International Journal of

Agricultural Research

ISSN 1816-4897

Academic Journals Inc.

www.academicjournals.com

International Journal of Agricultural Research 7 (7): 345-357, 2012
ISSN 1816-4897 / DOI: 10.3923/ijar.2012.345.357

Effect of Sowing Dates and Humic Acid on Productivity and Infection with Rot Diseases of Some Soybean Cultivars Cultivated in New Reclaimed Soil

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ABSTRACT

Two experiments were conducted at the experimental farm of Tag El-Ezz Research Station, Dakahlia Governorate, North Delta, Egypt, during 2010 and 2011 summer seasons. The field soil (new reclaimed soil) was clayey-loam in texture with medium salinity (EC = 2534 ppm). May 20th sowing date gave the highest values of all studied characters except for root rot and stalk rot disease severity which gives inverse this. The maximum seed yield (ton/fad) occurred under May 20th sowing date in Giza 83 cultivar in both seasons. Humic acid at 1000 ppm led to the highest values of yield and seed quality (protein and oil %). Moreover, the highest values of growth parameters occurred under the application of humic acid at 2000 ppm. May 20th sowing date interacted with Giza 83 cultivar was more effective in increasing Plant height, 100-seed weight, number of pods/plant, seed weight/plant and seed yield/fed The interaction between sowing date (May 20th) and humic acid (2000 ppm) gave the same effect. On the other side the maximum reduction in disease severity of damping-off, root and stalk rot diseases was recorded with Giza 83 in May 20th sowing date under application of humic acid at 1000 ppm. The present investigation recommend soaking seeds of Giza 83 cultivar in humic acid at 1000 ppm for 20 min then sowing it on May 20th and sprayed plants twice (after 50 and 65 days from sowing) with the same concentration to maximize the crop yield and minimize the disease severity of damping off and root and stalk- rots.

Key words: Sowing date, humic acid, root rot, stalk rot, soybean cultivars

INTRODUCTION

Soybean (*Glycine max* L. Merrill) is the world's most important crop whereas, in Egypt, it's an annual leguminous crop grown in many parts of the Delta. Soybean seeds are rich in vitamin content and of supreme importance as a source of oil and protein. The bulk of the produced oil is used in the production of cooking fats and food products. Protein uses in the diet of people of the Far East, its protein content is characterized by high levels of essential amino acids (Singh *et al.*, 1987; Abd El-Hai *et al.*, 2010). In addition to, soybean meal has a high protein content which is used in making stock and poultry feeds and in making adhesives and plastics (Snyder and Kwon, 1987).

Sowing date is one of the important production components that can be manipulated to obtain higher yields of soybean and to counter the adverse effects of environmental conditions during the growing seasons. Billore *et al.* (2000), El-Douby *et al.* (2002), Popp *et al.* (2002), Kumar *et al.* (2004), Kausale *et al.* (2004, 2006) and Grichar *et al.* (2008) found that plant would have passed critical reproduction stages before the onset of unfavorable environmental conditions at the end of the season. Board (2002) added that the main cause for lower yield at late planting dates is reduced day length, which results suboptimal vegetative growth for optimum yield. Shafshak *et al.* (1997) and El-Douby *et al.* (2002) reported that delayed sowing generally reduced protein and oil contents of soybean seeds. However, Shishodia and Singh (1995) found that seed protein content was increased with delayed sowing.

Cultivars are another important production component where yield is determined by the genetic make up of the cultivar and interaction with the environmental conditions. Schoffel *et al.* (2003) found significant interaction in cultivar and sowing date interaction for seed yield/ha and yield components.

Different pathogens are known to attack soybean seeds, seedlings and roots causing serious damage (Sinclair and Backman, 1989; Heweidy *et al.*, 2005). Root rot caused by *Rhizoctonia solani* and charcoal rot (stalk rot) caused by *Macrophomina phaseolina* are the most destructive diseases attacking soybean seedlings, roots and lower part of stem (Hassanien, 1985; Sinclair and Backman, 1989).

Humic Acid (HA) is a suspension, based on potassium humates, which can be applied successfully in many areas of plant production as a plant growth stimulant or soil conditioner (Scheuerell and Mahaffee, 2006). It can be sprayed directly to the plant foliage in liquid form or to the soil in the form of granules alone or as fertilizer mixture. Humic acid is one of the major components of humus. Humates are natural organic substances, high in humic acid and containing most of known trace minerals necessary to the development of plant life (Senn, 1991). Humic substances provide a stable fraction of carbon and improve water holding capacity, pH buffering and thermal in solution (McDonnell *et al.*, 2001). Studies of the positive effects of humic substances on plant growth have demonstrated the importance of optimum mineral supply, independent of nutrition (Yildirim, 2007).

