INFLUENCE OF SOME POTASSIUM HUMATE APPLICATION METHODS AND MINERAL FERTILIZATION OF NITROGEN AND PHOSPHORUS ON SOYBEAN YIELD AND QUALITY

K. E. M. Nassar, Hayam A. EL-Shaboury and Amany E. EL-Sonbaty
Plant Nutrition and Soil Fertility Res. Dep.; Soils, Water and Environment Res. Inst.; Agric. Res. Centre, Giza, Egypt.

Received: May 17, 2021

Accepted: May 22, 2021

ABSTRACT: Two field experiments were conducted on Gadila village, Mansoura city, Dakahlia Governorate during the two successive summer seasons of 2017 and 2018 as sake of studying the impact of some methods of potassium humate (KH) application along with nine mixtures of NP fertilizers on soybean plants. split plot design was used where KH application methods and NP mixtures were put in the main and sub plots, respectively. Addition of KH generally had enhancing impacts on soybean growth, seed and stalk yields as well as improved seed nutritive and biochemical contents. Foliar spraying of KH achieved the maximum values followed by seed coating and control in a descending order. Soil application of (100 % N + 100 % P) mixture attained the best results for all aforementioned characteristics with no significant difference between it and (75 % N + 100 % P) mixture. Foliar spraying of soybean plants with 2% KH solution (10% K₂O) in a volume of 200 L fed⁻¹ at 30 and 45 days after sowing and soil application of (75 % N + 100 % P) of the recommended doses, in a dual treatment achieved the superior impacts and recorded the highest values of plant growth criteria, productivity as well as improved seed quality characteristics and saved 25 % of N requirement for soybean plants.

Key words: *Potassium humate; NP fertilizers; soybean; seed coating; foliar spraying.*

INTRODUCTION

Soybean (*Glycine max* L.) is extensively planted in Egypt and many countries under different environments with a short duration around the world and has high nutritional value, with multiple uses as food and industrial products. It also contains high amounts of minerals, salts, vitamins (thiamine and riboflavin), protein (an average of 36 – 43 %), oil (19 - 20 %) and amino acid lysine (5 %), which is usually deficient in many cereal crops (Kravchenko *et al.*, 2013 and Yadav *et al.*, 2013). Also, there are many other products such as milk and flour can be extracted from it. Growing soybean can maintain the soil fertility through increasing fixation of atmospheric N (125-150 kg N ha⁻¹) and this may reduce nitrogen requirements for plants (Yadav *et al.*, 2013).

Humate substances can directly or indirectly affect the physiological processes of plant growth by promoting the uptake of both macro- and micronutrients and growth regulators, increasing the microorganisms population and activity as hormone like substances (Verlindern *et al.*, 2009). Yet, humate substances enhance the water retention, the seed filling intensity. The chelating agent through active groups also hold macronutrients and forming organometallic complexes which are considered as a storehouse, or more mobile or available to be taken up by plant and in turn reflected positively on development seed and straw yields and their attributes (Rafla, 2012). Yet, (El-Ghamry *et al.*, 2009; El-Bassiony *et al.*, 2010 and Nassar and Abd El-Rahman,

2015) reported that all morphological characteristics, yield components as well as contents of chlorophyll and nutrients were significantly increased by foliar application of humate substances. Nassar and Abd El-Rahman (2015) also stated that soil additions of both compost and K-humate increased the quantities of both wheat grain and straw yields, improved their qualities and raised the use efficiency of the added N-fertilizer. Habashy and Aly (2005) also observed that soaking the wheat grains in K-humate solution had a superior effect on germination characteristics and emergence.

Mineral fertilization is essential for plant growth, development and yield productivity. (El-Bassiony *et al.*, 2010) reported that applying the adequate quantities of balanced NPK mineral fertilizers is the first requirement for achieving optimum yield and doing so will result in soybean of acceptable quality. Nitrogen is essential for synthesis of chlorophyll, enzymes and proteins. Phosphorus is essential for root growth, phosphoproteins, phospholipids and ATP & ADP formation. It may be a critical constraint of legumes under low nutrient environments because there is substantial need for P in the N₂ fixation processes (Tsvektova and Georgiev, 2007) because of the involvement of P in the high rates of energy transfer that must take place in the nodule. In addition, phosphorus has an enhancing impact on plant growth and biological yield through its importance as energy storage and transfer necessary for metabolic processes (Nassar and Ismail, 1999). Phosphorus cause early ripening in plants, decreasing grain moisture and improving crop quality (Malakooti, 2000). It also raises the efficiency of plants to photosynthesis, enhances the activity of rhizobia and increases the number of branches and pods / plant. Consequently,

it produces a greater total yield of soybean.

Therefore, the aim targets of the current investigation are increasing soybean seed and stalk yields and improving seed quality through the addition of K-humate along with different mixtures of N-and P-mineral fertilizers as sake of rationalization the use of mineral fertilizers. Evaluation the impact of two different methods of K-humate application was also taken into consideration as sake of selecting the best method which achieve the highest yield with better quality.

