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Response of Maize Intercropping with Soybean to Nitrogen Fertilizer and Humic Acid Application.

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ABSTRACT

Two field experiments were conducted at Zarzoura Experimental Station in Etay El-Baroud El-Behira Governorate, during 2013 and 2014 seasons, to study the effect of nitrogen fertilizer with humic acid (for maize), i. e. 120 Kg N/faddan, soil humic acid (5Kg/ fad.), foliar application humic acid (5g/litter), soil and foliar application humic acid, 60 Kg N/faddan plus soil humic acid, 60 Kg N/faddan in combination with foliar humic acid, 60 Kg N/faddan plus soil and foliar humic acid on growth, yield and chemical constituents under one intercropping system 2 : 2 row maize/soybean, as well as maize sole and soybean sole. Results indicated that: 1-Maize: growth, yield and its components had significant effect for nitrogen fertilizer with humic acid except ear position %, ear diameter and rows number/ear, sole maize, 120 Kg N/faddan and 60 Kg N/faddan with soil and foliar humic treatments had the highest values, while the lowest values were obtained with foliar humic, soil humic as well as soil and humic application in both seasons. 2-Soybean: growth and yield and its components characters did not significantly affected by nitrogen fertilizer with humic acid except shoot dry weight, number of pods/plant, seed weight/plant and seed yield/faddan, the highest values were obtained in sole soybean.3- The results verified that chemical characters of maize and soybean were significantly affected by nitrogen fertilizer with humic acid except protein% and oil% in maize as well as carbohydrates% and oil% in soybean the highest values were obtained with sole treatments followed by the combination between soil application on nitrogen and soil or foliar humic acid, while the lowest values were obtained with foliar humic, soil humic as well as soil and foliar humic acid application. 4- The data of competitive relationships indicated that all the imposed treatments showed yield advantage compared with solid planting. Maximum values LER and K were obtained when applied 120 Kg N/faddan followed by 60 Kg N/faddan plus soil and foliar humic acid application. Aggressivity, maize was dominated in 120 Kg N/faddan and 60 Kg N/faddan with soil and foliar humic acid, while soybean was dominated in foliar humic and soil and foliar humic acid application.

Keywords: Nitrogen, Humic acid, Intercropping, Maize, Soybean.

INTRODUCTION

Maize is one of the major cereal crops grown in Egypt and in the world after wheat and rice. Soybean as oil crop does not achieve a self sufficiency of its production, due to competition of other summer crops which have good popularity and occupied high area in the crop structure and so, for its weak competition, we can increase its productivity by some intensification programs such as intercropping with summer crops such as maize, tomato, cucumber and other crops.

Most of researches appeared that intercropping especially with legumes crops helps to maintain and improve soil fertility, fix atmospheric nitrogen which may be utilized the host plant, or may be excreted from the nodules into the soil and be used by other plants growing nearly. The fixed nitrogen may also be released by decomposition of the nodules or leguminous residue after the legumes plants die or are ploughed under.

The crop residues left on the surface after harvest or incorporated into the soil are not leached by surface run-off in the same manner as liquid and chemical fertilizers can. This means fewer nutrients are lost and more water is available for crop growth. Because of these reassures, intercropping of cereal and legume crops helps to maintain and improve soil fertility (Shen and Chu, 2004; Dahmardeh *et al*., 2010).The intercropping system lead to increasing land equivalent ratio (LER) and land unit productivity (Patra and Pio, 1998; Abdalla *et al*., 1999 and willy, 1990).

Intercropping is the practice of growing more than one crop simultaneously in alternating rows of the same field (Beets, 1990).

Humic acid is a commercial product contains many elements which improve the soil fertility and increase the availability of nutrients and consequently increase plant growth and yield (Javanmard *et al*., 2009)

Hafez (2003) found that the dry matter yield of barley plants grown on sandy and calcareous soils was significantly increased with increasing the addition rate of humic acid from 450 to 900 mg/Kg soil.

Humic acid is an important constituent and an intimate part of the soil organic structure which is highly effective in improving soil condition and plant growth (Pettit, 2004). Humic acid is one of the main components of humic substances. Humic matter is formed through the biological and chemical humfication of dead animal and plant parts and through the biological actions of microorganisms.

Humic acid may be utilized in agriculture as a fertilizer, plant growth promoter, nutrient carrier and soil conditioner (Bidegain *et al*., 2000). Small concentrations of humic acid have been reported to enhance shoot growth length, plant growth, root length, moisture and nutrient uptake significantly (Yilmaz, 2007).

Some researchers (David, 1991 and Padem *et al.* 1997) have concluded that humic acid as foliar sprays enhanced growth, nutrient uptake and yield improved the quality of the produce in some crops, this may be decrease the NPK fertilizer applied as soil application and also decrease pollution and costs.

The present work designed to study the effect of nitrogen fertilizer with humic acid under intercropping condition on growth, yield and its components as well as chemical constituents of maize and soybean.

MATERIALS AND METHODS

The present investigation was conducted at Zarzoora Experiment station, Etay El-baroud, El-

Beheira governorate, Egypt Agriculture Research Center, during 2013 and 2014 seasons. The main objective was to study the effect of nitrogen fertilization and humic acid on growth and yield of maize and soybean intercropping.

Maize variety (W T C, 323) and soybean variety (Giza111) were sown at 2nd and 1st June in both seasons, respectively. Plot area was 16.8 m^2 (5.6 x 3m) included 8 rows, 70 cm apart, 3m long. The intercropping system was 2 rows maize alternated with 2 rows soybean. Maize was sown in hills spaced 30 cm and plants were thinned to two plants per hill in the intercropping treatments, but in sole maize treatment one plant only was grown per hill. Soybean was sown in hills spaced 20 cm and 2 plants were grown per hill in either intercropping or in sole treatments.

Some physical and chemical properties of the experimental site are shown in **Table (1)**

Table (1): Physical and chemical properties of the experimental site during two growing seasons.