The present investigation was aimed to study the effect of sowing date and humic acid on reduction the infection of soybean with root and stalk rots and increasing the productivity in new reclaimed soil.

MATERIALS AND METHODS

Source of HA and soybean seeds: Humic acid were kindly obtained from Egyptian Fertilizer Development Center, El-Mansoura, Egypt, while soybean seeds CV. Giza 21, Giza 22, Giza 82 and Giza 83 were obtained from Field Crops Research Institute, Leguminous Research Department, Agricultural Research Center, Giza, Egypt at the end of 2009 summer season.

Soil analysis: The soil analyses are presented in Table 1. Samples of soil were taken after harvesting from depth of 0-30 cm from all sites of the field experiments. Nitrogen was determined according to Kjeldahl method as described by Jackson (1967). The field soil (new reclaimed soil) was clayey-loam in texture with medium salinity (2534 ppm) according to Richards *et al.* (1954).

Field experiments: Field experiment was carried out at the experimental farm of Tag El-Ezz Agricultural Research Station, Dakahlia Governorate, North Delta, Egypt in 2010 and 2011 summer seasons to study the effect of two sowing dates and three levels of humic acid (HA) on

Table 1: Physical and chemical analysis of soil of Tag El-Ezz field experiments

Soil sample	Coarse sand (%)		Fine sand (%)			Silt (%)		Clay (%)		Soil texture
Average	3.30		10.30			32.30		54.10		Clayey loam
Soil sample	Na^+	K^+	Ca^{++}	Mg^{++}	HCO_3^-	CL^-	SO_4^-	EC (ppm)	EC (m.moh)	pH
Average	13.6	0.25	14.60	7.63	0.51	15.16	17.65	2534.0	3.97	8

growth and the rate of infection with root and stalk-rot diseases as well as yield attributes and seed quality of four soybean cultivars. In each season, two sowing dates were applied, i.e., April 20th (D1) and May 20th (D2). The four cultivars used in both seasons of study were Giza 21 (V1), Giza 22 (V2), Giza 82 (V3) and Giza 83 (V4). The three concentrations used for HA were Zero (tap water) (C1), 1000 ppm (C2) and 2000 ppm (C3).

A split-split plot design with three replicates was used in this experiment. The main plots were occupied by sowing dates while, sub plots were occupied by cultivars and sub-sub plots were occupied by HA levels. Each sub-sub plot consisted of five ridges, 3.5 m in length and 3 m in width (area 10.5 m^2). Cultivars were sown at the rate of 40 kg/faddan in hills 20 cm apart and thinned to two plants per hill after three weeks from sowing. Sub-sub plot were fertilized with 22.5 kg P_2O_5/faddan during seedbed (in the form of calcium super phosphate; 15.5% P_2O_5), 60 kg N/fad. In two split applications after three and five weeks from sowing (in the form of ammonium nitrate; 33.5% N) and 24 kg K_2O/fad. in a single dose after three weeks from sowing (in the form of potassium sulphate 48% K_2O). Other production practices were applied as recommended for soybean production in the region. Soybean seeds were soaked for 20 min. in humic acid as well as plants sprayed after 50 and 65 days from sowing.

Morphological and yield characters: At harvesting, plant samples were taken at random from each plot to estimate the following parameters:

- Plant height (cm)
- Number of branches/plant
- Number of pods/plant
- Seed weight/plant (g)
- 100-seed weight (g)
- Seed yield (Ton/fad)

Seed quality: Soybean seeds were dried at 70°C for 48 h, grounded and analyzed for oil percentage (AOAC, 1997) and total nitrogen by semi-micro Kjeldahl (Pregl, 1945). The protein percentage was calculated by multiplying the %N by 6.25.

Disease assessment: Disease assessment of natural infection was recorded as pre- and post-emergence damping-off as well as root rot and stalk rot. Pre- and post-emergence damping-off was recorded after 20 and 40 days from sowing, respectively. The disease severity of root rot was determined in mature stage according to the scale (from 0 to 4) suggested by Kravea (1960). Moreover, Stalk-rot disease severity was determined based on the scale of Phillips (1971). The severity of root and stalk rot diseases were calculated using the following formula:

$$Sd = \frac{\sum(ab)}{Ak} \times 100$$

Where:

Sd = Severity of disease
a = Number of diseased plants having similar degree of infection
b = Degree of infection
∑ = Sum of (ab)
A = Number of examined plants
K = Highest degree of infection (in this case = 4)

Statistical analysis: Data were statistically analyzed using "MSTAT-C" software package where analysis of variance for a split-split plot design was performed. The Least Significant Difference (LSD) was used to test the differences between treatment means at 5% probability (Gomez and Gomez, 1984). The relationships among dependent and independent variables through calculation of simple correlation coefficient (Snedecor and Cochran, 1982) was estimated by means of the correlation coefficient® between each of the dependent and independent variables. Multiple regression analysis was done according to Draper and Smith (1987) to determinate (R2) and to estimate relative contribution of independent variables for each dependent variable and to get the prediction equations and stepwise multiple regression analysis to determine the variables accounting for the majority of the total variability independent characters as described by Draper and Smith (1987). Correlation coefficient (R) between different soybean characters was also calculated.

