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EFFECT OF NITROGEN SOURCES, HUMIC ACID AND IRON FOLIAR APPLICATIONS ON PEA.

Samar M.A. Doklega
Veget. and Flori. Dept., Fac. Agric., Mansoura Univ., Egypt.

ABSTRACT

This investigation was conducted at the Experimental Station, Mansoura University, Egypt during the two successive winter seasons of 2013/2014 and 2014/2015 to study the effect of three nitrogen sources (ammonium sulphate, ammonium nitrate and urea), humic acid addition and iron foliar application on vegetative growth, yield and chemical constituents of pea plants cv. Little Marvel. The results indicated that the highest values of vegetative growth parameters, i.e. fresh and dry weights, plant length and number of leaves/plant were recorded when plants treated with ammonium nitrate, humic acid and sprayed with iron solely in the two seasons.

The same treatments gave superiority comparing with the other treatments as for chemical composition: N, P, K, Fe, Mn, Zn, Chlor. a, b and total in leaves and seeds, the highest values of pods quality i.e. carbohydrates, sugar contents, VC% and minimum value of NO3-N were also recorded.

Moreover interaction treatment of ammonium nitrate, humic acid addition and foliar spraying with iron gave the highest value of yield with significant differences in two seasons of study. Therefore, this treatment could be recommended for improving pea performance under similar conditions of this study.

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the most important legumes grown worldwide. It is mainly grown for green pods, dry seeds. It is considered as a cool season vegetable crop. Pea is known as a rich vegetable crops in proteins, vitamin a, b and c and also it contains a high proportion of minerals (Baloch, 1994). Moreover, pea plays an important role for improving soil fertility. The cultivated area devoted to green pods reached about 47951 fed., which produced a total production of 180631 tons with an average productivity 3.77 ton/ fed. (Agricultural statistics, Ministry of agriculture 2012).

Pea fertilization with nitrogen is one of the most yield limiting factor. It plays important roles in plant growth and development. Plants absorb N only as inorganic form such as, nitrate ions (NO_3^-) or ammonium (NH_4^+) and or amino (NH_2^+) ions. Available N is often a more limiting factor influencing plant growth than any other nutrient.

Continued use of nitrogen fertilizers can affect the pH of the soil. Some sources are residually acid forming, i.e., ammonium sulfate and ammonium nitrate. The most common source of nitrogen for the cultivation of crops is nitrate, which promotes plant growth and is considered to be more preferable than ammonium.

Ammonium nitrate (33.5% N) is a suitable nitrogen fertilizer for the most crops. It can be applied before planting crops or as side and top dressing because its N is half ammonium and half nitrate, it is also intermediate in leaching relative to ammoniacal or nitrate fertilizers. It contains N in the form of the NO_3^- . It is very easy to lost by leaching because it is not retained by soil colloids. Ammonium sulphate (20 %N) contains about 24% sulpher, which plays an important role in decreasing pH of the soil. Urea (46% N) considered the most concentrated solid nitrogen fertilizer. It's a lower cost per unit of N than other N fertilizers. When it applies to soil it converts rapidly to ammonium carbonate. When urea mixes with the soil the ammonia held on the colloids, but if it applies on the soil surface considerable amounts of ammonia may be lost. Urea is an effective fertilizer if used in suitable conditions.

Tartoura (2001) studied the effect of two sources of N-fertilizers $Ca(NO_3)_2$ and $(NH_4)_2SO_4$ on pea plant and found that $Ca(NO_3)_2$ increase stem length, No. of leaves, fresh and dry weight per plant.$Ca(NO_3)_2$ increased No. of seeds, weight of pod and weight of shell, 100-green seeds weight, total No. pods/plot and total fresh pod yield/feddan. Also, Wang and Li (2003) studied the effect of N forms and rates on growth of cabbage and spinach plants. They found that the application of ammonium nitrate and urea significantly increased the yield of both plants. El-Deweny (2011) studied the effect of N-forms as ammonium sulphate, ammonium nitrate and calcium nitrate; the results stated that the greatest contents of chlorophyll, nitrogen and phosphorus were recorded when NO_3 was the dominant in the combination of N-forms (NH_4^+:NO_3^-) during the both seasons, while the maximum mean values of potassium percentage were fulfilled for the plants supplied with N-form as 100%NO_3.

