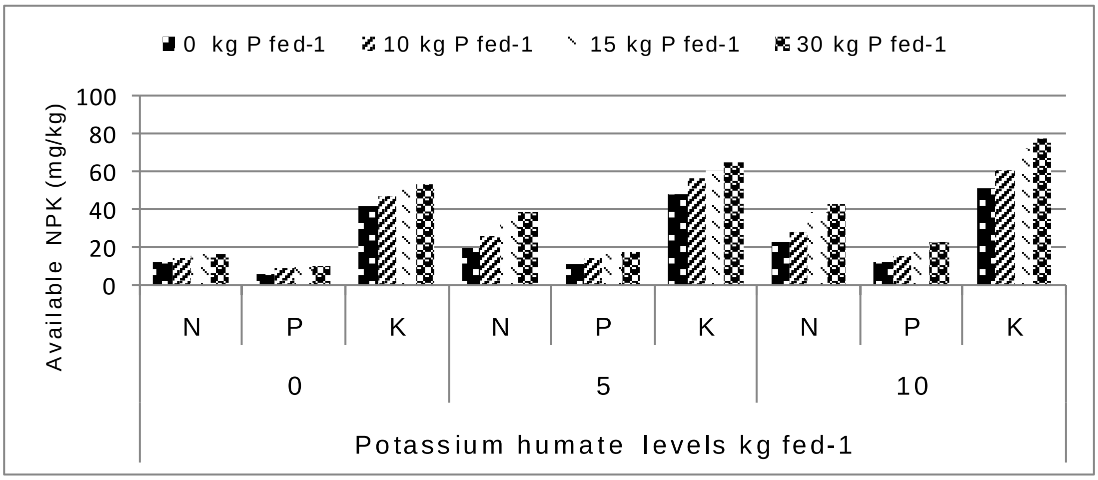

Fig. (1): Effect of phosphorus fertilizer and potassium humate on N,P and K available.

An examination of data in Fig. (1) revealed that phosphorus applied with potassium humate, there was a significant increase in available nitrogen, phosphorus and potassium in soil in comparison to phosphorus alone. These results are in conformity with those obtained by Zaheer et al. (2020) who observed that enhancing in, available nitrogen, phosphorus and potassium by the use of potassium humate. Cimrin and Yilmaz (2005) found that addition of humic acid to soil increased the yield of lettuce due to increasing the availability of phosphorus and nitrogen in soil.

Agronomic efficiency (AE) and apparent recovery efficiency (ARE)

The results of this study indicated that application of potassium humate with P improved the agronomic efficiency and apparent recovery efficiency in comparison with P alone Table (5).

The highest mean values of both agronomic efficiency (AE) (39.89 kg kg^{-1}) and apparent recovery efficiency (ARE) 14.57 % were obtained due to application of P at high rate compared with the other rates. On the other hand, the highest mean values of AE and ARE were (51.71 kg kg^{-1} and 23.24%), respectively for plant received potassium humate at high rate. Interaction between P and potassium humate, results, showed that the application P at rate of (30 kg fed^{-1}), combined with potassium humane at rate of (10 kg fed^{-1}), recorded the highest values AE (56.72 kg kg^{-1}) and ARE 26.57%, respectively mean rates from 11.91 kg of faba bean seed kg of P_2O_5 applied for superphosphate treatment to 26.83 and 57.75 kg of faba bean seed kg of P_2O_5 for superphosphate + 10 kg potassium humate and 20 kg potassium humate, respectively. Data in table 5 also, documented that potassium humate applications with superphosphate caused significant increases in the apparent recovery efficiency of when compared to the applied phosphorus alone. Increasing in the ARE was noticed from 4.30 % kg P uptake kg applied P2O5 at SP to 26.83 and 23.24 kg P uptake kg applied P2O5 for SP +10 kg fed^{-1} potassium humate + SP and 20 kg fed^{-1} potassium humate, respectively. The obtained these results may be due to the enhanced and increased the availability of phosphate in the soil as well as increased the efficiency. Also, the highest increase in P uptake this might be due to that humic acid helped in solubilizing P from insoluble to soluble form resulting in its increasing uptake. Sherif and Ali (2018).

Table (5). Agronomic efficiency (AE) and apparent recovery efficiency (ARE) of applied phosphorus (REP) fertilized with potassium humate

Phosphorus levels kg fed^{-1}	Potassium humate levels kg fed^{-1}					
	0		5		10	
	AE (kg kg-1)	ARE (%)	AE (kg kg-1)	ARE (%)	AE (kg kg-1)	ARE (%)
10	14.61	3.46	27.78	10.70	44.53	29.93
15	23.66	4.30	33.65	9.70	53.88	13.23
30	22.26	5.15	40.71	12.00	56.72	26.57
Mean	20.18	4.3	34.05	10.8	51.71	23.24
LSD 0.05	AE H =1.6651e-14 * P =0.00495			ARE H =0.0779 * P =0.0393		

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تأثير التسميد بهيومات البوتاسيوم والفوسفور على محصول الفول البلدى ومحتواه من المغذيات

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الملخص العربى

اجريت تجربه حقليه فى الموسم الشتوى 2015 – 2016 فى ارض رمليه بمدينة السادات – محافظة المنوفيه – جمهورية مصر العربية.

لدراسة اثر اضافة كل من التسميد الفوسفورى وهيومات البوتاسيوم على نمو وانتاجية الفول البلدى وكانت معاملات التجربة هى اضافة الفوسفور بثلاث مستويات مختلفة وهى (0 ، 10 ، 15، 30 كجم للفدان) وبوتاسيوم هيومات بمعدل (0، 5، 10كجم للفدان) ايضا تم تقيم كفاءه استخدام كل من الهيومات والفوسفور.

ويمكن تلخيص النتائج المتحصل عليها بعد تحليل النتائج كالاتى:

- زادت مقايس النمو والمحصول وزيادة معنويه بزياده مستويات التسميد الفوسفاتى كما زاد الوزن الجاف ووزن ال 100 بذره والمحصول معنويا بزيادة مستويات هيومات البوتاسيوم وكان المستوى الذى جمع بين الفسفور عند 30 كجم P_2O_5 فدان وبوتاسيوم هيومات بمعدل 10 كجم فدان اعلى نسبه نمو وانتاج وكذلك تركيز العناصر نتروجين ، فوسفوروبوتاسيوم مقارنه بالمعاملات الاخرى. من ناحيه اخرى فان هيومات البوتاسيوم عند المستوى المرتفع مع الفوسفور المضاف بمعدلات اكبر ادت الى زياده فى النتروجين والفوسفور والبوتاسيوم. فيما يتعلق بدراسه كفاءه الفوسفور اضهرت النتائج ان كلا من الكفاءه والانتاج الزراعى وكفاءه استرداد العائد الاقتصادى سجلت اعلى القيم فى وجود الهيومات مع الفوسفور مقارنه باضافه السماد الفوسفاتى منفردا.

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