MATERIALS AND METHODS

Two field experiments were carried out at a private farm on Gadila village (5 km north-west to Mansoura), Mansoura city, Dakahlia Governorate, Egypt during the two successive summer seasons of 2017 and 2018. Mechanical and chemical properties of the soils under investigation as well as their nutritive contents are presented in Table 1 (a , b and c).

The mechanical and chemical properties of the soils under investigation were determined according to USDA (2014) and (Jackson, 1973), respectively. However, soil nutritive contents were determined according to (Chapman and Pratt, 1978) .

Soybean (*Glycine max* L.) seeds variety Giza 111 were purchased from Leguminous Crops Res. Depart., ARC and were planted on 7 and 10 May for the 1st and 2nd seasons, respectively, in rows 3.5 m a length, 50 cm a part with an intra-row spacing of 20cm (plot size = 3×3.5m). Potassium humate solution containing 10 % K₂O was obtained from Plant Nutrition and Soil Fertility Res. Depart., ARC.

Influence of some potassium humate application methods and mineral

Table 1: Mechanical and chemical analyses as well as available nutritive contents of the soils under investigation (surface layers, at the depth of 0 – 30 cm), before planting for the two studied seasons.

a) Mechanical analysis :

Season	Particle size distribution (%)				Texture class
	Coarse sand	fine sand	Silt	Clay	
1 st	8.32	19.67	36.74	35.27	Clay loam
2 nd	7.46	18.32	37.50	36.72	Clay loam

b) Chemical analysis :

Season	CaCO ₃ (%)	EC (dSm ⁻¹) (1:5)	PH (1:2.5)	O.M (%)	Soluble ions meq. L-1 (1:5 soil : water extract)							
					Cations				Anions			
					Na+	K+	Ca++	Mg++	CO ₃ --	HCO ₃ --	Cl -	SO ₄ --
1 st	3.91	0.86	7.90	1.47	2.87	0.21	3.90	1.58	0.00	1.02	2.72	4.82
2 nd	3.64	0.89	7.86	1.45	2.96	0.27	3.97	1.66	0.00	1.09	2.78	4.99

c) Available nutritive contents (mg kg⁻¹) :

Season	Macro			Micro		
	N	P	K	Fe	Mn	Zn
1 st	54.13	4.79	177	2.98	1.35	0.65
2 nd	52.64	4.62	179	2.56	1.22	0.62

Each experiment included twenty seven treatments which were the combinations of three treatments of potassium humate (KH) and nine mixtures of N- and P- mineral fertilizers. So, the layout of each experiment was split plot design with three replications. Each replicate was divided into three main plots representing the different treatments of potassium humate as the following:

- A - Without the addition of K- humate (control).
- B - Seed coating with 2 % K- humate, in the presence of adhesive agent (gum arabic) , directly before sowing.
- C - Foliar spraying of soybean plants with 2% KH solution (10% K₂O) in a volume of 200 L fed⁻¹ , at 30 and 45 days after sowing.

Each main plot was randomly subdivided into nine sub plots representing the different mixtures of N- and P- mineral fertilizers as the following:

1. 100 % N + 100 % P.

2. 100 % N + 75 % P.
3. 100 % N + 50 % P.
4. 75 % N + 100 % P.
5. 75 % N + 75 % P.
6. 75 % N + 50 % P.
7. 50 % N + 100 % P.
8. 50 % N + 75 % P.
9. 50 % N + 50 % P.

Doses of N- and P- mineral fertilization recommended for soybean plant are 20 kg N fed⁻¹ and 22.5 kg P₂O₅ fed⁻¹. However, the abovementioned percentages represent 100 % of the recommended doses, mentioned before.

N- and P- mineral fertilizers were applied in the forms of urea (46.5% N) and single superphosphate (15.5% P₂O₅), respectively. Calcium superphosphate was broadcasted during the soil preparation, whilst, urea was applied in two equal doses before the first and second irrigations. The other usual agronomic processes of soybean were practiced.

At 65 days age, a sample of 10 plants from each plot was randomly chosen to calculate fresh and dry weights of the whole plants. Yet, a sample of the fourth leaves was taken to determine Chlorophyll a , b and carotenoids according to (Gavrilenko and Zigalova, 2003).

At harvest (120 days after sowing), a sample of 20 plants from each plot was harvested . Then, number of branches and pods plant⁻¹, seed yield plant⁻¹ as well as 100 seed weight were recorded. Seed and stalk yields were recorded on plot basis. Then, they were estimated as ton fed⁻¹ (fed. = 0.42 hectare). N, P and K percentages of soybean seed were determined in wet digested extract using the methods described by Mertens (2005 a and b). Values of N, P and K contents in seed were also estimated as Kg fed⁻¹. Seed crude protein (Kg fed⁻¹) was determined by multiplying the values of N (Kg fed⁻¹) in seed by 6.25, according to (A.O.A.C., 2000). Total carbohydrate, dietary fiber and oil percentages were determined according to (Shumaila and Safdar, 2009 ; Rai and Mudgal, 1988 and A.O.A.C., 2000) , respectively. Then, total carbohydrate, dietary fiber and oil contents in Kg fed⁻¹ were also estimated.