Radwan (2011) investigated the effect of different sources of nitrogen fertilization, i.e., ammonium nitrate, ammonium sulphate and urea and found that there were significant differences among N-sources on nitrate and nitrite content of potato tuber. Taha *et al.* (2011) revealed that nitrate content was significantly increased in lettuce plants treated with ammonium nitrate, while the lowest values were obtained from ammonium sulfate. Hemada and Awadall (2012) on potato studied the effect of different sources of nitrogen fertilization, i.e., ammonium nitrate, ammonium sulphate and urea. They found that there were significant differences among N-sources on all vegetative growth characters (plant height, fresh and dry weight) and ammonium nitrate gave the highest values of all vegetative growth characters. El-Tantawy and Mahmoud (2013) studied the effect of four N-sources (unfertilized, urea, ammonium nitrate and ammonium sulphate) on broad bean and showed that application of urea followed by ammonium nitrate gave the highest values of plant height, both No. of leaves and branches/plant, weight of active nodules and weight of green seeds/pod compared to the control.

Recently, great attention has been focused on the possibility of using humic acid as a natural and sate material for improving plant growth, yield and its components. Humic substances, plays an important role in soil fertility and plant nutrition. It is in common use as major components of vegetable bio-stimulant formulations such as auxine and cytokinin, it is considered to increase the permeability of plant membranes and enhance the uptake of nutrients (Piccolo *et al*., 1992). Norman *et al*. (2002) reported that, substitution of humates ranging from 250-1000 mg/kg MM360, increased root growth of pepper. In the same trend, it significantly increased root growth and number of fruits of strawberries. Humic acid is one of the major components of humic substances which are dark brown and major constituents of soil organic matter humus that contributes to soil chemical and physical quality. Humic substances consist of heterogenous mixture of transformed bio-molecules exhibiting a supramolecular structure that can be separated in their small molecular components by sequential chemical fractionation (Piccolo, 2002). Since the end of the 18^{th} century, humic substances have been designated as either humic acid, fulvic acid or humin. These fractions are defined strictly on their solubility in either acid or alkali (Fiorentino *et al* ., 2006). El-Shabrawy *et al.* (2010) stated that soil application of humic acid at 0.5% increased vegetative growth parameters on cucumber expressed as No. of leaves, plant height, plant fresh and dry weight, but nitrate content in leaves was insignificant. Hanafy *et al.* (2010) reported that foliar application of humic acid to snap bean plants significantly increased chlorophyll a and total chlorophyll content as well as P% in shoots. Moreover, Unlu *et al.* (2011) concluded that foliar and soil application of humic acid on cucunber plants led to significant higher fruit weight, early and total yield than the control. On pepper, Swelam (2012) revealed that foliar application of humic acid resulted in a significant increase in all studied growth characters, i.e., plant height, number of leaves and branches, leaf area as well as fresh, dry weights, chlorophyll, N, P, K, VC and total yield of plants. Arafa *et al.* (2012) studied the effect of bio-stimulants (seaweed extract and humic acid) and showed that foliar exogenous application of bio-stimulants significantly increased photosynthetic pigments, N, P and K % content of potato. El-Nemr *et al.* (2012) used humic acid at 0, 1, 2 and 3 g/L as foliar application and showed that total chemical contents percentage N, P, K, Ca and Mg in leaves of cucumber plants were increased with increasing the amount of humic acid level 3 g/L. It increased also significantly yield and its components.

Shabana *et al.* (2012) stated that humic acid had a significant effect on content of VC, TSS and total fruit yield/fed. of tomato and kidney bean plants. El-Seifi *et al.* (2013a and b) studied the effect of two bio-stimulants (seaweeds extract and humic acid) on sweet pepper and showed that humic acid increased vegetative growth parameters i.e., plant height, No. of leaves and branches, fresh, dry weights, N, P, K, Mg, Fe, Zn, Mn, photo-synthetic pigment content (chlorophyll a & b and a+b) and fruit yield. Helmy (2013) found that spraying pea plants with humic acid increased values of plant height, number of branches per plant, number of leaves per plant and dry weight of plant, photosynthetic pigments (chlorophyll a, b and total chlorophyll a + b), nitrogen, phosphorus, potassium in leaf tissues and yield.

Iron plays many important roles in the growth and development of higher plants. Iron has many plant metabolic functions, and it's also a component of many enzymes. Uptake of iron by crop plants exceeds uptake of all other essential micronutrients except chlorine (Naeve, 2006).