Soil properties	Soil texture	Clay %	Silt %	Sand %	PH	Organic matter %	Available N ppm	Available P ppm	Available K ppm
Season 2013	Clay	47.10	26.85	13.81	8.05	2.17	33.0	24.0	302
Season 2014	Clay	51.79	27.88	12.63	7.80	1.99	30.0	21.0	220

Maize was fertilized under intercropping system treatments as follows:

1-120 Kg N/ fad.
2- Soil humic acid application.
3- Foliar humic acid application.
4- Soil and foliar humic acid application.
5- 60 Kg N/ fad. + Soil humic acid.
6- 60 Kg N/ fad. + Foliar humic acid.
7- 60 Kg N/ fad. + Soil and foliar humic acid.
In addition:
8- Maize in pure stand fertilized by 120 Kg N/faddan.
9- Soybean in pure stand.
Soybean was fertilized by 25 Kg N/faddan.

A nitrogen fertilizer in the form of ammonium nitrate (33.5 % N) was applied in two equal doses, before the first and second irrigation.

All agricultural practices were carried out according to the recommendations of Ministry of Agriculture, Egypt.

Humic acid was added in soil in the rate of 5 Kg/faddan before the first irrigation. Plants were sprayed with humic acid in the rate of 5g /litter at two times after 25 and 39 days from planting.

Characters studied:

1-Maize growth characters:

Five plants were taken randomly from each plot at 52 and 77 days after planting to determine: leaf area/plant (cm^2), leaf area index (LAI) and shoot dry weight (g) and at harvest time, plant height (cm), ear height (cm) and ear position (%) were estimated.

2-Maize yield and its components:

Five plants were taken at harvesting from each plot to determine: ear length (cm), ear diameter (cm), rows number/ear, grains number/row, 100-grain weight (g), grains weight/ear (g) and grains yield/fed. (Ardab) was estimated from the whole plot basis.

3-Soybean growth and yield traits:

At 52 and 77 days after sowing, leaf area/plant (cm^2), LAI and shoot dry weight (g) were determined from five plants in each plot. While, five plants were taken at harvest time to determine: plant height (cm), pods number/plant, 100-seed weight (g) and seed weight/plant (g). Seed yield /fad. (Kg) was calculated from the whole plot.

4-Chemical analysis for maize and soybean:

At the age of 77 days, chlorophyll content was estimated as mg/g leaf fresh weight (according to Moran and Porath 1980).

Samples of maize grains and soybean seeds were taken and dried at 70 c^0 until constant weight to estimate the percentage of:

Protein percentage (%): nitrogen content was determined using modified Micro- Kjeldahl method.

Crude protein content (%) was calculated by multiplying nitrogen content by 6.25 (A.O.A.C., 1988).

Carbohydrates content (%): total carbohydrates was determined using phenol sulphuric method (Dubois *et al*., 1956).

Oil percentages (%): was determined by extracting using Soxhlet apparatus according to the method described by (A.O.A.C., 1990).

5-Competitive relationships and yield advantages were also calculated:

Land equivalent ratio (LER): from Mead and Willey (1980).

$$LER = \frac{yab}{yaa} + \frac{yba}{ybb}$$

Relative crowding coefficient (K): From Dewit (1960).

K (RCC)=Ka x Kb were Ka =

$$\frac{Yab \ x \ Zba}{(Yaa - (Yaa - ab) x \ Zab} X \ Kb = \frac{Yba \ x \ Zab}{(Ybb - Yba) x \ Zba}$$

Aggressivity (Agg): From Mc-Gilchrest (1965).

$$Agg = \frac{yab}{yaa \ x \ Zab} - \frac{yba}{ybb \ x \ Zba}$$

Where:

Yaa = yield of component (a) in pure stand.
Ybb= yield of component (b) in pure stand.
Yab=yield of component(a)in intercrop with component (b).
Yba = yield of component (b) in intercrop with component (a).
Zab = the proportion of component (a) in the mixture.
Zba = the proportion of component (b) in the mixture.

Statistical analysis:

The experiment included 9 treatments applied on intercropping system with four replicates were assigned in a randomized complete block design (RCBD), the compared between treatments using (L.S.D.) at 5% probability level according to (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

1- Effect of nitrogen fertilizer and humic acid on growth characters of maize in 2013 and 2014 seasons.

Results in Table (2) showed that leaf area/plant, leaf area index (LAI) and shoot dry weight were significantly affected by nitrogen fertilizer and humic acid at 52 and 77 days after planting in both seasons, plant height and ear height were significantly affected by nitrogen fertilizer and humic acid the highest values were obtained in the solid planting under fertilizer 120 Kg N/faddan for leaf area/plant while, leaf area index had the highest values with the same dose (120 Kg N/faddan) but when maize intercropped with soybean the highest values of shoot dry weight were estimated when maize grown as pure stand in the two seasons, respectively.

Table (2) Effect of nitrogen fertilizer and humic acid application on maize growth under intercropping in 2013 and 2014 seasons.