Combined analyses for the two growing seasons were statistically analyzed according to (Gomez and Gomez, 1984). The significant differences among the means of treatments were tested using the least significant difference (L.S.D.) at the 5% level of probability.

RESULTS AND DISCUSSION

Data presented in Tables (2, 3 and 4) represent the average of the values attained in 2017 and 2018 summer seasons. The current investigation aimed to raise the productivity of soybean and improve seed quality through the addition of potassium humate in two methods (seed coating and foliar

spraying) along with different mixtures of N- and P-mineral fertilizers as well as their possible combinations on some growth criteria and yield components of soybean. Yet, their impacts on the seed contents of some nutrients and biochemical constituents were also taken into consideration.

I. Effect of methods of potassium humate application :

Data obtained in Table (2) revealed that the addition of potassium humate (KH) significantly increased the concentrations of photosynthetic pigments and weight of whole plant at 65 days age. At harvest, seed and stalk yields as well as yield components (No. of branches and pods / plant, 100 seed weight and yield / plant) gave trends similar the trend mentioned before. Moreover, seed nutritive and biochemical contents were also significantly enhanced by KH application. The enhancements of plant growth criteria, yield components as well as seed nutritive and biochemical contents were mainly due to foliar spraying with KH rather than seed coating and control in a descending order. The beneficial impact of KH on the concentrations of photosynthetic pigments, plant growth , seed and stalk yields ,contents of seed nutrients and biochemical constituents could be explained on the basis of that humic substances can directly or indirectly affect the physiological processes of plant growth by promoting the uptake of macro-and micronutrients and affecting the biochemical substances, carrying nutrients and growth regulators and acting as hormone like substances (Verlindern *et al.*, 2009). On the other hand, (Wang *et al.*, 2015; Ismail *et al.*, 2017 and Dawood *et al.*, 2019) also attributed the enhancing impact of KH to the beneficial functions of potassium on osmoregulation, photosynthesis, transpiration, open and

Table 2: Photosynthetic pigments , plant growth criteria , seed , stalk yields and their components as well as seed nutritive and biochemical contents as affected by methods of KH application*.

Methods of K-humate application	At 65 days age				At harvest																
	Photosynthetic Pigments (mg g ⁻¹ FW)				Plant growth criteria (g plant ⁻¹)		Yield Components								Yield (ton Fed ⁻¹)		Seed contents (Kg Fed ⁻¹)				
	Ch.(a)Ch.(b)		Ch. Carotenoids (a+b)		Fresh weight	Dry weight	No. of branches Plant ⁻¹	No. of pods Plant ⁻¹	100 seed weight (g)	Seed yield (g plant ⁻¹)	Seed	Stalk	N	P	K	Crude Protein	Total Carbohydrate	Dietary Fiber	Oil		
Control	0.547	0.388	0.935	0.766	232	31.7	6.22	118	14.1	45.7	1.22	3.23	52.4	1.92	16.9	401	392	129	216		
Seed coating	0.644	0.458	1.102	0.844	250	34.1	7.31	132	16.2	57.0	1.41	3.65	68.3	2.76	22.5	506	460	159	257		
Foliar spraying	0.682	0.472	1.154	0.860	257	35.3	7.69	145	17.4	59.5	1.46	4.02	80.7	3.32	26.3	583	492	177	269		
L.S.D at 5%	0.004	0.005	0.005	0.003	1.82	0.28	0.10	2.55	0.12	0.73	0.01	0.01	2.47	0.11	0.43	3.08	18.9	4.96	5.48		

*combined analysis of 2017 and 2018 summer seasons.

closure of stomata, protein synthesis and translating of assimilates into sink organs.

The superiority impact of KH foliar spraying method compared to KH coating one and control may be due to stimulating of leaf area and water retention, impacting as an activator for physiological respiration, photosynthesis, protein synthesis, water and nutrient uptake, cationic exchange capacity, enzyme activities and antioxidant metabolism. As a result, photosynthetic materials help in the fill grains that can increase yield. In this respect, (Afifi et al., 2010) on Faba bean and (Kaya, 2005) on common bean also stated that humic acid molecules are small which allows them to reach the plant plasma, increases the permeability of plant cellular membranes and enhances the uptake of nutrients. Yet, (Dorneanu et al., 2008) reported that foliar spraying of humate substances (HS) enhance the penetration of nutritive ions in leaves, stimulate the formation of some physiological active metabolic compounds and enlarge the capacity of plants for root absorption. As increasing nutrients uptake especially N and K which increase number of chloroplast per cell as well as photosynthetic efficiency and increase sugar content (Chen and Avid, 1990). Obtained findings are in confirmity by those of (El-Bassiony et al., 2010) on snap bean, (Khan et al., 2012) on peas, (Shafeek et al., 2013) on broad bean (Nassar and Abd EL-Rahman, 2015) on wheat, (Wang et al., 2015) on soybean, (Ismail et al., 2017) on Pea, (Fuda, 2017; Dawood et al., 2019) on faba bean who reported that all morphological characteristics, yield components as well as contents of chlorophyll, nutrients and biochemical constituents were significantly increased by foliar spraying of humate substances. Similar results were also attained by (Yousif et al., 2019) where they stated that foliar spraying of

broad bean plants with humic acid (18m L-1) is very beneficial to the crop growth, yield and nutrient content (N, P, and K%).