Abdel (2006) indicated that spraying faba bean plants with 100 mg L^{-1} Fe EDDHA significantly increased seed yield by 19.75%. Sahu *et al*. (2008) reported that the application of $FeSO_4$ at 2kg ha^{-1} significantly increased the growth characters over control in chickpea. Kumar *et al*. (2009) conducted an experiment and reported that the branches, number of pods/ plant, number of grains/ pod and test weight significantly increased with levels of Fe up to 10 kg Fe ha^{-1} over control in choick pea. Kobrace *et al*. (2011) reported that growth, nodulation, photosynthesis pigments and dry matter production were increased in soybean by Fe application.

This work aimed to evaluate the yield, quality and chemical composition of pea plants under the application of several N sources, humic acid as a organic fertilizer, spraying with iron element and their interactions.

MATERIALS AND METHODS

Two field experiments were conducted in the two winter seasons of 2013/2014 and 2014/2015 on pea plants c.v. Little Marvel at the Experimental Station, Mansoura University, Egypt to study the effect of three nitrogen sources, humic acid addition and foliar application of iron element either solely or combined with each other on growth, yield, chemical constituents and quality of pea plant.

Experimental design and treatments:

The experimental layout was strip split plot design with three replicates. Each experiment included 12 treatments including three nitrogen sources, two humic acid soil addition and two foliar application with iron element.

The vertical plots were assigned to three nitrogen sources treatments as follows:

1- Ammonium sulphat (AS).
2- Ammonium nitrate (AN).
3- Urea (U).

The Horizontal plots were devoted to two humic acid treatments as follows:

1- Without humic (0).
2- Humic acid (H) was applied to the soil before seed sowing at rate of (20 Kg/fed.*).*

The sub – plots were located to two iron treatments as follows:

1- Without iron (0).
2- Iron (Fe) added as foliar application, twice. Once after 4 week from seed sowing and the other one weeks later at the rate of 500 ppm.

Each treatment was replicated three times; thus, the total numbers of the experimental plots were 36. Nitrogen fertilizers was added from three sources i.e ammonium sulphate (20.5% N), ammonium nitrate (33.5% N) and urea (50% N) in rates of 60 Kg $N.fed^{-1}$. Phosphorus and Potassium were added in rate 45 and 70, respectively. The given doses were divided into two equal parts; the first at 3 weeks from sowing and the other at two weeks later in both seasons. All other agricultural practices were conducted as a Ministry of Agriculture recommendation.

The experimental unit area was 10.5 m^2 and it contained three rows 5m long and 70 cm wide. Seeds of pea (*Pisium sativum* L.*)* were inoculated with *rhizobium* and sown into the field on 30 and 20 November for the first and second seasons, respectively.

Mechanical and chemical analysis of soil:

Soil samples were taken at random from the experimental field area at a depth of 0 – 30 cm from soil surface before sowing to estimate mechanical and chemical soil properties as shown in Table 1.

Table 1: Mechanical and chemical analysis of the experimental soil during 2013/2014 and 2014/2015 seasons:

season	Mechanical analysis %				Texture class	OM %	SP %	$CaCO_3$ %	E.C $dS.m^{-1}$ 1:5	pH 1:2.5	Available ppm		
	Clay sand	Fine sand	silt	clay							N	P	K
1st	2.3	18.7	42.9	36.1	Loamy	2.05	53.2	2.19	1.34	7.83	52.1	6.91	326
2nd	2.9	17.8	43.7	35.6	Loamy	1.98	54.1	3.92	1.09	8.06	49.7	7.03	326

***Soil suspension (1:2.5) ** Soil extraction (1:5)**
OM%: Organic matter SP%: Saturation percentage E.C: Electrical conductivity

Measurements:

After 50 days from the sowing, a sample of 10 plants were randomly taken from each experimental unit to determine the following parameters:
Vegetative growth:
1- Fresh weight (g)
2- Dry weight (g)
3- Plant length (cm)
4- Number of leaves/plant

Chemical composition:-

1- Chlorophyll content was estimated as the method described by Goodwine (1965).
2- Total nitrogen content in the leaves and seeds of pea plant was determined using the modified method described by Jones *et al*., (1991)
3-Total phosphorus in the leaves and seeds of pea plant was determined spectrophotomitrically as described by Jackson (1973).
4- Total Potassium content in the leaves and seeds of pea plant were estimated Flamephotometrically according to the method described by Peterburgski (1968).
5-Total Fe, Mn and Zn in the leaves and seeds of pea plant were estimated using atomic absorption spectrophotometer according to the methods of Chapman and Pratt (1982)

Quality parameters and yield:

Green pods of each plot were harvested at the maturity stage, then the following parameters were recorded.
1- Carbohydrates% : It was estimated in seeds of pea plant according to the method described by Hedge and Hofreiter (1962).