RESULTS AND DISCUSSION

Morphological characters: The effects of sowing date, soybean cultivars and humic acid on morphological characters are presented in Table 2. Results markedly indicated that May 20th sowing date gave increase in plant height and number of branches/plant compared with April 20th sowing date. These findings were in agreement with those reported by El-Douby *et al.* (2002), Hassan *et al.* (2002), Husein *et al.* (2006) and Bastidas *et al.* (2008). They attributed that the increase in vegetative growth period due to increased day length with delayed sowing, resulting in optimal vegetative growth for optimum yield and yield components.

Among all cultivars tested, Giza 83 gave the highest values of plant height and number of branches/plant in both seasons (Table 2). Plant height in Giza 83 was higher by 3, 18 and 12% in the first season and by 3, 20 and 13% in the second season than Giza 82, Giza 22 and Giza 21, respectively.

Both levels of humic acid increased significantly plant height and number of branches/plant in both seasons. Humic acid at 2000 ppm was more effective in plant height while, 1000 ppm was more effective in number of branches/plant. These effects are similar to the findings of McDonnell *et al.* (2001), Atiyeh *et al.* (2002) and Chen *et al.* (2004), who stated that humic substance stimulation plant growth through increased cell division and optimized uptake of nutrients and water. Moreover, Ulukan (2008) stated that HA are extremely important component because they constitute a stable fraction of carbon, thus regulating the carbon cycle and release of nutrients, including nitrogen, phosphorus and sulfur, which decreasing the need for inorganic fertilizer for plant growth. HA stimulate plant growth by the assimilation of major and minor elements, enzyme activation and/or inhibition, changes in membrane permeability, protein synthesis and finally the activation of biomass production.

Table 2: Plant height and number of branches/plant as influenced by sowing dates, soybean cultivars and humic acid concentrations in 2010 and 2011 seasons

	Plant height (cm)			No. of branches/plant		
	2010	2011	Combined[a]	2010	2011	Combined[a]
A: Sowing dates						
April 20th	61.74	61.09	61.67	3.79	3.34	3.54
May 20th	73.47	69.83	70.96	4.73	4.10	4.36
F-test	**	**	**	*	*	*
B: Cultivars						
Giza 21	64.92	62.61	62.97	3.71	3.18	3.46
Giza 22	61.75	59.26	62.56	3.96	3.60	3.67
Giza 82	70.98	69.04	69.98	4.46	3.86	4.13
Giza 83	72.77	70.92	71.85	4.92	4.26	4.56
F-test	**	**	**	**	**	**
LSD	0.08	0.12	0.13	0.03	0.02	0.01
C: Humic acid concentration						
0 ppm (control)	60.81	60.56	61.06	3.67	3.26	3.45
1000 ppm	68.66	65.29	66.49	4.88	4.13	4.53
2000 ppm	73.48	70.52	71.40	4.23	3.78	3.89
F-test	**	**	**	**	**	**
LSD	0.07	0.13	0.08	0.01	0.01	0.01
Interactions						
A×B	**	ns	**	ns	ns	ns
A×C	**	**	**	ns	ns	ns
B×C	ns	ns	ns	ns	ns	ns

[a]Data of both seasons were combined and averaged, *Significant, **Highly significant, ns: Non significant

Yield and its attributes: Data presented in Table 3 show that sowing date had effect on yield and yield attributes in both seasons. May 20th sowing date was more effective in this respect. Hence, increased number of pods/plant by 14 and 11%, seed weight/plant by 10 and 6%, 100-seed weight by 29 and 28% and seed yield/fad by 48 and 51% compared with April 20th sowing date in both seasons, respectively. Similar results were obtained by Shafshak *et al.* (1997), Popp *et al.* (2002), Ibrahim (2009) and Robinson *et al.* (2009). They reported that May is the best sowing date for soybean due to the environmental conditions are suitable for soybean plant life.

Regarding the effects of soybean cultivars, data in Table 3 indicate that Giza 83 produced the highest number of pods/plant, seed weight/plant, 100-seed weight and seed yield/fad followed by Giza 82 while Giza 21 came to late. The superiority of Giza 83 seed yield may be due to increasing in number of pods/plant, seed weight/plant and 100-seed weight. These results are in line with those reported by Muhammad and Shah (2003), Carrao-Panizzi and Erhan (2003), Hagsin *et al.* (2006), Husein *et al.* (2006), De Burin and Pedersen (2008) and Grichar *et al.* (2008) The difference among varieties may be due to the genetic structure that plays a role in these parameters.