I. Effect of different mixtures of N- and P- mineral fertilizers:

As shown in Table (3), plant growth parameters, yield components as well as seed nutritive contents and biochemical constituents were progressively descended by decreasing the levels of N and / or P in the tested mixtures. In this respect, the addition of full recommend doses for both N- and P- fertilizers namely the treatment of (100% N +100% P) achieved the maximum values for all abovementioned parameters followed by the treatment of (75%N + 100% P) but there was no significant difference between the aforementioned two treatments. On the other hand, the least values for the growth, yield as well as seed nutritive and biochemical contents were recorded when the addition of half amounts of the recommended doses for both N-and P-fertilizers namely the treatment of (50% N + 50% P).

Date attained herein clearly show the following important topics :

- 1- Application of mineral fertilizers is essential for plant growth, development as well as yield productivity and quality. (El-Bassiouny et al., 2010) also reported that applying of adequate quantities of balanced NPK mineral fertilizers is the first requirement for achieving optimum yield and doing so will result in soybean for acceptable quality.
- 2- As soybean is a leguminous crop and fixes N in large amounts, it is able to compensate a part of mineral N to cover N requirement
- 3- Characters of soybean growth, yield, nutritive and biochemical constituents tested herein were largely affected by the diminution of P-levels in the

Table 3: Photosynthetic pigments, plant growth criteria, seed, stalk yields and their components as well as seed nutritive and biochemical contents as affected by different mixtures of N- and P- mineral fertilizers^a.

Mixtures of N- and P-mineral fertilizers	At 65 days age				At harvest														
	Photosynthetic Pigments (mg g ⁻¹ FW)				Plant growth criteria (g plant ⁻¹)		Yield Components						Yield (ton fed ⁻¹)		Seed contents(Kg fed ⁻¹)				
					Fresh weight	Dry weight	No. of branches plant ⁻¹	No. of pods plant ⁻¹	100 seed weight (g)	Seed yield (g plant ⁻¹)	Seed	Stalk	N	P	K	Biochemical constituents			
	Ch.(a)	Ch.(b)	Ch. (a+b)	Carotenoids												Crude Protein	Carbohydrate	Dietary Fiber	Oil
100%N+100%P	0.716	0.515	1.231	0.930	285	39.3	8.75	163	18.2	62.9	1.62	4.45	84.2	3.68	29.9	615	547	192	304
100%N+75%P	0.671	0.473	1.144	0.846	264	36.2	8.03	147	17.4	60.0	1.50	4.11	75.9	2.99	25.3	557	498	173	275
100%N+50%P	0.632	0.444	1.076	0.805	247	33.7	7.01	130	14.7	49.0	1.28	3.73	60.5	2.23	18.3	450	420	141	226
75%N+100%P	0.709	0.504	1.213	0.920	278	38.6	8.53	158	17.8	62.5	1.57	4.34	81.0	3.46	28.7	592	526	185	293
75%N+75%P	0.646	0.473	1.119	0.874	258	35.1	7.57	137	17.0	57.3	1.42	3.93	71.2	2.73	22.9	524	470	163	259
75%N+50%P	0.600	0.421	1.021	0.766	229	31.2	6.16	115	13.7	45.5	1.15	3.18	53.5	1.94	15.7	400	367	126	202
50%N+100%P	0.619	0.431	1.050	0.783	237	32.4	6.57	122	16.2	53.9	1.34	3.34	65.9	2.83	22.4	487	438	153	244
50%N+75%P	0.590	0.412	1.002	0.752	216	29.4	5.67	109	15.7	51.4	1.31	2.88	61.8	2.42	19.8	468	423	146	234
50%N+50%P	0.579	0.402	0.981	0.735	204	27.4	5.39	105	12.3	43.9	1.10	2.74	50.3	1.73	14.1	377	345	118	190
L.S.D at 5%	0.003	0.008	0.008	0.006	4.02	0.41	0.11	2.59	0.25	1.12	0.03	0.06	3.02	0.12	0.44	13.5	15.7	4.72	4.52

^acombined analysis of 2017 and 2018 summer seasons.

mixtures used under the present study. this might be due to the depression of available phosphorus contents in the experimental soils (4.79 and 4.62 mg/kg, in the 1st and 2nd seasons, respectively), Table 1 -b and/or a substantial need for P in the N₂ fixation process (Tsvetkova and Georgiev, 2007) because of the involvement of P in the high rates of energy transfer that must take place in the nodule. In addition, phosphorus has an enhancing impact on plant growth and transfer necessary for metabolic processes (Nassar and Ismail, 1999). Phosphorus also causes early ripening in plants, decreases grain moisture , improves crop quality , raises the efficiency of plants to photosynthesis , enhances the activity of rhizobia and increases the number of branches and pods / plant . Consequently, it produces a greater total yield of soybean (Malakooti, 2000).