2- Sugar%: Total soluble sugar, it was determined according to the method described by Sadasivam and Manickam, (1996).
3- Vitamin C (mg/100g): Ascorbic acid (vitamin C) in pea seeds was determined according to the method reported in AOAC (1975).
4- Crude protein %: According to AOAC (2000) , crude protein of each sample was calculated by multiplying the total nitrogen by the factor 6.25.
5- NO_3-N ppm: Nitrate content in plant were determined according to the method described by Singh (1988).
6- Total yield of pea plant: It was calculated as the total weight of green pods (ton/ fed.).

Statistical analysis:

All data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip split – plot design as published by Gomez and Gomez (1984) by means of "MSTAT-C" Computer software package.

Treatment means were compared using least significant difference (LSD) method at 5 % levels of probability according to the procedure outlined by Snedcor and Cochran (1980).

RESULTS AND DISCUSSION

Data are presented under separate heading including vegetative growth parameters, chemical composition, quality parameters and yield of pea plant as affected by nitrogen sources, humic acid fertilization, iron foliar application and their interactions.

1- Vegetative growth parameters of pea plant.

The parameters used for measuring vegetative growth in this study are fresh weight, dry weight, plant length and number of leaves/plant.

Ammonium nitrate fertilizer caused a significant increment in vegetative growth characters i. e fresh, dry weights and plant length, but number of leaves/plant the differences were insignificant in the two seasons. Ammonium sulfate came in the second order in that respect, as shown in Table 2.

Table 2 also shows that plants treated with humic acid gave significant increased in all above vegetative growth characters in the two seasons of study comparing with untreated plants, except dry weight in the second season and No. of leaves/plant in the first season.

Data in Table 2 shows that iron spraying resulted significant increases in fresh, dry weights , plant length and number of leaves/plant of pea comparing with untreated plants.

Table 2: Fresh weight, Dry weight, Plant length and Number of leaves/plant as affected by Nitrogen sources, humic acid and iron as well as their interactions on pea plants during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Fresh weight (g)		Dry weight (g)		Plant length (cm)		Number of leaves/plant	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
A- N sources								
AS	31.10	34.20	3.67	4.31	37.33	43.25	10.58	11.75
AN	31.55	34.47	3.72	4.37	38.00	44.00	11.33	11.91
U	30.79	33.93	3.62	4.44	36.83	42.75	10.58	11.58
LSD at 5%	0.10	0.11	0.01	0.04	0.75	0.61	NS	NS
B- Humic :								
0	30.00	33.67	3.49	4.21	35.22	42.61	10.61	11.44
H	32.30	34.73	3.85	4.54	39.55	44.05	11.05	12.05
F. test	*	*	*	NS	*	*	NS	*
C- Fe:								
0	30.50	33.10	3.57	4.08	36.11	42.33	10.61	11.38
Fe	31.79	35.30	3.77	4.67	38.66	44.33	11.05	12.11
F. test	*	*	*	*	*	*	*	*
D- Interactions:								
A × B	*	NS	NS	NS	NS	NS	NS	NS
A × C	*	NS	*	NS	NS	NS	NS	NS
B × C	*	*	*	NS	*	NS	NS	NS
A × B × C	NS	NS	NS	NS	NS	NS	NS	NS

(AS): Ammonium sulphat. (AN): Ammonium nitrate. (U):Urea.
(H): Humic acid (Fe): Iron

2- Chemical composition of pea plant.

The parameters used for measuring chemical composition in this study are N %, P%, K%, Fe ppm, Mn ppm , Zn ppm, chlorophyll a, b, total in leaves, as well as N%, P%, K% and Fe ppm in seeds in both seasons of study.