Treatments	At 52 days after planting			At 77 days after planting			At harvest time		
	Leaf area /plant (cm^2)	Leaf area index (LAI)	Shoot dry weight (g)	Leaf area /plant (cm^2)	Leaf area index (LAI)	Shoot dry weight (g)	Plant height (cm)	Ear height (cm)	Ear position (%)
2013									
120 Kg N/fad.	5981	5.70	160.0	10817	10.30	2844.8	288.6	134.6	46.6
Soil hu.appli.	5010	4.77	137.2	9063	8.63	245.2	259.4	119.4	46.0
Foliar hu. appli.	4801	4.57	135.0	8684	8.27	234.8	253.4	116.0	45.8
Soil and foliar hu. appli.	5162	4.92	138.0	9340	8.90	252.0	263.0	120.2	45.7
60 Kg N/fad.+Soil hu.	5777	5.50	156.0	10448	9.95	286.4	289.2	134.2	46.4
60 Kg N/fad.+Foliar hu.	5710	5.43	153.4	10329	9.84	281.2	283.6	129.0	45.5
60 Kg N/fad.+Soil and foliar hu.	5897	5.62	157.4	10665	10.16	288.4	291.8	135.4	46.4
Sole maize (120 Kg N/fad.)	6129	2.92	162.0	11090	5.28	292.6	282.2	130.2	46.1
L. S. D. at 5%	475	0.45	13.4	755	0.76	22.9	19.6	9.1	NS
2014									
120 Kg N/fad.	5905	5.62	158.0	10777	10.26	281.0	286.6	1333.0	46.4
Soil hu.appli.	4942	4.71	135.8	8935	8.51	241.0	258.4	119.6	46.3
Foliar hu. appli.	4750	4.52	133.2	8568	8.16	230.0	254.8	116.4	45.7
Soil and foliar hu. appli.	5090	4.85	136.6	9214	8.78	247.4	263.6	120.0	45.5
60 Kg N/fad.+Soil hu.	5704	5.43	154.4	10320	9.83	282.0	288.2	133.4	46.2
60 Kg N/fad.+Foliar hu.	5638	5.37	152.0	10200	9.71	277.2	282.6	128.4	45.4
60 Kg N/fad.+Soil and foliar hu.	5825	5.55	155.2	10540	10.04	284.0	292.8	135.6	46.3
Sole maize (120 Kg N/fad.)	6042	2.88	160.0	10930	5.20	289.0	282.4	130.6	46.2
L. S. D. at 5%	431	0.41	13.2	733	0.69	22.1	19.2	8.9	NS

hu. = humic acid appli. = application

Also, each of plant height and ear height showed the highest values by application 60 Kg nitrogen and foliar application of humic acid.On the other hand ear position did not significantly affected by nitrogen fertilizer and humic acid in the two seasons. While, the lowest values for leaf area/plant were obtained when maize intercropped with soybean under foliar humic and when maize grown as pure stand gave the lowest values under fertilizer with 120 Kg nitrogen for leaf area index but the lowest values of shoot dry weight were indicated by foliar application humic acid, these results were indicated during the two interval 52 and 77 days and the two studied seasons. On the other hand the results showed that the lowest values of plant height and ear height were recorded when maize intercropped with soybean and fertilizer by foliar humic acid in the two studied seasons.

The results in Table (2) evidenced that the soil applications either of nitrogen fertilizer or humic acid were superior on the foliar application of humic acid where the values of all studied characters appeared to be higher than these with the foliar application. This observation may be attributed with efficiency of use of these applications by plant where, the roots of plants may be most usage by fertilizers than leaves because of temperature humidity, loose and light which lead to least usage of the fertilizer.

Tan (2003) reported that application of humic acid in nutritional solution led to increased content of nitrogen within aerial parts and growth of shoots and root of maize.

Also, the obtained data indicate that the solid growing gave high estimates of all studied characters except in case of leaf area index compared to intercropping treatments, this observation may be attributed to the number of plants grown in the hills under intercropping system compared to that in the monoculture system. Also, the superiority of LAI for plants grown in intercropped treatments compared to that in the solid culture may be attributing to the low intra-competition between the plants in the one crop (maize). Similar results were obtained by Tattini *et al*. (1990); Adani *et al*. (1998); Toaima (2006); Zen El-Dein (2009) and El-Nemr *et al*. (2012).

Table (3)Effect of nitrogen fertilizer and humic acid application on maize yield and its components under intercropping in 2013 and 2014 seasons.

Treatments	Ear length (c)	Ear diameter (cm)	Rows No. /ear	Grains No. /row	100-grain weight (g)	Grain weight/ ear (g)	Grain yield /fad. (ardab)
		2013					
120 Kg N/fad.	23.8	4.25	12.8	50.0	37.77	222.4	20.74
Soil hu.appli.	21.0	3.95	12.4	44.6	34.12	185.2	17.66
Foliar hu. appli.	20.6	3.85	12.0	43.8	33.52	174.8	17.14
Soil and foliar hu. appli.	21.2	4.00	12.4	45.2	34.44	190.4	17.88
60 Kg N/fad.+Soil hu.	23.8	4.15	12.0	50.2	37.78	227.0	20.33
60 Kg N/fad.+Foliar hu.	23.0	4.10	12.4	48.8	37.38	220.0	19.71
60 Kg N/fad.+Soil and foliar hu.	24.4	4.25	12.6	51.0	37.99	232.8	20.50
Sole maize (120 Kg N/fad.).	24.6	4.30	12.8	52.0	38.44	248.6	24.99
L. S. D. at 5%	1.5	NS	NS	3.4	2.52	18.8	1.32
		2014					
120 Kg N/fad.	24.4	4.25	12.8	49.6	38.03	227.6	21.03
Soil hu.appli.	21.8	3.90	12.2	44.2	34.83	187.3	18.18
Foliar hu. appli.	21.4	3.80	12.0	43.4	33.77	175.0	17.60
Soil and foliar hu. appli.	22.4	3.95	12.4	44.6	35.05	192.0	18.39
60 Kg N/fad.+Soil hu.	24.2	4.20	12.4	49.6	38.04	229.5	20.70
60 Kg N/fad.+Foliar hu.	23.8	4.10	12.2	48.4	37.66	220.8	20.16
60 Kg N/fad+Soil and foliar hu.	24.8	4.25	12.6	50.6	38.28	233.8	20.95
Sole maize (120 Kg N/fad.)	25.2	4.25	11.6	51.2	38.82	251.4	25.42
L. S. D. at 5%	1.7	NS	NS	3.2	2.60	19.4	1.38

hu. = humic acid appli. = application

2-Effect of nitrogen fertilizer and humic acid on yield and its components of maize in 2013 and2014 seasons.

Data in Table (3) reflected that ear length, number of grains/row, 100-grain weight, grain weight/ear and grain yield/faddan were significantly affected by nitrogen fertilizer and humic acid. On the other hand the differences between treatments did not reach to the level 5% of significance for each of ear diameter and number of rows/ear in the two studied seasons.