Concerning the effects of HA, data in the same table show that yield and yield components were significantly affected by spraying of humic acid at both levels. The highest seed yield/fad and 100-seed weight obtained with the application of humic acid at 1000 ppm in both seasons. These results are similar to those of MacCarthy *et al.* (1990), Fagbenro and Agboola (1993) and Atiyeh *et al.* (2002). They stated that HA is a suspension, based on potassium-humates, which can

Table 3: Number of pods/plant, seed weight/plant, 100-seed weight and seed yield/fad as influenced by sowing dates, cultivars and humic acid (HA) concentrations in 2010 and 2011 growing seasons

	Number of pods/plant			Seed weight/plant (g)			100-seed weight (g)			Seed yield (ton/ fad)		
	2010	2011	Com.[a]	2010	2011	Com.[a]	2010	2011	Com.[a]	2010	2011	Com.[a]
A: Sowing date												
April 20th	68.78	64.06	66.34	60.12	56.66	58.41	16.22	15.14	15.58	1.152	1.020	1.080
May 20th	78.33	71.39	74.89	66.07	60.05	62.93	20.91	19.39	20.15	1.710	1.540	1.606
F-test	**	**	**	**	**	**	**	**	**	**	**	**
B: Cultivars												
Giza 21	69.66	63.41	66.43	58.81	56.03	57.24	16.99	15.88	16.41	1.216	1.085	1.155
Giza 22	73.38	67.27	70.51	61.42	55.85	58.67	18.13	17.14	17.65	1.411	1.234	1.321
Giza 82	74.07	68.84	71.28	64.91	59.67	62.30	19.12	17.68	18.28	1.506	1.362	1.382
Giza 83	77.10	71.37	74.24	67.24	61.86	64.58	20.01	18.37	19.07	1.592	1.439	1.515
F-test	**	**	**	**	**	**	**	**	**	**	**	**
LSD	0.11	0.10	0.09	0.10	0.08	0.03	0.03	0.02	0.02	0.003	0.002	0.005
C: HA level (ppm)												
0 (control)	65.08	60.33	62.82	56.43	56.71	54.50	16.97	16.05	16.43	1.302	1.136	1.218
1000	82.05	75.43	78.50	69.62	61.33	67.10	20.22	18.46	19.30	1.589	1.434	1.512
2000	73.53	67.41	70.53	63.23	63.54	60.50	18.49	17.30	17.82	1.402	1.270	1.300
F-test	**	**	**	**	**	**	**	**	**	**	**	**
LSD	0.09	0.08	0.07	0.09	0.09	0.08	0.03	0.02	0.02	0.003	0.004	0.004
Interactions												
A×B	ns	**	*	ns	*	**	**	ns	**	**	ns	ns
A×C	**	ns	**	ns	*	ns	**	**	**	ns	**	*
B×C	*	*	ns	ns	ns	ns	**	**	**	ns	**	ns

[a]Data of both seasons were combined and averaged, *Significant, **Highly significant, ns: Non significant

be applied successfully in many areas of plant production as a plant growth stimulate or soil conditioner for enhancing plant productivity. Moreover, Yildirim (2007) added that plant growth is influenced indirectly and directly by humic substances. Positive correlations between the humus content of the soil, plant yields and product quality have been published in many different scientific journals. Indirect effects, previously are those factors which provide energy for the beneficial organisms within the soil, influence the soil's water holding capacity, influence the soil's structure, release of plant nutrients from soft minerals, increased availability of trace minerals and in general improved soil fertility. Direct effects include those changes in plant metabolism that occur following the uptake of organic macromolecules, such as humic acids, fulvic acids. Once these compounds enter plant cells several biochemical changes occur in membranes and various cytoplasmic components of plant cells and at the end increased plant yield.

Seed quality: Soybean seeds were dried at 70°C for 48 h, grounded and analyzed for oil percentage and total nitrogen then protein percentage was calculated by multiplying the %N by 6.25. Analysis of variance in Table 4 indicated that both sowing dates gave significant response to F-test. Seed protein contents increased in May 20th sowing date in both seasons while, oil content increased in second season only. In this respect May 20th sowing date was more effective. On the other hand, soybean cultivars had no significant effects on seed protein. On contrast, significant differences were observed between soybean cultivars for oil percentage in both seasons. The application of HA led to significant increase in protein percentage in the second season and in oil percentage in both seasons. HA at 1000 ppm was more effective. Similar findings were reported by Carrao-Panizzi and Erhan (2003) and Karaaslan (2008). Moreover, Atiyeh *et al*. (2002) and Chen *et al*. (2004) stated that humic substances will maximized the efficient use of residual plant nutrients, reduce fertilizer costs and help release those nutrients presently bound is minerals and salts.