II. Interaction effect of application methods of potassium humate and different mixtures of N- and P-mineral fertilizers :

Date presented in Table (4) clearly show that the addition of potassium humate raises the efficiency of mineral fertilizers adding to the soil compared

with the control treatment (untreated). It was reflected on all studied characteristics (photosynthetic pigments, plant growth , productivity as well as seed quality characters namely nutritive and biochemical contents. In this concern , application of KH and mineral fertilizers simultaneously achieved values higher than those recorded when their application singly . The highest values were observed when foliar spraying of KH together with the addition of full recommended doses of NP fertilizers i.e. (100 % N + 100 % P) followed by the dual treatment of KH foliar spraying and (75 % N + 100 % P) but there was no significant difference between the abovementioned two treatments .

CONCLUSIONS

Foliar spraying the soybean plants with 2% K-humate solution (10 % K₂O) at 30 and 45 days after sowing and soil application of (75 % N + 100 % P) of the recommended doses , in a dual treatment achieved the superior impact and recorded the highest values of photosynthetic pigments , plant growth criteria , seed and stalk yields and improved seed quality characteristics namely seed nutritive and biochemical contents . In addition , this treatment saved 25 % of the N recommended dose.

Table 4: Photosynthetic pigments, plant growth criteria, seed, stalk yields and their components as well as seed nutritive and biochemical contents as affected by the interaction between methods of KH application along with different mixtures of N- and P- mineral fertilizers*.

Methods of K-humate application	Mixtures of N- and P-mineral fertilizers	At 65 days age				At harvest															
		Photosynthetic pigments (mg g ⁻¹ FW)			Plant growth criteria (g/plant)	Yield Components					Yield (ton fed ⁻¹)		Nutrients			Seed contents (Kg fed ⁻¹)		Biochemical constituents			
		Ch.(a)	Ch.(b)	Ch. (a+b)	Carotenoids	Fresh weight	Dry weight	No. of branches plant ⁻¹	No. of 100 seed pods plant ⁻¹	Seed yield (g plant ⁻¹)	Seed stalk	N	P	K	Crude Protein	Total Carbohy. hydrate	Dietary Fiber		Oil		
Control	100%N+100%P	0.888	0.431	1.150	0.885	270	37.2	7.32	148	18.1	54.4	1.50	4.03	89.2	2.85	24.3	5.17	482	188	275	
	100%N+75%P	0.808	0.428	1.035	0.788	248	33.3	8.37	134	15.3	51.1	1.33	3.85	59.1	2.13	20.0	4.48	428	143	238	
	100%N+50%P	0.582	0.420	1.002	0.747	231	31.8	8.33	117	12.8	40.1	1.14	3.28	47.1	1.80	13.5	3.81	333	118	187	
	75%N+100%P	0.858	0.485	1.124	0.850	281	38.0	7.43	141	15.8	53.5	1.42	3.88	84.3	2.58	22.3	4.85	481	158	257	
	75%N+75%P	0.584	0.423	1.017	0.771	233	32.8	8.50	122	14.8	48.8	1.22	3.48	53.4	1.83	18.4	4.05	380	128	218	
	75%N+50%P	0.583	0.407	0.97	0.723	215	28.3	5.52	103	11.3	38.5	1.07	2.77	43.3	1.38	12.2	3.34	330	103	183	
	50%N+100%P	0.574	0.414	0.883	0.733	224	30.8	5.83	108	14.7	45.4	1.14	2.80	48.1	1.84	18.5	3.73	381	123	208	
	50%N+75%P	0.558	0.388	0.852	0.713	205	27.8	4.38	95.8	13.8	43.3	1.18	2.81	45.2	1.74	15.3	3.78	385	120	201	
	50%N+50%P	0.547	0.333	0.835	0.689	188	28.7	4.84	82.3	11.4	38.1	1.03	2.45	40.7	1.24	11.2	3.18	315	102	174	
	100%N+100%P	0.735	0.615	1.250	0.868	233	38.7	3.87	180	18.3	85.2	1.88	4.40	84.3	3.82	30.7	8.20	553	188	313	
Seed coating	100%N+75%P	0.883	0.481	1.184	0.808	288	38.3	3.40	147	18.0	83.7	1.53	4.11	78.7	3.08	24.8	5.84	503	178	284	
	100%N+50%P	0.833	0.452	1.085	0.828	251	34.2	7.35	131	14.3	52.3	1.32	3.73	81.5	2.24	18.0	4.58	422	145	235	
	75%N+100%P	0.731	0.608	1.239	0.848	283	38.3	3.31	168	18.4	85.1	1.83	4.31	82.8	3.82	30.0	8.08	544	181	308	
	75%N+75%P	0.841	0.478	1.120	0.877	285	35.7	7.88	133	17.3	80.3	1.48	3.80	73.1	2.88	23.2	5.58	483	188	273	
	75%N+50%P	0.588	0.424	1.020	0.781	232	31.8	8.22	115	14.1	43.2	1.13	3.31	53.8	2.01	18.1	4.05	375	123	203	
	50%N+100%P	0.811	0.433	1.049	0.783	240	32.3	8.80	123	18.0	57.0	1.40	3.41	87.3	2.88	24.3	5.93	455	167	255	
	50%N+75%P	0.584	0.414	0.883	0.783	218	28.8	5.37	108	15.8	54.1	1.38	2.88	84.2	2.50	20.1	4.73	440	152	248	
	50%N+50%P	0.573	0.402	0.875	0.745	208	27.4	5.81	105	12.7	48.5	1.11	2.78	50.2	1.75	14.2	3.73	348	118	184	
	100%N+100%P	0.743	0.650	1.281	0.871	288	40.8	8.48	178	18.7	88.1	1.71	4.81	88.7	4.33	34.8	7.07	580	215	324	
	100%N+75%P	0.716	0.488	1.213	0.827	277	33.5	8.32	180	18.3	85.3	1.83	4.57	81.3	3.78	30.87	8.80	558	200	303	
Roller spraying	100%N+50%P	0.830	0.480	1.140	0.841	253	35.4	7.38	144	18.8	54.7	1.37	4.17	72.8	2.85	22.33	5.50	451	181	248	
	75%N+100%P	0.738	0.638	1.277	0.883	280	40.5	8.28	175	18.3	88.0	1.87	4.83	86.7	4.21	34.0	8.88	573	203	317	
	75%N+75%P	0.704	0.438	1.180	0.880	270	38.8	3.54	150	18.3	82.8	1.58	4.44	87.0	3.43	28.2	8.27	523	180	288	
	75%N+50%P	0.842	0.433	1.075	0.785	238	32.7	8.73	127	15.2	50.0	1.21	3.48	83.3	2.42	18.3	4.82	385	141	214	
	50%N+100%P	0.872	0.442	1.114	0.813	247	33.8	8.33	134	17.8	58.3	1.43	3.71	80.8	3.53	28.3	5.85	487	173	272	
	50%N+75%P	0.830	0.425	1.055	0.778	225	30.7	8.25	122	17.3	58.3	1.40	3.13	78.0	3.02	23.80	5.50	484	187	264	
	50%N+50%P	0.817	0.415	1.032	0.781	210	28.1	5.82	118	12.8	48.1	1.15	2.88	58.8	2.18	17.0	4.33	372	132	202	
	L.S.D at 5%		0.007	0.014	0.015	0.011	8.87	0.72	0.18	4.43	0.43	1.84	0.04	0.10	5.22	0.20	0.77	23.5	27.2	3.18	7.33