Pea plant fertilized with ammonium nitrate gave the highest values of N, P, K percentage in plant leaves in the two seasons with significant differences (Table 3) except P% in the first season. Ammonium sulfate occupied the second order. Results of concentrations of Fe , Mn and Zn in pea leaves in the same table show superiority of ammonium sulfate, urea fertilizer in the second order with significant differences in the two season of study.

Results in Table 4 show significantly increase in chlorophyll a, b and total in plants fertilized with ammonium nitrate in the two seasons. Concerning, the effect of nitrogen sources on N, P, K% and Fe concentration in seeds, obtained data show the same trend of previous data as shown in Table 5.

It is clear from the results in Table 3 that the highest values in all above mentioned characters were recorded from the plant treated with humic acid in the two seasons of study comparing with control plants with significant differences.

Table 3: N, P, K% ,Fe, Mn and Zn ppm in leaves of pea plants as affected by nitrogen sources, humic acid and iron as well as their interactions during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	N (%)		P (%)		K (%)		Fe (ppm)		Mn (ppm)		Zn (ppm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
A- N sources												
AS	4.35	4.36	0.311	0.334	3.01	2.55	80.31	71.99	45.88	39.55	30.54	26.33
AN	4.47	4.42	0.326	0.341	3.16	2.61	107.30	96.85	46.90	39.71	31.48	26.99
U	4.25	4.29	0.307	0.326	2.87	2.48	93.83	84.57	43.75	37.40	29.99	25.67
LSD at 5%	0.02	0.03	NS	0.002	0.03	0.02	0.56	0.46	0.90	0.66	0.57	0.55
B- Humic :												
0	4.28	4.21	0.306	0.320	2.94	2.42	88.56	79.95	44.62	38.15	29.97	25.58
H	4.44	4.50	0.323	0.347	3.08	2.68	99.06	88.98	46.40	39.63	31.37	27.06
F. test	*	*	NS	*	*	*	*	*	*	*	*	*
C- Fe:												
0	4.32	4.09	0.311	0.306	2.97	2.29	73.89	66.65	44.96	38.40	30.28	26.00
Fe	4.39	4.62	0.318	0.362	3.06	2.80	113.73	102.28	46.06	39.37	31.06	26.65
F. test	*	*	NS	*	*	*	*	*	*	*	*	*
D- Interactions:												
A × B	NS	NS	NS	*	NS	NS	*	*	NS	NS	NS	NS
A × C	NS	NS	NS	NS	NS	NS	*	*	NS	NS	NS	NS
B × C	NS	NS	NS	NS	NS	NS	NS	*	NS	*	NS	NS
A × B × C	NS	NS	NS	NS	NS	*	NS	*	NS	*	NS	NS

(AS): Ammonium sulphat. (AN): Ammonium nitrate. (U):Urea.
(H): Humic acid (Fe): Iron

Table 4: Chlorophyll a, b and (a+b) in pea leaves as affected by nitrogen sources, humic acid and iron as well as their interactions during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Chlor. A (mg/g F.W)		Chlor. B (mg/g F.W)		Chlor. A+b (mg/g F.W)	
	1st	2nd	1st	2nd	1st	2nd
A- N sources						
AS	0.624	0.590	0.425	0.411	1.048	1.001
AN	0.633	0.598	0.434	0.420	1.067	1.018
U	0.616	0.579	0.417	0.419	1.032	0.999
LSD at 5%	0.003	0.007	0.004	0.014	0.004	0.016
B- Humic :						
0	0.604	0.568	0.409	0.405	1.012	0.973
H	0.645	0.610	0.442	0.428	1.086	1.039
F. test	*	*	*	*	*	*
C- Fe :						
0	0.582	0.549	0.389	0.387	0.972	0.936
Fe	0.666	0.629	0.461	0.446	1.127	1.076
F. test	*	*	*	*	*	*
D- Interactions:						
A × B	NS	*	NS	NS	*	NS
A × C	NS	NS	NS	*	NS	*
B × C	NS	*	NS	*	NS	*
A × B × C	NS	NS	NS	*	NS	*

(AS): Ammonium sulphat. (AN): Ammonium nitrate. (U):Urea.
(H): Humic acid (Fe): Iron

It is evident from data in Tables 4 and 5 that humic acid application significantly enhanced chlorophyll a, b and total, N, P, K% and Fe concentration in seeds of pea plants than control treatment in both seasons.

It observed a clear increase in all studied traits in the same Table 3 with significant differences when plants sprayed with iron in the two seasons in pea leaves in the first season.