The Interactions effects: The interaction between sowing dates and humic acid concentrations on plant height and 100-seed weight in both seasons are presented in Table 5. The highest values

Table 4: Seed contents of protein and oil as influenced by sowing date, soybean cultivars and humic acid in 2010 and 2011 seasons

	Protein (%)			Oil (%)		
	2010	2011	Combined[a]	2010	2011	Combined[a]
A: Sowing dates						
April 20th	36.51	36.62	36.66	20.76	18.61	19.69
May 20th	37.60	37.66	37.63	21.01	19.80	20.41
F-test	*	*	ns	ns	*	ns
B: Cultivars						
Giza 21	36.65	36.98	36.82	20.06	18.35	19.23
Giza 22	36.86	36.79	36.83	21.16	19.55	20.27
Giza 82	37.68	37.49	37.54	21.00	19.54	20.35
Giza 83	37.03	37.29	37.16	21.30	19.39	20.35
F-test	ns	ns	ns	**	**	ns
LSD	-	-	-	0.01	0.03	-
C: Humic levels						
0 ppm (control)	35.88	34.89	35.38	20.25	18.60	19.46
1000 ppm	38.24	39.43	38.84	21.54	19.85	20.70
2000 ppm	34.06	37.90	35.98	20.76	18.17	19.47
F-test	ns	**	**	**	**	ns
LSD	-	0.03	0.21	0.03	0.17	-
Interactions						
A×B	ns	ns	ns	*	**	ns
A×C	ns	ns	ns	*	ns	ns
B×C	ns	ns	ns	ns	**	ns

[a]Data of both seasons were combined and averaged, *Significant, **Highly significant, ns: Non significant

Table 5: Plant height and 100-seed weight as affected by the interaction between sowing dates and humic acid concentrations in both seasons

	Plant height (cm)				100-seed weight (g)			
	2010		2011		2010		2011	
Sowing dates	April 20th	May 20th	April 20th	May 20th	April 20th	May 20th	April 20th	May 20th
0 ppm (control)	57.45	64.17	57.87	63.26	15.06	18.89	14.32	17.77
1000 ppm	62.08	75.25	60.88	69.69	19.55	22.89	16.04	20.88
2000 ppm	65.70	80.98	64.52	76.53	16.06	20.94	15.06	19.54

	Plant height (cm)		100-seed weight (g)	
	2010	2011	2010	2011
F-test	**	**	**	**
LSD	0.21	0.36	0.08	0.06

*Significant, **Highly significant, ns: Non significant of plant height and 100-seed weight obtained with 2000 ppm humic acid in both sowing dates (May 20 and April 20th) in both seasons. The maximum plant height (80.98 cm) was observed with 2000 ppm in May 20th in the first season and (76.53 cm) in the second season, but 1000 ppm was superior in increasing 100-seed weight in the two sowing dates to reach (22.89 g) in the first season and (20. 88 g) in the second season with May 20th sowing date.

The interaction between soybean cultivars and humic acid concentrations on 100-seed weight in 2010 and 2011 growing seasons are presented in Table 6. Giza 83 was the superior cultivar followed by Giza 82, then Giza 22 and Giza 21 under different humic acid concentrations. The maximum value (21.79 g) obtained from Giza 83 under the application of HA at 1000 ppm and. On contrast, the minimum 100-seed weight (13.84 g) obtained from Giza 21 under untreated control treatment.

Disease assessment: Disease assessment of natural infection was recorded as pre- and post-emergence damping-off as well as root rot and stalk rot. Pre- and post-emergence damping-off was recorded after 20 and 40 days from sowing, respectively. The disease severity of root rot and stalk rot were determined in mature stage.

Data in Table 7 show that both sowing dates had significant response to F-test. Second sowing date (May 20th) was the best in decreasing the disease severity of damping-off and root rot as well as stalk rot in both seasons compared with the first sowing date (April 20th).