*combined analysis of 2017 and 2018 summer seasons

REFERENCES

- Afifi, M. H. M., M. F. Mohamed and S. H. A. Shaaban (2010). Yield and nutrient uptake of some Faba bean varieties grown in newly cultivated soil as affected by foliar application of humic acid. *Journal of Plant Production* 1 (1): 77-85.
- A.O.A.C., (2000). Association of Official Analytical Chemists, 17th ed. of A.O.A.C. international published by A.O.A.C. international Maryland, U.S.A., 1250 pp.
- Chapman, H. O. and P. E. Pratt (1978). *Methods of Analysis for Soils, Plants and Waters*. Univ. California Div. Agric. Sci.
- Chen, Y. and T. Aviad (1990). Effects of humic substances on plant growth. In: *Humic Substances in Soil and Crop Science: Selected Readings*, eds. P. Mac Carthy, C. E. Clapp, R. L. Malcolm, and P. R. Bloom, pp. 161–186. Madison, WI: SSSA and ASA.
- Dawood, M.G., Y.R. Abdel-Baky, , M. E. El-Awadi and G.S. Bakhoum (2019). Enhancement quality and quantity of Faba bean plants grown under sandy soil conditions by nicotinamide and/or humic acid application. *Bulletin of the National Research Centre* 43:28.
- Dorneanu, A.D. , M. E. Dorneanu, C. Preda, L. Anton and L. Oprica (2008). Fertilization with liquid humic fertilizers, procedure of high efficiency in improving plant nutrition along the growing season. *Proc. 17th Intern. Symp. of CIEC*, 24-27 Nov. Micronutrient Project, Cairo, Egypt, pp. 259-264.
- El-Bassiony, A. M., Fawzy, Z. F., Abd El-Baky, M. M. H. & Mahmoud, A. R. (2010). Response of snap bean plants to mineral fertilizers and humic acid application. *Research Journal of Agriculture and Biological Sciences*, 6(2): 169-175.
- El-Ghamry, A.M., K.M. Abd El-Hai and K.M. Ghoneem (2009). Amino and humic acids promote growth, yield and disease resistance of Faba bean cultivated in clayey soil. *Australian Journal of Basic and Applied Sciences*, 3(2):731-739.
- Fouda, K.F. (2017). Effect of Phosphorus level and some growth regulators on productivity of Faba bean (*Vicia faba* L.). *Egypt Journal Soil Sci.*, 57 (1): 73 - 87.
- Gavrilenko, V. F. and T. V. Zigalova (2003). *The Laboratory Manual for the Photosynthesis*. Academia, Moscow. 256 стр. (in Russian).
- Gomez, K. A. and A. A. Gomez (1984). *Statistical Procedures for Agricultural Research*, 2nd ed., John Wiley and Sons., Inc. New York.
- Habashy, N. R. and L.M. Aly (2005). Effect of organic growth promoting substances as humic acids and indol acetic acid on Wheat crop with special reference to some chemical composition. *Minufiya Journal of Agricultural Research*, 30:1607-1624.
- Ismail, E. E. M., R. M. Galal and M. E. Mahseb (2017). Effect of some Potassium sources on productivity and quality of Pea under conditions of saline soil. *Journal Plant Production*, Mansoura University, 8 (12): 1323 – 1328.
- Jackson, M. L. (1973). " *Soil Chemical Analysis*". Prentice Hall of Indian Private Limited, Dew Delhi. India.
- Kaya, M., M. Atak , K.M. Khawar, C.Y. Ciftci and S. Ozcan (2005). Effect of pre-sowing seed treatment with zink and foliar spray humic acids on field of Common bean (*Phaseolus vulgaris* L.). *Int. Journal Agriculture Biological*, 7(6): 875-878.
- Khan, A., A. Gurmani, M. Z. Khan, F. Hussain, M. E. Akhtar and S. Khan (2012). Effect of humic acid on the growth, yield, nutrient composition, photosynthetic pigment and total sugar contents of Peas (*Pisum*