The highest values were recorded in sole maize (120 Kg N/fad.), followed by 60 Kg N/fad. with soil and foliar humic application in both seasons respectively. These results may be due to the role of humic acid in soil and foliar application with nitrogen fertilizer as a nutrient supplying which increase soil fertility and increase the availability of nutrients as reported by (Chen and Aviod, 1990 and David *et al.*, 1994). In the same respect, Shuixiu and Ruizhen(2001) as well as El-Hefny(2010) mentioned that KOMIX, humic acid used as soil treatment or as spray at the seedling stag significantly lead to increasing the yield and its components. Crop yield in maize increased by application of humic acid based fertilizers (Juhi *et al.*, 2011 and Baloach *et al*., 2014).

Shaaban *et al*. (2009) found that 50% NPK + 5cm/litter humic acid and 100% NPK (control) had not significantly effect on yield of wheat. On the other hand maize planting in pure stand had significant increased compared to maize grown in intercropping. Similar findings were reported by Assey *et al*. (1992b); Patra and Poi (1998); Abdalla, *et al*. (1999); Rana *et al*. (2001); Toaima (2006) and Zen El-Dein (2009) whom found that maize planting in pure stand was increased significantly compared with maize in intercropping planting.

3-Effect of nitrogen fertilizer and humic acid on growth, yield and its components of soybean in 2013 and 2014 seasons.

Results in Table (4) showed the effect of nitrogen fertilizer and humic acid on growth, yield and its components of soybean, the differences between treatments failed to reach to the 5% level of significance for each of leaf area/plant, LAI and shoot dry weight at 52 and 77 days after planting in the two seasons except, in case of shoot dry weight at 77 days of planting which was affected by nitrogen fertilizer and humic acid. The data cleared that grown soybean in sole planting gave the highest values in shoot dry weight and that effect may be due to the absent of shading by maize on soybean plants which gave soybean plants strong and high vegetative growth which reflected in highest shoot dry weight in sole soybean treatment.

On the other hand, the lowest values were obtained by growing soybean in intercropped planting and maize fertilized by foliar application of humic acid.

Table (4) Effect of nitrogen fertilizer and humic acid application (for maize) on growth, yield and its components of soybean under intercropping in 2013 and 2014 seasons.

Treatments	At 52 day			At 77 day			At harvest				
	Leaf area/ plant (cm^2)	Leaf area index (LAI)	Shoot dry weight (g)	Leaf area/ plant (cm^2)	Leaf area index (LAI)	Shoot dry weight (g)	Plant height (cm)	No of pods/ plant	100 - seed weight (g)	Seed weight/ plant (g)	Seed yield/ fad. (Kg)
2013											
120 Kg N/fad.	1106	1.58	10.40	3338	4.77	40.86	128.4	65.0	18.49	31.46	558
Soil hu.appli.	1023	1.46	1026	3187	4.55	40.02	129.0	66.4	17.68	29.02	570
Foliar hu. appli.	1001	1.43	10.15	3121	4.46	39.92	128.8	65.6	17.45	28.28	585
Soil and foliar hu. appli.	1059	1.51	10.29	3196	4.57	40.26	128.0	67.4	18.12	29.21	563
60 Kg N/fad.+Soil hu.	1091	1.56	11.22	3293	4.70	41.18	129.4	69.6	18.92	30.90	575
60 Kg N/fad.+Foliar hu.	1083	1.55	10.85	3269	4.67	40.63	129.2	69.2	18.52	30.30	570
60 Kg N/fad.+Soil and foliar hu.	1107	1.58	11.27	3341	4.77	41.34	128.8	69.4	19.00	31.79	576
Sole soybean.	1112	1.59	11.46	3356	4.79	48.94	125.0	78.4	19.33	38.73	1437
L. S. D. at 5%	NS	NS	NS	NS	NS	5.21	NS	4.9	NS	3.46	97.72
2014											
120 Kg N/fad.	1113	1.59	10.79	3394	4.85	41.29	128.8	66.0	18.37	32.34	545
Soil hu.appli.	1066	1.52	10.53	3225	4.61	40.45	129.2	67.4	17.40	29.25	555
Foliar hu. appli.	1022	1.46	10.38	3164	4.52	39.95	123.8	66.4	17.16	28.48	567
Soil and foliar hu. appli.	1076	1.54	10.59	3254	4.65	40.71	125.2	68.6	18.24	29.61	550
60 Kg N/fad.+Soil hu.	1112	1.59	11.53	3331	4.76	41.37	125.6	70.6	18.86	31.66	570
60 Kg N/fad.+Foliar hu.	1100	1.57	11.39	3286	4.69	40.33	125.0	70.2	18.57	31.25	578
60 Kg N/fad.+Soil and foliar hu.	1112	1.59	11.62	3389	4.84	41.73	126.6	70.8	19.01	31.98	566
Sole soybean.	1121	1.60	11.90	3417	4.88	49.51	124.6	79.2	19.22	39.60	1465
L. S. D. at 5%	NS	NS	NS	NS	NS	5.29	NS	5.3	NS	3.59	92.67

hu = humic acid appli = application

Vishwanatha *et al*. (2011) recorded that sole crop was significantly higher in plant height, primary and secondary branches, number of leaves and dry matter, production as compared to intercropped pigeon pea under different fertilizer treatments, At the harvest, the data showed that plant height and 100- seed weight were did not significantly affected by nitrogen and humic acid fertilizer, but each of number of pods/plant, seed weight/plant and seed yield/faddan were significantly affected by nitrogen and humic acid fertilizer, where the highest values for these characters were recorded with the sole treatment and fertilized by 25 Kg nitrogen as soil application Sadeghi and Kazemeini (2012) found similar results. On the other hand the lowest values were obtained when growing soybean in intercropped and maize fertilized by 120 Kg nitrogen or foliar humic acid application and 120 Kg nitrogen for number of pods/plant, weight of seeds/plant and seed yield/faddan, respectively. It is clear that in spite of fertilized maize by 120 Kg nitrogen under the intercropping system, but the yield was much less than in the sole culture and this effect may be attributes to the same factors i. e., shading, competition above land service and competition below land service.