Data also show that there were significant differences in disease severity between humic acid treatments of different soybean cultivars. Giza 83 was the highest disease tolerant followed by Giza 82, then Giza 22, while Giza 21 was the highest susceptible for those diseases. On the other side, both levels of humic acid (1000 and 2000 ppm) significantly reduced disease incidence of pre- and post-emergence damping-off and disease severity of root rot and stalk rot. Humic acid at 1000 ppm was more effective. Concerning the interaction effects, it was observed that the highest reduction of root rot disease severity in soybean cultivars occurred under the application of humic acid at 1000 ppm interacted with Giza 83 cultivar in both seasons as shown in Table 8. The same results were recorded in post-emergence damping-off and stalk rot in the second season only. The decrease in root and stalk- rots under the application of humic acid may be due to its effect in

Table 6: Weight of 100-seeds as affected by the interaction between soybean cultivars and humic acid (HA) concentrations in 2010 and 2001 seasons

	100-seed weight (g)							
	2010				2011			
Treatment	Giza 21	Giza 22	Giza 82	Giza 83	Giza 21	Giza 22	Giza 82	Giza 83
0 ppm (control)	14.59	16.69	17.96	18.66	13.84	16.16	16.80	17.39
1000 ppm	19.13	19.55	20.41	21.79	17.67	18.17	18.52	19.48
2000 ppm	17.26	18.16	18.99	19.57	16.14	17.08	17.71	18.25

	100-seed weight (g)	
	2010	2011
F-test	**	**
LSD	0.12	0.10

*Significant, **Highly significant

regulating hormone level (Piccolo *et al.*, 1992) and enhancing the formation of antioxidants such as α-tocopherol, β-carotene, super oxide dismutase and ascorbic acid concentrations (Achuo *et al.*, 2004). These antioxidants play a role in chilling of disease resistance.

Correlation coefficient: The correlation coefficients in Table 9 show the interrelationships among yield and yield attributes. It is clear that positive and significant correlation coefficients

Table 7: Damping-off (%) and disease severity of root rot and stalk rot as influenced by sowing dates, soybean cultivars and humic acid (HA) concentrations in 2010 and 2011 growing seasons

	Pre-emergence		Post-emergence		Root-rot		Stalk rot	
Treatments	2010	2011	2010	2011	2010	2011	2010	2011
A: Sowing dates								
April 20th	25.45	23.51	7.99	11.48	13.46	16.10	16.49	18.61
May 20th	23.02	20.75	5.91	9.24	11.31	13.70	14.32	16.15
F-test	**	ns	**	**	*	**	*	**
B: Cultivars								
Giza 21	32.14	29.59	8.66	13.97	15.55	20.13	18.73	22.66
Giza 22	28.23	25.56	7.19	11.77	13.66	17.27	16.62	19.64
Giza 82	23.64	22.11	6.34	8.98	10.59	13.49	14.70	16.05
Giza 83	12.92	11.26	5.62	6.71	9.73	8.71	11.55	11.17
F- test	**	**	**	**	**	**	**	**
LSD	0.86	4.16	0.63	0.21	0.48	0.29	1.71	
C: HA levels								
0 ppm (Control)	32.13	27.18	8.95	12.89	17.29	20.52	17.94	22.43
1000 ppm	18.26	16.51	5.05	8.20	8.12	10.68	12.51	13.33
2000 ppm	22.31	22.69	6.86	9.98	11.74	13.51	15.77	16.38
F- test	**	**	**	**	**	**	**	**
LSD	0.77	5.06	0.87	0.16	0.88	0.23	2.02	
Interactions								
A×B	ns	ns	ns	**	ns	**	ns	**
A×C	**	ns	ns	**	ns	**	ns	**
B×C	ns	ns	ns	**	**	**	ns	**
A×B×C	ns	ns	ns	ns	ns	**	ns	ns

*Significant, **Highly significant, ns: Non significant

Table 8: Disease severity of root rot as affected by the interaction between soybean cultivars and humic acid (HA) in 2010 and 2011 growing seasons

	2010				2011			
HA concentration	Giza 21	Giza 22	Giza 82	Giza 83	Giza 21	Giza 22	Giza 82	Giza 83
0 ppm (control)	18.81	14.91	15.73	19.69	22.62	14.47	19.39	25.61
1000 ppm	9.11	6.14	6.49	10.73	12.93	5.13	8.67	16.01
2000 ppm	13.05	8.13	9.54	16.23	16.27	6.53	12.43	18.77
				2010				2011
F-test				**				**
LSD				0.74				0.45

*Significant, **Highly significant

were obtained between seed yield/fad and plant height (r = 0.842**), number of branches/plant (r = 0.880**), number of pods/plant (r = 0.547**), seed weight/plant (r = 0.746**), 100-seed weight r = 0.957**) and protein percentage (r = 0.581*). Seed yield/plant was positively and significantly correlated with plant height (r = 0.863**), number of branches/plant (r = 0.875**) and number of pods/plant (r = 0.602**). Number of pods/plant was positively and significantly correlated with plant height (r = 0.847**) and number of branches/plant (r = 0.905**). Number of branches/plant was positively and significantly correlated with plant height (r = 0.530*). Protein percentage was significantly correlated with plant height (r = 0.685**), number of branches/plant (r = 0.719**), number of pods/plant (r = 0.580*) and seed weight/plant (r = 0.848**). On the other hand, oil percentage was not significantly correlated with plant height, number of branches/plant, number of pods/plant and protein %, however, it was positively and significantly correlated with seed weight/plant (r = 0.508*). Thus, it can be concluded that seeds can be increased by selection for higher number of branches/plant, heavier number of pods/plant, seed weight/plant and heavier 100-seed weight. These results are in agreement with those obtained by Nigem *et al.* (1983).