Results in Tables 4 and 5 indicate that chlorophyll a, b and total in leaves, N, P, K% and Fe concentration in seeds of pea were significantly increased by spraying plants with iron as compared with control treatments a in both seasons.

Table 5: N, P, K% and Fe ppm in seeds of pea as affected by nitrogen sources, humic acid and iron as well as their interactions during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	N (%)		P (%)		K (%)		Fe (ppm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
A- N sources								
AS	3.76	4.18	0.338	0.385	4.38	3.95	93.64	85.88
AN	3.89	4.29	0.355	0.408	4.56	4.11	69.91	64.30
U	3.65	4.02	0.323	0.361	4.23	3.84	82.10	76.50
LSD at 5%	0.02	0.39	0.007	0.017	0.04	0.63	0.67	0.54
B- Humic :								
0	3.69	4.08	0.326	0.369	4.28	3.87	77.47	71.47
H	3.84	4.24	0.351	0.400	4.50	4.06	86.30	79.64
F. test	*	*	*	*	*	*	*	*
C- Fe:								
0	3.73	4.09	0.332	0.377	4.33	3.93	64.78	60.33
Fe	3.81	4.24	0.346	0.392	4.45	4.00	98.98	90.78
F. test	*	*	*	*	*	*	*	*
D- Interactions:								
A × B	NS	NS	*	NS	*	NS	*	*
A × C	NS	NS	NS	NS	NS	*	*	*
B × C	NS	NS	NS	NS	*	NS	NS	*
A × B × C	NS	*	NS	NS	*	*	*	*

(AS): Ammonium sulphat. (AN): Ammonium nitrate. (U):Urea.
(H): Humic acid. (Fe): Iron.

3- Quality parameters and Yield of pea plant.

The parameters used for measuring yield quality in this study are total carbohydrates %, total soluble sugars %, vitamin C ,crude protein NO_3-N ppm and yield ton/fed. of pea.

It observed a clear increase in Carbohydrates, Sugars %, Vitamin C concentration, Crude protein and nitrate concentration in plant leaves when fertilized with Ammonium nitrate followed by plant fertilized with Ammonium sulfate and the differences were significant in the two seasons of study (Table 6).

Results in Table 6 show a significant superiority of Ammonium nitrate treatment over the other treatments in yield /fedden. Plants fertilized with Ammonium nitrate gave the highest yield (4.25 - 4.30 ton/feddan) followed by plants fertilized with Ammonium sulfate (4.02 - 4.20 ton/feddan) with significant differences in the two seasons.

Table 6 : Carbohydrate, Sugar, Vitamin C, Crude protein, NO_3-N and Yield of pea plants as affected by nitrogen sources, humic acid and iron as well as their interactions during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Carbohydrates (%)		Sugars (%)		Vitamin C (mg/100g)		Crude protein (%)		NO_3-N (ppm)		Yield (t/fed)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
A- N sources												
AS	48.54	51.17	16.09	15.33	41.12	43.25	23.47	26.10	16.48	17.70	4.02	4.20
AN	50.49	52.95	16.70	15.95	42.76	44.93	24.32	26.81	19.39	18.05	4.25	4.30
U	47.40	49.74	15.62	14.87	39.95	42.03	22.80	25.14	16.04	17.26	3.95	4.00
LSD at 5%	0.32	0.23	0.14	0.09	0.10	0.08	0.012	0.37	0.16	0.14	0.17	0.14
B- Humic												
0	47.78	50.16	15.81	15.06	40.39	42.44	23.04	25.52	18.77	18.25	3.81	3.96
H	49.83	52.40	16.46	15.70	42.17	44.36	24.02	26.51	15.83	17.08	4.30	4.41
F. test	*	*	*	*	*	*	*	*	*	*	*	*
C- Fe:												
0	48.26	50.50	15.97	15.22	40.86	42.93	23.28	25.55	17.75	18.82	3.86	3.86
Fe	49.36	52.07	16.30	15.53	41.70	43.86	23.78	26.48	16.85	16.52	4.25	4.51
F. test	*	*	*	*	*	*	*	*	*	*	*	*
D- Interactions:												
A × B	NS	*	NS	NS	NS	NS	*	NS	NS	NS	*	*
A × C	NS	NS	NS	*	*	*	NS	NS	NS	NS	*	*
B × C	NS	NS	*	*	NS	*	NS	NS	NS	NS	*	*
A × B × C	NS	NS	NS	*	*	*	NS	*	NS	NS	*	*

(AS): Ammonium sulphat. (AN): Ammonium nitrate. (U):Urea.
(H): Humic acid. (Fe): Iron.