These results indicated that soybean plants physiological consider much response to maize fertilizer with humic acid as a foliar or soil application with 60 Kg N/fad. and these results may be due to the role of humic acid soil and foliar application with nitrogen fertilizer as a nutrient supplying which increase soil fertility and increase the availability of nutrients as reported by Chen and Avoid (1990).

Tattini *et al*. (1990); Adani *et al.* (1998); Abdalla *et al*. (1999);Toaima (2006) and Zen El-Dein (2009) found that soybean grown in pure stand significantly increased on soybean grown in intercropping planting.

4- Effect of nitrogen fertilizer and humic on chemical contents of maize and soybean in 2013 and 2014 seasons.

1- Maize

Data in Table (5) revealed that chlorophyll estimates (a, b and total) at 77 days after planting were significantly affected by nitrogen fertilizer and humic acid in the two studded seasons, the highest values were with 60 Kg N/fad. with soil and foliar humic treatments followed by sole maize in both seasons, while the lowest values obtained with foliar humic followed by soil humic application in both seasons, these results may be due to nitrogen fertilizer with humic acid lead to increasing elements nutrients which make to enhanced chlorophyll (a, b and a+b) in leaf tissues. Selim *et al.* (2012) found that, a significant correlation ($P < 0.05$) was established between chlorophyll contents with mineral nutrients in leaf tissues i. e., N, K, Fe, Mn and Zn elements except for P element and revealed that leaf chlorophyll contents were positively influenced by micronutrients, i. e., Fe, Mn and Zn than macronutrients i. e., N, P and K under the combined effect of water stress and humic acid.

Table (5) Effect of nitrogen fertilizer and humic acid application on chemical analysis of maize and soybean under intercropping in 2013 and 2014 seasons.

Treatments	Chlorophyll content (mg/g leaf fresh weight) at 77 day						Protein %	Carbohyd-rates %	Oil %
	2013			2014					
	a	b	a+b	a	b	a+b			
Maize	Grain content (%) in 2014								
120 Kg N/fed.	1.87	0.70	2.57	1.84	0.71	2.55	8.19	70.44	5.28
Soil hu.appli.	1.66	0.62	2.28	1.63	0.63	2.26	8.72	67.42	5.22
Foliar hu. appli.	1.65	0.61	2.26	1.62	0.62	2.24	8.57	67.36	5.11
Soil and foliar hu. appli.	1.67	0.63	2.30	1.65	0.64	2.29	8.79	67.41	5.24
60 Kg N/fed.+Soil hu.	1.83	0.69	2.57	1.81	0.70	2.51	8.18	69.86	5.36
60 Kg N/fed.+Foliar hu.	1.80	0.67	2.42	1.77	0.68	2.45	8.81	69.49	5.24
60 Kg N/fed.+Soil and foliar hu.	1.90	0.72	2.62	1.87	0.72	2.59	8.26	70.05	5.53
Sole maize (120 Kg N/fed.)	1.89	0.71	2.60	1.86	0.72	2.58	8.29	70.42	5.47
L. S. D. at 5%	0.11	0.04	0.15	0.10	0.04	0.14	NS	2.13	NS
Soybean	Seed content (%) in 2014								
120 Kg N/fed.	1.93	1.12	3.05	1.95	1.20	3.15	35.73	30.12	20.01
Soil hu.appli.	1.75	1.00	2.75	1.76	1.10	2.86	33.77	30.73	20.38
Foliar hu. appli.	1.72	0.97	2.69	1.73	1.06	2.79	33.39	31.07	20.17
Soil and foliar hu. appli.	1.77	1.02	2.79	1.78	1.12	2.90	33.88	30.61	20.52
60 Kg N/fed.+Soil hu.	1.90	1.13	3.03	1.90	1.24	3.14	35.82	30.33	20.29
60 Kg N/fed.+Foliar hu.	1.89	1.08	2.97	1.88	1.19	3.07	34.43	30.67	20.37
60 Kg N/fed.+Soil and foliar hu.	1.98	1.19	3.17	1.98	1.28	3.26	36.05	30.17	20.14
Sole soybean.	2.00	1.20	3.20	2.03	1.28	3.31	36.14	30.30	20.35
L. S. D. at 5%	0.12	0.08	0.20	0.13	0.09	0.22	2.21	NS	NS

hu. = humic acid appli. = application

On the other hand, effect of nitrogen fertilizer with humic acid on protein %, carbohydrates and oil% of maize grain was estimated in 2014 season only, data in Table (5) indicated that, nitrogen with humic fertilizer had not significant effect on protein% and oil% while, carbohydrates% was significantly affected by nitrogen with humic fertilizer, the highest values were (70.42, 70.44 and 70.05) recorded in sole maize, 120 Kg N/fad. and 60 Kg N/fad plus soil and foliar humic respectively, while the lowest values were (67.36, 67.41 and 67.42) recorded with foliar humic, soil and foliar humic as well as soil humic respectively.

Similar findings were obtained by Shaaban *et al*. (2009) and Selim *et al*. (2012), mentioned that increasing application rates of nitrogen up to 120 Kg/ha or 50%

NPK with 5 cm/litter humic gave the highest values and lead to the highest biological yield, total chlorophyll and starch total. While, Morgado and Willey (2003) found that maize dry matter accumulation decreased with increases in bean plant population.

2- Soybean.

Data presented in Table (5) clearly showed that chlorophyll (a, b and a+b) at 77 days after planting were significantly affected by nitrogen fertilizer with humic acid in both seasons, the pure stand of soybean was superior on all treatments and showed the highest values for total chlorophyll followed by the treatment 60 Kg N/fad. plus soil and foliar humic acid in the two seasons, while the lowest values were obtained with foliar humic followed by soil humic in both seasons, these results may be due to generally soybean does not need to high levels of nitrogen fertilizer more than 25 – 30 kg/faddan and also, the humic acid may helps in increasing chlorophyll quantity in plants, Shuixiu and Ruizhen (2001) and Shaaban *et al*. (2009) mentioned that 50% NPK and humic acid used as soil and foliar application increased chlorophyll content of spring soybean plants.