Multiple regressions: Results of multiple regression analysis are presented in Table 10. Data showed that the relative contribution R^2 for all variables in the total variation of seed yield was 93.07%. On the other hand, R^2 for the residual variables was 6.93%, which indicates that most characters were included in this analysis.

Stepwise regression analysis: Data in Table 10 also show that four variables out of the six were accepted as significantly contributing variables to variation in soybean seed yield. These variables were 100-seed weight, number of branches/plant, number of pods/plant and seed weight/plant. With R^2 being 91.61, 0.76, 0.41 and 0.28% according to stepwise analysis, respectively. The results indicated that stepwise analysis develops a sequence of multiple regression equation by removing R^2 from the full model equation with relative contribution of 0.01%. In conclusion it can be stated that 100-seed weight, number of branches/plant, number of pods/plant and seed weight/plant were the most important characters since they have not only high significant positive associated with seed yield/fad but also had relative contributing towards seed yield/fad in the prediction equation. Therefore, maximum effort should be given to these characters for the improvement of soybean seed yield by selection through breeding programs.

Table 9: Correlation coefficients among soybean characters (average of combined data for two seasons; 2010 and 2011

Parameter	1	2	3	4	5	6	7
Plant height							
No. of branches/plant	0.530*						
No. of pods/plant	0.847**	0.905**					
Seed weight/plant	0.863**	0.875**	0.602**				
Protein (%)	0.685**	0.719**	0.580**	0.848**			
Oil (%)	0.394	0.426	0.328	0.508*	0.365		
Seed yield/fad.	0.882**	0.880**	0.547**	0.746**	0.957**	0.581**	

*Significant, **Highly significant

Table 10: Multiple regression and stepwise regression analysis for seed yield (ton/fad) (Y) as affected by all yield attributes in soybean

Parameters	Percentage
Prediction equation according to multiple regression:	
Y = a + b1X1 + b2X2 + b3X3 + b4X4+ b5X5 + b6X6	
Y = -0.38 + 0.001X1+ 0.149X2+ 0.002X3 + 0.006X4 + 0.093X5 + 0.002X6	
Relative contribution (R^2) for all variables according to full model regression	93.07
Production equation according to stepwise:	
Y = a + b5X5 + b2X2 + b3X3 + b4X4	
Y = 0.404 + 0.094X5 +0.152X2 + 0.002X3 + 0.007X4	
Relative contribution (R^2) for each of accepted variables according to stepwise regression	
X5-100-seed weight	91.61
X2-number of branches/plant	0.76
X3-number of pods/plant	0.41
X4-Seed weight/plant	0.28
The total relative contribution (R^2) for all accepted variables according to stepwise regression	93.06
The relative contribution (R^2) for all removed variables to stepwise regression	0.01
The relative contribution (R^2) for residual variables according to stepwise regression	6.93
Total effect (accepted, removed and residual)	100.00

CONCLUSION

The present investigation recommend soaking seeds of Giza 83 cultivar in humic acid at 1000 ppm for 20 min then sowing it on May 20th and sprayed plants twice (after 50 and 65 days from sowing) with the same concentration to maximize the crop yield and minimize the disease severity of damping off and root and stalk-rots.

REFERENCES

AOAC, 1997. Official Methods of Analysis of Association of Official Analytical Chemists, International. 16th Edn., AOAC International, Arlington, Virginia, USA,.

Abd El-Hai, K.M., M.A. El-Metwally and S.M. El-Baz, 2010. Reduction of soybean root and stalk rots by growth substances under salt stress conditions. Plant Pathol. J., 91: 149-161.

Achuo, E.A., K. Audenaert, H. Meziana and M. Hofte, 2004. The salicylic acid-dependent defense pathway is effective against different pathogens in tomato and tobacco. Plant Pathol., 53: 65-72.

Atiyeh, R.M., S. Lee, C.A. Edwards, N.Q. Arancon and J.D. Metzger, 2002. The influence of humic acids derived from earthworm-processed organic wastes on plant growth. Bioresour. Technol., 84: 7-14.

Bastidas, A.M., T.D. Setiyono, A. Dobermann, K.G. Cassman, R.W. Elmore, G.L. Graef and J.E. Specht, 2008. Soybean sowing date: The vegetative, reproductive and agronomic impacts. Crop Sci., 48: 727-740.