- sativum* L). Journal of the Chemical Society of Pakistan, 1: 1-7.
- Kravchenko, I., A. Kizilova , L. Titova and G. Iutinskaya (2013). Effect of microbial fertilizers on rhizospheric bacterial diversity and yield response of Soybean plants. Agriculture Science Developments, 2 (12): 120-125.
- Malakooti, M.J. (2000). Sustainable Agriculture and Yield Increment by Optimum Fertilizer Utilization in Iran. 2nd edition. Agricultural Extension Publications, Iran.
- Mertens, D. (2005a). A.O.A.C. Official method 922.02. plants preparation of laboratory sample. Official Methods of Analysis, 18th ed. North Frederick Avenue, Gaithersburg, Maryland, 1-2 pp.
- Mertens, D. (2005b). A.O.A.C. Official method 975.03. Metal in plants and pet foods. Official Methods of Analysis, 18th ed. North Frederick Avenue, Gaithersburg, Maryland, 3-4 pp.
- Nassar, K. E. and L. A. Abd EL-Rahman (2015). Impact of compost and methods of potassium humate application on Wheat. Minufiya Journal of Agriculture Research, 40 (5): 1377-1385.
- Nassar, K.E. and K.M. Ismail (1999). Effect of ascorbic acid and phosphorus application on Lupin yield (*Lupinus termis* L.) grown on sandy soil. Egypt Journal of Applied Sciences, 14 (10): 357-368.
- Rafla, H. H. (2012). Effect of humic acid and macronutrients on growth, yield and chemical composition of Faba bean (*Vicia faba* L.). Egypt Journal of Applied Sciences, 27: 927-944.
- Rai, S. N. and V. D. Mudgal (1988). Synergistic effect of sodium hydroxide and steam pressure treatment on compositional and fiber utilization of Wheat straw. Biological waster, 24: 105-114.
- Shafeek, M. R., Y. I. Helmy, N. M. Omer and F. A. Rizk (2013). Effect of foliar fertilizer with nutritional compound and humic acid on growth and yield of Broad bean plants under sandy soil conditions. Journal of Applied Sciences Research, 9(6) : 3674-3680.
- Shumaila, G. and M. Safdar (2009). Proximate Composition and Mineral Analysis of Cinnamon. Pakistan Journal of Nutrition, 8 (9) : 1456-1460.
- Tsvetkova, G.E. and G.I. Georgiev (2007). Changes in phosphate fractions extracted from different organs of phosphorus starved nitrogen fixing Pea plants. Journal Plant Nutrition, 30: 2129-2140.
- USDA, (2014) . " Keys to Soil Taxonomy" . 12th Edition, United States Department of Agriculture, Natural Resources Conservation Service, New York , USA.
- Verlindern, G., B. Pycke , j. Mertens, F. Debersaques, K. Verheyen, G. Baert, J. Bries and G. H. saert (2009). Application of humic substances results in consistent increases in crop yield and nutrient uptake. Journal of Plant Nutrition 32:1407-1426.
- Wang, X.G., X.H. Zhao, C.J. Jiang, C.H. Li, S. Cong , Y.Q. Chen, H. Q. Yu and C.Y. Wang (2015). Effects of potassium deficiency on photosynthesis and photoprotection mechanisms in Soybean (*Glycine max* (L.) Merr.). Journal of Integrative Agriculture, 14(5): 856–863.
- Yadav, H., M. A. Shekh, S.S. Takar and B.S. Kherawat (2013). Effect of phosphorus and sulphur on content, uptake and quality summer Soybean. International Journal of Agricultural Science, 9: 91-94.
- Yousif, S. H., K. H. Yousif and S. M. Salih (2019). Effect of bread yeast and humic acid on growth and yield traits on Broad bean (*Vicia faba* L.).