On the other hand, Morgado and Willey (2003) found that intercropping decreased all traits, dry matter and biomass yield of bean as compared to sole cropping system.

Data in Table (5) cleared that portion% in seeds recorded significant differences between treatments affected by nitrogen and humic acid fertilization and indicated that the treatments included high levels of nitrogen fertilizer for maize (i. e., 120 or 60 Kg/fad.) recorded high levels of protein content in seed of soybean. The highest protein% was obtained by sole soybean, 60 Kg N/faddan with soil and foliar humic as well as 60 Kg N/faddan plus soil humic application, while the lowest protein% recorded by foliar humic, soil humic and soil as well as foliar humic application.

On the other hand, each of carbohydrates and oil content in seed were not significantly affected by nitrogen and humic acid fertilizer, El-Hefny (2010), found that protein and carbohydrate content in cowpea seeds showed significant increase with increasing rate of humic acid application from 0, 3, and 4.5 up to 6 Kg/faddan, whereas Eftekharinasab *et al.* (2011) verified that intercropping had no significant effect on oil and protein contents of pumpkin seed yield.

3- Assessment yield and yield advantages of intercropping:

The relative yield and total relative yield for maize and soybean grown as sole and in mixture according to land equivalent ratio (LER) are presented

in Table (6), the results indicated that values of LER were more than unite, indicating that the actual productivity was higher than expected.

It's clear that intercropping maize with soybean achieved more usage of land unit where, treatment 120 Kg N/faddan recorded the highest values (1.22 and 1.20) followed by treatment 60 Kg N/faddan with soil and foliar humic application in both seasons respectively while, the lowest values (1.10 and 1.08) with treatment foliar humic application in both seasons, respectively.

Data in Table (6) revealed that increasing the efficiency land usage by 22% using intercropping system compared with monoculture. Similar results were obtained by Abdalla *et al*. (1999); Toaima (2006); Zen El-Dein (2009) and Willey, (1990) indicated that yield advantage was produced and land usage was increased by intercropping.

Table (6) Effect of nitrogen fertilizer and humic acid application on competitive relationships and yield advantages in 2013 and 2014 seasons.

Treatments	Relative yield		Land equivalent ratio (LER)	Relative crowding coefficient (K)			Aggressivity (Agg)	
	L_m	L_s		K_m	K_s	K	A_m	A_s
			2013					
120 Kg N/fad.	0.83	0.39	1.22	2.44	1.27	3.10	+0.08	-0.08
Soil hu.appli.	0.71	0.40	1.11	1.20	1.31	1.58	-0.13	+0.13
Foliar hu. appli.	0.69	0.41	1.10	1.09	1.37	1.50	-0.19	+0.19
Soil and foliar hu. appli.	0.72	0.39	1.11	1.26	1.29	1.62	-0.11	+0.11
60 Kg N/fad.+Soil hu.	0.81	0.40	1.21	2.18	1.33	2.91	+0.02	-0.02
60 Kg N/fad.+Foliar hu.	0.79	0.40	1.19	1.87	1.31	2.46	0.00	0.00
60 Kg N/fad+Soil and foliar hu.	0.82	0.40	1.22	2.28	1.34	3.05	+0.03	-0.03
			2014					
120 Kg N/fad.	0.83	0.37	1.20	2.40	1.18	2.84	+0.12	-0.12
Soil hu.appli.	0.72	0.38	1.10	1.26	1.22	1.54	-0.07	+0.07
Foliar hu. appli.	0.69	0.39	1.08	1.13	1.26	1.43	-0.12	+0.12
Soil and foliar hu. appli.	0.72	0.38	1.10	1.31	1.20	1.57	-0.04	+0.04
60 Kg N/fad.+Soil hu.	0.81	0.39	1.20	1.19	1.27	2.79	+0.05	-0.05
60 Kg N/fad.+Foliar hu.	0.79	0.39	1.18	1.92	1.30	2.50	0.00	0.00
60 Kg N/fad+Soil and foliar hu.	0.82	0.37	1.19	2.34	1.26	2.95	+0.08	-0.08

m maize s soybean hu. = humic acid appli. = application

The data in Table (6) also, revealed that the overall tendency of the treatments imposed on the relative crowding coefficient were similar to that of land utilization .It is evident that all (RCC) values (Km, Ks,) indicated more yield advantage than expected.

Data presented in Table (6) showed that the values of aggressivity as affected by studied treatments, indicated that maize was the dominant in treatments, 120 Kg N/fad., 60 Kg N/fad. with soil humic application as well as 60 Kg N/faddan plus soil and foliar humic acid application, but it was the dominated in treatments, soil humic application, foliar humic application as well as soil and foliar application in the two studied seasons, these results due to nitrogen element which is necessary for maize where this crop need high levels of nitrogen fertilizer.

On the other hand soybean was dominant in treatments, soil humic application, foliar humic application as well as soil and foliar humic application, but it was the dominated in treatments, 120 Kg N/fad., 60 Kg N/faddan with soil humic application as well as 60 Kg N/faddan plus soil and foliar humic application in two the studied seasons, these results may be due to for nitrogen fixation by soybean nodulation may act fertilizer for soybean.

CONCLUSION

This study demonstrated that addition of 60 Kg N/faddan plus soil and foliar humic acid application (for maize) under intercropping 2: 2 row maize/ soybean was the extra benefit, which lead to increase of the growth, yield and chemical constituents as well as decreasing nitrogen fertilizer by 50%, pollution and costs of production.

REFERENCES

A.O.A.C., (1988). Official Methods of Analysis 21st Ed., Association of Official Agriculture Chemists, Washington, D.C., USA.

A.O.A.C., (1990). Official Methods of Analysis 15th Ed., Association of Official Agriculture Chemists, Washington, D.C., USA.