As for the effect of humic acid, results in Table 6 indicate that humic acid shows significant increases in all quality parameters and Yield of pea plant than the control treatment during both growing seasons.

Referring the effect of iron spraying, data in Table 6 reflect that quality parameters and Yield of pea plant were significantly increased when pant treated with iron compared with untreated plants in both seasons.

Effect of interactions:

Impact of interaction among the experimental treatments gave insignificant differences in the majority of cases. (Tables 2 to 6)

The overlap among fertilization with ammonium nitrate, humic acid application and iron spraying caused significant increment comparing with other treatments in K %, Fe ppm, Mn ppm, chlorophyll B and total in leaves , N% , sugars % and cured protein % in seeds in the second season, K% and Fe in seeds as well as vitamin C and total yield in both seasons.

Interaction among Ammonium sulphate, humic acid and iron raised significantly Mn concentrations in plant leaves in the second season and iron concentration in seeds in both seasons.

While the interaction among Urea fertilizer, humic acid and iron caused significantly increment in total chlorophyll in the second season.

The effect of interaction among nitrogen sources, humic acid addition and iron foliar application on yield of pea plants was shown in Table 7. It is clear that the highest values obtained when plants treated with ammonium nitrate with humic acid and iron foliar addition in the two seasons of study followed by plant treated with ammonium sulfate plus humic acid addition plus iron foliar application.

Table 7: Yield (t/fed) of pea as affected by the interaction among nitrogen sources, humic acid and iron during 2013/2014 and 2014/2015 seasons.

Treatments Characters		AS				AN				U				LSD 5%
		0		H		0		H		0		H		
		0	Fe	0	Fe	0	Fe	0	Fe	0	Fe	0	Fe	
Yield	1st	3.54	4.11	4.16	4.34	3.72	4.28	4.25	4.46	3.11	4.09	4.27	4.32	0.16
Ton/fed.	2nd	3.81	4.33	4.22	4.67	3.83	4.38	4.27	4.71	3.08	4.32	3.93	4.64	0.15

(AS): Ammonium sulphat. (AN): Ammonium nitrate. (U):Urea.
(H): Humic acid. (Fe): Iron.

The positive overlap among the factors under study can be attributed to the individual influences for each factor. As already mentioned that fertilization with ammonium nitrate, humic acid addition and iron spraying, all of them caused significant superiority for vegetative growth, yield and its components as well as the concentrations of the estimated elements in the leaves, seeds and the concentration of chlorophyll a, b and total. This individual superiority of the mentioned materials reflected on these qualities when the three factors overlapped.

Obtained results can be discussed and interpreted based on the roles played by each of the factors under study in influencing the vegetative growth, yield, quality attributes and chemical composition.

Superiority pea plants fertilized with ammonium nitrate fertilizer in the most of parameters under study may be due to one or more of the following reasons:

Different soil nitrogen forms have different effects on plant growth. Some plants prefer NH^+_4 and some NO^-_3 but the relative absorption rate of soil nitrogen by plants is related to soil NO^-_3 : NH^+_4 ratio (Serna *et al 1992*).

The N from (nitrate or ammonium) supplied affects the growth and development of the plant and its chemical composition. Most plants can use both nitrogen forms, but the efficiency and preference depends on the plant species, variety and the age of plant as well as the nutritional and environmental conditions and the other concentrations of nutrients (Marscher, 1995).

Nitrate and ammonium ions are the two major forms of nitrogen taken up by plants. Although nitrate taken up from the medium is reduced to ammonium before its assimilation into the organic nitrogen compounds, it has long been observed that ammonium and nitrate , as nitrogen sources , differ in their effects on the growth and chemical composition of plants (Jimenz and Lao , 2005).

Urea is decomposed by the enzyme urease of chemically hydrolyzed into ammonia and CO_2 in the ammonification prosses, ammonia is converted by ammonium oxidizing bacteria into ammonium, in the next step, ammonium is converted by nitrifying bacteria into nitrate (nitrification).