تأثير بعض طرق إضافة هيومات البوتاسيوم والتسميد المعدني الآزوتي والفوسفاتي على المحصول الكمي والنوعي لفول الصويا

كرم السيد محمد نصار، هيام عبد الفتاح الشابوري، أمانى السيد السنباطى

قسم خصوبة الأراضي وتغذية النبات - معهد بحوث الاراضى والمياه والبيئة - مركز البحوث الزراعية - جيزة - مصر

الملخص العربى

أجريت تجربتان حقليتان في قرية جديلة - مركز المنصورة - محافظة الدقهلية فى المواسم الصيفية لعامي 2017 ، 2018 بغرض دراسة التأثير الفردي لثلاث طرق لإضافة هيومات البوتاسيوم (K_2O % 10) بتركيز % 2 : [بدون إضافة (كنترول) ، تغليف البذور بالهيومات قبل الزراعة ، إضافة الهيومات رشاً على النباتات بمعدل 2% (كمية محلول الرش 200 لتر/ الفدان) عند أعمار 30 ، 45 يوم] و تسعة مخاليط من الأسمدة النيتروجينية والفوسفاتية المعدنية والتي تمثل المستويات المختلفة من عنصري النيتروجين والفوسفور (100 ، 75 ، 50 % من المعدلات الموصى بها) وكذلك دراسة التأثير المشترك للعاملين السابقين على صبغات التمثيل الضوئي ، النمو ، المحصول الكمي لبذور فول الصويا والقش وكذا جودة البذور (محتواها الغذائي والحيوي).. لذا صممت التجربتان بنظام القطع المنشقة مرة واحدة فى ثلاث مكررات حيث خصصت القطع الرئيسية لطرق إضافة هيومات البوتاسيوم الثلاث بينما توزعت المخاليط التسع للأسمدة المعدنية عشوائياً فى القطع الفرعية .

وقد أشارت نتائج البحث لأهم النقاط الأتية :

1 - أدت إضافة هيومات البوتاسيوم بصفة عامة إلى زيادة محتوى الأوراق من صبغات التمثيل الضوئي ، ومقاييس النمو ، ومحصولى البذور والقش لنباتات فول الصويا فضلاً عن تحسين المحتوى الغذائي والحيوي للبذور.. وقد سجلت الإضافة الورقية لهيومات البوتاسيوم أعلى القيم لجميع الصفات المدروسة السابقة تلاها إضافة الهيومات تغليفاً للبذور قبل الزراعة ثم النباتات الغير معاملة بقيم متناقصة على التوالي.

2 - تناقصت قيم جميع الصفات المدروسة والسابق الإشارة إليها بانخفاض مستويات النيتروجين أو الفوسفور أو كليهما في المخاليط التسع موضوع الدراسة وقد سجلت أقل القيم عند إضافة نصف المقررات الموصى بها من سمادي كلا العنصرين أي مع المعاملة (50 % نيتروجين + 50 % فوسفور) بينما تحققت أعلى القيم عند إضافة الأسمدة المعدنية النيتروجينية والفوسفاتية بكامل المقررات الموصى بها من كليهما (100 % نيتروجين + 100 % فوسفور) ثم المعاملة (75 % نيتروجين + 100 % فوسفور) بينما لم تكن هناك فروق معنوية بين هاتين المعاملتين السابقتين.

3- سجلت إضافة هيومات البوتاسيوم والأسمدة المعدنية معاً زيادات ملحوظة في جميع المقاييس المدروسة مقارنة بإضافة أي من عاملي الدراسة منفرداً .. وفي هذا الصدد سجلت معاملة الرش ب 2% هيومات البوتاسيوم مع إضافة النيتروجين والفوسفور بكامل مقرراتها الموصي بها (100 % نيتروجين + 100 % فوسفور) أعلى القيم وبدون وجود فرق معنوي بينها ومعاملة الرش بالهيومات وإضافة النيتروجين والفوسفور بمعدلات (75% + 100%) من مقرراتهما الموصي بها على التوالي.

ومن ثم يمكن القول أن الرش الورقي لنباتات فول الصويا بمحلول هيومات البوتاسيوم بتركيز 2% عند أعمار 30 ، 45 يوم يزيد من كفاءة الأسمدة النيتروجينية والفوسفاتية المعدنية المضافة ويزيد من فعاليتها في زيادة محتوى النباتات من صبغات التمثيل الضوئي ومقاييس النمو والمحصول الكمي لنباتات فول الصويا وتحسين جودته فضلاً عن توفير 25% من إحتياجاته من التسميد الأزوتي.

أسماء السادة المحكمين

أ.د/ رمضان إسماعيل كنانسى معهد بحوث الأراضى والمياه - مركز البحوث الزراعية
أ.د/ صلاح عبدالمجيد رضوان كلية الزراعة - جامعة المنوفية