Abdalla, M.M.F., M.A. El-Metwally and W.K. Mohammed (1999). Effect of intercropping soybean and maize on their yield and components. Zagazig J. Agric. Res., 26 (6):1495-1520.

Adani, F., P. Genevini, P. Zaccheo and G. Zocchi (1998). The effect of commercial humic acid on tomato plant growth and mineral nutrition. J. plant Nutrition, 21(3): 561-575.

Assey, A.A.; E.M. Zeidan, A.G. Eraky, M.A. Mohamed and A.A. Sarhan (1992b).Intercropping soybean with maize. 2- Effect of intercropping, soybean plant population and N fertilizer on yield and competitive relations of maize and soybean. Proc.5thConf.Agron.Zagazig,13-15Sept.:516-528.

Baloach, N., M. Yousaf, W.P. Akhter, S. Fahad, B. Ullah, G.Qadir and Z.I. Ahmed(2014). Integrated effect of phosphate solubilizing bacteria and humic acid on physiomorphic attributes of maize. International J. of Current Microbiology and Applied Sciences,3(6):549-554.

Beets, W. C. (1990). Raising and sustaining productivity of smallholder forming systems in the tropics. Alkmaar, Holland: AgBe Publishing.

Bidegain, R.A., M. Kaemmerer, M. Guiresse, M. Hafidi, F. Rey, P. Morard and J.C. Revel (2000). Effects of humic substances from composted or chemically decomposed poplar sawdust on mineral nutrition of ryegrass. J. Agric. Sci., 134:259-267.

Chen, Y. and T. Aviad (1990). Effects of humic substances on plant growth. Am. Soc. Agron. & Soil Sci. Soc. Am., Madison, WI. PP: 161 – 186.

Dahmardeh, M., A. Ghanbari, B.A. Syahsar and M. Ramrodi (2010). The role of intercropping maize (*Zea maize* L.) and cowpea (*Vigna unguiculata* L.) on yield and soil chemical properties. African J. of Agricultural Rsearch, 5 (8): 631-636.

David, P. P., P. V. Nelson and D. C. Sanders (1994). A humic acid improves growth of tomato seedlings in solution culture. J. Plant Nutr., 17 (1): 173 – 184.

David, P.P. (1991). Effects of applied humic acids on yield, growth, nutrient accumulation content in selected vegetable crops and soil interactions that reduce their effectiveness. Dissertation Abstracts International B, Sciences and Engineering. 52(3): 1136 B-1137 B.

Dewit, C.T. (1960). On competition Versl. Landbouwk Onder Z. 66:1-82.

Dubois, M.; K.A. Gilles, J.K. Hamilton, P.A. Rebers and F. Smith (1956). Colorimetric Method for Determination of Sugars and Related Substances. Analytical Chemistry, 28 (3): 350- 356.

Eftekharinasab, N., M. Khoramivafa, K. Sayyadian and A. Najaphy (2011). Nitrogen fertilizer effect on grain yield, oil and protein content of pumpkinseed (Cucurbita pepo L. var. styiaca) intercropped with lentil and chickpea. International J. of Agri. Science, 1(5): 283 – 289.

El-Hefny, E.M. (2010). Effect of saline irrigation water and humic acid application on growth and productivity of two cultivars of cowpea (Vigna unguiculata L. Walp). Aust. J. Basic and Appl. Sci., 4(12): 6154-6168.

El-Nemr, M.A., M. El-Desuki, A.M. El-Bassiony and Z.F. Fawzy (2012). Response of growth and yield of cucumber plants (Cucumis sativus L.) to different foliar applications of humic acid and bio-stimulators. Aust. J. of Basic and Appl. Sci., 6(3): 630-637.

Hafez, M. M. (2003). Effect of some sources of nitrogen fertilizer and concentration of humic acid on the productivity of squash plant. Egypt J. Appl. Sci., 19(10): 293-309.

Javanmard, A., A.D.M. Nasab, A. Javanshir, M.Moghaddam and H. Janmohammadi (2009). Forage yield and quality in intercropping of maize with different legumes as double-cropped. Journal of food, Agriculture and Environment. 7 (1): 163-166.

Juhi,Y., S. Yadav and S.G. Singh (2011). Plant growth promotion in wheat crop under environment by PSB as bio- fertilizer. Res. J. Agri. Sci., 2: 76-78.

Mc- Gilchrest C. A. (1965). Analysis of competition experiments. Biometrics. 21: 975 – 985.

Mead, R. and R.W. Willey (1980). The concept of "land equivalent ratio" and advantages in yields for intercropping. Exp. Agric., 16: 217-218.

Moran, R. and D. Porath (1980). Chlorophyll determination in intact tissues using N, N-dimethylformamide. Plant Physiology, 65: 478-479.

Morgado, L .B. and R. W., Willey (2003). Effects of plant population and nitrogen fertilizer on yield and efficiency of maize – bean intercropping. Pesq. Agropec. Bras., Brasilia, 38 (11): 1257 – 1264.

Padem, H., A. Ocal and R. Alan (1997). Effect of humic acid added foliar fertilizer on seedling quality and nutrient content of eggplant and pepper. Acta Horticulturae, 491: 241-246.

Patra, B., and S.C. Pio (1998). Influence of intercropping on the nodulation in legumes. Environment and Ecology, 16 (2): 418-423.

Pettit, R. E. (2004). Organic matter, humus, humate, humic acid, fulvic acid and Humin: their importance in soil fertility and plant health (online). Available at www. Humate. Info/ mainpage.htm.

Rana, R.S., Bhupinder-Singh, S.C. Negi and B. Singh (2001). Management of maize / legume intercropping under mid-hill sub-humid condition. Indian. J. of Agric. Res., 35(2): 100-103.

Sadeghi, H. and S.A. Kazemeini (2012). Interaction between different nitrogen fertilizer levels and maize- bean intercropping patterns. J. Ecol. Field Biol., 35 (4): 269-277.