Combined NH^{+}_{4} and NO^{-}_{3} fertilization at an appropriate ratio results in greater biomass accumulation compared with plants fed with either nitrogen source alone as reported by El- Deweny (2011). Our results are in agreement with those obtained by El- Nemer *et al*. (2012) and Arafa *et al*., (2012).

Humic acid improve soil structure and change physical properties of soil, increasing holding water, promote the chelation of many elements and make these available to plants, also it increase nutrient uptake such as N, Ca, P, K, Mg, Fe , Zn and Cu which play an important role in photosynthetic processes which reflection on plant growth , development and therefore increase the yield and quality (Mayhew, 2004).

Our results are in the same trend with those demonstrated by Helmy (2013) and El- Sefi *et al*. (2013 a, b).

Iron is essential for the synthesis of chlorophyll . It is involved in N fixation, Photosynthesis and electron transfer. It is required in protein synthesis and is a constituent of hemoprotein. It is also a component of many enzymes and involved in respiratory enzyme system as a part of cytochrome and hemoglobin. Iron is involved in nitrogen fixation, chlorophyll formation, protein synthesis, enzyme systems, plant respiration and photosynthesis and energy transfer. Solubility and uptake of iron is highly PH dependent, decreasing with increasing soil PH. (Bennett, 1993).

The promotive effect of Fe on broad bean nodulation might be attributed to that Fe contributes in very enzymatic activities, such as catalase, peroxidase and nitrate reductase. Iron metabolism is of particular importance in nodules since this metal is a constituent of key proteins such as nitrogenase and leghemoglobin (Moreau *et al*., 1995).

In this connection, El-Mansi *et al*.(2005) found that application of Fe increased number of nodules/plant. Kobrace *et al*. (2011) reported that growth, nodulation, photosynthesis pigments and dry matter production were increased by Fe application and *Vice versa.*

Perhaps the reason outweigh the plants that have been sprayed with iron on the untreated plants in the traits under study to the positive impact of iron on the formation of nodules and chlorophyll. Our results are in the line with those obtained by some researches in this regard. (Abdel, 2006; Naeve, 2006 ; Sahu *et al*. 2008 and Kumer *et al*. 2009).

As mentioned above our result may be due to the positive effects of the material used (ammonium nitrate plus humic acid addition and iron foliar application) on aforementioned parameters of vegetative growth, elements absorption and chlorophyll content. These reflected on yield of plant.

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تأثير مصادر النتروجين و حمض الهيوميك و الرش بالحديد علي البسلة

سمر محمد عبد الحميد دقليجه

قسم الخضر والزينة - كلية الزراعة - جامعة المنصورة

أجريت تجربتان حقليتان بمزرعة كلية الزراعة جامعة المنصورة فى الموسميين الشتويين2013/2014 و 2014/2015 لدراسة تأثير استخدام ثلاثة مصادر من النتروجين و إضافة الهيوميك اسد (٢٠ كجم/ الفدان) والرش بالحديد بتركيز (٥٠٠ ppm) على النمو والمحصول والمكونات الكيماوية وصفات الجودة لنباتات البسلة صنف لتل مارفل.

وقد أظهرت النتائج أن اعلي القيم المتحصل عليها لقياسات النمو الخضري المتمثلة فى الوزن الطازج والجاف للنباتات وطول النبات وعدد الأوراق / النبات كانت عند تسميد النباتات بسماد نترات الامونيوم و اضافه الهيوميك اسد والرش بالحديد فى كلا الموسمين. ونفس المعاملات المذكورة سابقا سببت التفوق بدرجه معنوية لتركيز عناصر النتروجين و الفسفور و البوتاسيوم والحديد والمنجنيز وكذلك تركيز كلوروفيل أو ب والكلى فى أوراق وبذور البسلة كما أعطت اعلى القيم فى صفات الجودة المتمثلة فى النسبة المئوية للكربوهيدرات الكلية والسكريات الكلية وفيتامين c علاوة على انخفاض تركيز النترات.

وقد أظهرت التجربة ان تداخل العوامل الثلاث (التسميد بنترات الامونيوم مع إضافة الهيوميك والرش بالحديد) قد أعطى اعلي محصول متفوقا بدرجه معنوية على المعاملات الأخرى فى كلا الموسمين لذا فإن هذه المعاملة يمكن التوصية بها لزيادة محصول البسلة وصفات الجودة تحت نفس الظروف.