Selim E. M., I. S. Shedeed, F. F. Asaad and A. S. El-Neklawy (2012). Interactive effects of humic acid and water stress on chlorophyll and mineral nutrient contents of potato plants. J. of Applied Sci. Research, 8(1): 531 – 537.

Shaaban, S.H.A., F.M. Manal and M.H.M. Afifi (2009). Humic acid foliar application to minimize sold applied fertilization of surface- irrigated wheat. World J. Agric. Sci., 5(2): 207-210.

Shen, Q.R. and G.X. Chu (2004). Bi-directional nitrogen transfer in an intercropping system of peanut with rice cultivated in aerobic soil. Biol. Fertil. Soil, 40: 81-87.

Shuixiu, H. and W. Ruizhen, (2001). A study on the effect of KOMIX, humic acid-containing organic fertilizer, on spring soybean. Acta Agriculturae Universitatis Jiangxiensis, 23(4): 463 – 466.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods. 7 th Edit., Iowa State Uni. Press Ames, Iowa, USA., PP: 507.

Tan, K.H. (2003). Humic matter in soil and environment, principles and controversies- New York,USA,155-278.

Tattini, M., A. Chiarini, R. Tafani and M. castagneto (1990). Effect of humic acid on growth and nitrogen uptake of container-grown olive (Olea europaea L. Maurino). Internat. Symp. On Olive Growing, Proceeding, Wageningen (Netherlands), 125-128.

Toaima, S.E.A. (2006). Effect of intercropping soybean, cowpea and guar with maize on yield and its components. J. Agric. Sci. Mansoura Univ., 31(1): 55-70.

Vishwanatha S, B. G. Koppalkar, S. N. Anilkumar and A. S. Halepyati (2011). Influence of fertilizer levels on growth and dry matter production of pigeonpea in companion cropping of pigeonpea (Cajanus cajan L. Millsp.) and sunflower (Helianthus annuus). Research J. of Agrc. Sci., 2(2): 364 – 367.

Willey, R.W. (1990). Resource uses in intercropping systems. *Agricultural Water Management*, 17: 215-231.

Yilmaz, C. (2007). Humik ve fulvik asit, Hasad Bitkisel Uretim.Ocak., 260: 74-74.

Zen El-Dein, A.A.M. (2009). Effect of sowing directions and maize cultivars on intercropping efficiency of soybean and maize. Ph. D. Thesis, Fac. Agric., Alex. Univ., Egypt.

استجابة محصول الذرة الشامية المحمل على فول الصويا للتسميد النيتروجينى وحمض الهيوميك

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أقيمت تجربتان فى محطة بحوث زرزورة- إيتاى البارود- بحيرة. خلال موسمى ٢٠١٣و٢٠١٤ لدراسة تأثير التسميد النيتروجينى مع حمض الهيوميك على محصول الذرة المحمل مع فول الصويا كالآتى : ١٢٠كجم نيتروجين/ الفدان ، إضافة الهيوميك أرضى (٥كجم / الفدان) ، إضافة الهيوميك رش (٥جم / اللتر) ، إضافة الهيوميك أرضى ورش ، ٦٠كجم نيتروجين /الفدان +هيوميك أرضى ، ٦٠كجم نيتروجين / الفدان +هيوميك رش ، ٦٠كجم نيتروجين / الفدان +هيوميك أرضى ورش تحت نظام تحميل ٢خط فول صويا :٢خط ذرة شامية بالإضافة إلى زراعة الذرة الشامية منفرد وفول الصويا منفرد .أظهرت النتائج :١-الذرة الشامية : صفات النمو والمحصول ومكوناتة كانت معنوية للتسميد النيتروجينى مع حمض الهيوميك ماعدا نسبة وضع الكوز على النبات ، وسمك الكوز ، وعدد الصفوف على الكوز فكانت المعاملات الآتية وهى زراعة الذرة نقى ، ١٢٠كجم نيتروجين / الفدان ، ٦٠كجم نيتروجين / الفدان +الهيوميك أرضى ورش أعطت أعلى القيم ، بينما المعاملات إضافة الهيوميك رش ،الهيوميك أرضى ، الهيوميك أرضى ورش أعطت أقل القيم فى كلا الموسمين.٢-فول الصويا : صفات النمو والمحصول ومكوناته كانت غير معنوية فى فول الصويا لتأثير التسميد النيتروجينى مع حمض الهيوميك ماعدا الوزن الجاف للمجموع الخضرى ، عدد القرون على النبات ، محصول النبات ، محصول الفدان . فكانت زراعة فول الصويا منفرد أعلى من المحمل ولكن لم تصل إلى حد المعنوية بين المعاملات الأخرى تحت ظروف التحميل .٣- الصفات الكيماوية : أظهرت تأثيرا معنويا للتسميد النيتروجينى مع حمض الهيوميك ماعدا نسبة البروتين ونسبة الزيت بالنسبة لحبوب الذرة ونسبة الكربوهيدرات ونسبة الزيت فى بذور فول الصويا فكانت أعلى القيم فى الزراعة النقية ، ٦٠كجم نيتروجين / الفدان +الهيوميك أرضى ورش و١٢٠كجم نيتروجين /الفدان بينما أقل القيم فى المعاملات الهيوميك رش ، الهيومك أرضى والهيوميك أرضى ورش على الترتيب لكل من الذرة الشامية وفول الصويا.٤- العلاقات التنافسية : أظهرت النتائج أن كل المعاملات أظهرت زيادة فى المحصول للزراعة المحملة عن النقية. وكانت أعلى القيم فى معدل استغلال الأرض (LER) ومعامل الحشدالنسبى (K) فى المعاملات١٢٠كجم نيتروجين/الفدان يليها٦٠كجم نيتروجين /الفدان + الهيوميك أرضى ورش .اما بالنسبة للعدوانية (Agg) كان الذرة الشامية سائدا فى المعاملات ١٢٠كجم نيتروجين / الفدان ويليها٦٠كجم نيتروجين /الفدان +الهيوميك أرضى ورش بينما فول الصويا كان سائدا فى المعاملات الهيوميك رش والهيوميك أرضى ورش .