Billore, S.D., O.P. Josni and A. Ramesh, 2000. Performance of soybean (*Glycine max*) genotypes on different sowing dates and row spacing in Vertisols. India J. Agric. Sci., 70: 577-580.

Board, J.E., 2002. A regression model to predict soybean cultivar yield performance at late planting dates. Agron. J., 94: 483-492.

Carrao-Panizzi, M.C. and S.Z. Erhan, 2003. Effects of cultivars and sowing locations on oil, protein and fatty acid composition of soybeans. Proceedings of the Annual Meeting and Expo of the American Oil Chemist's Society, May 20, 2003, USA., pp: 118.

Chen, Y., M. De-Nobili and T. Aviad, 2004. Stimulatory Effect of Humic Substances on Plant Growth. In: Soil Organic Matter in Sustainable Agriculture, Magdoft, F. and R. Ray (Eds.). CRC Press, Washington, DC., ISBN: 0849312949, pp: 103-130.

De Burin, J.L. and P. Pedersen, 2008. Soybean cultivars and planting date in response to soil fumigation. Argon. J., 100: 965-970.

Draper, N.R. and H. Smith, 1987. Applied Regression Analysis. John Wiley and Sons, Inc., New York, pp: 397-402.

El-Douby, K.A., S.H. Mansour and A.A. Zohry, 2002. Effect of plant density on some soybean cultivars under two planting dates. Egypt. J. Agric. Res., 80: 275-291.

Fagbenro, J.A. and A.A. Agboola, 1993. Effect of different levels of humic acid on the growth and nutrient uptake of teak seedings. J. Plant Nutr., 16: 1465-1483.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. 2nd Edn., John Wiley and Sons Inc., New York, USA., ISBN-13: 9780471879312, Pages: 680.

Grichar, W.J., J.D. Janak and P. McGuill, 2008. Texas gulf coast soybean yield as affected by soybean variety and planting dates. Crop Manage.

Hagsin, K., K. Haongsig, K. Kyongho and Oh. Yeang-Lin, 2006. Changes in the yield components and yield sport soybean cultivars affected by sowing date. Korean J. Crop Sci., 51: 584-592.

Hassan, M.Z., K.A. Al-Assily, M.S.A. Mohamed and A.E. Sharaf, 2002. Cultivars under different sowing dates at the newly reclaimed lands of East Owinat and Kharga. Arab Univ. J. Agric. Sci., 10: 173-179.

Hassanien, A.M., 1985. Pathological and physiological studies on some root diseases of soybean. Ph.D. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., Egypt.

Heweidy, M.A., D. M. Swelim; I. A. Ismail and Nagwa, M. A. Mahmoud, 2005. Effectiveness of two *Bradyrhizobium japonicum* strains and soil application with some copper fungicides on soybean damping-off disease and plant biological activity. Zagazig J. Agric. Res., 32: 471-490.

Husein, T.F., G.A. Darweish and M.M. Rahiba, 2006. Effect of planting dates on growth, yield and quality of soybean cultivars. J. Agric. Sci. Mansoura Univ., 31: 587-594.

Ibrahim, H.M., 2009. Effect of sowing dates on yield and quality of some soybean cultivars. J. Agric. Sci., 34: 4741-4752.

Jackson, M.L., 1967. Soil Chemical Analysis. Printice Hall, New Delhi, India, pp: 498.

Karaaslan, D., 2008. Determination of total protein and fatty acid composition of soybean seed as affected by sowing dates. Asian J. Chem., 20: 767-775.

Kausale, S.P., B.S. Ekshinge, D.M. Lomte, G.M. Kote, G.D. Gadade and B.M. Lambade, 2004. Response of soybean varieties of varying sowing dates. Ann. Plant Physiol., 18: 167-170.

Kausale, S.P., B.S. Ekshinge, G.M. Kote, G.D. Gadade and D.M. Lomte, 2006. Effect of sowing dates on physiological parameters and seed yield of soybean. Ann. Plant Physiol., 20: 208-211.

Kravea, G.A., 1960. Root rot diseases on soybean in virgin lands and their control. Ph.D. Thesis, Leningrad (In Russian).

Kumar, V., R. Anita and G.S. Chauhan, 2004. Effect of delayed sowing on oil content and fatty acid composition of soybean. Indian J. Agric. Biochem., 16: 67-91.

MacCarthy, P., C.E. Clopp, R.L. Malcolm and R.R. Bioom, 1990. Humic Substances in Soil Crop Science. American Society of Agronomy, Madison, Wisconsin, USA.

McDonnell, R., N.M. Holden, S.M. Ward, J.F. Colins, E.P. Farrell and M.H.B. Hayes, 2001. Characteristics of humic substances in health land and forested peat soils of the wick low mountains. Biol. Environ., 101: 187-197.

Muhammad, A. and P. Shah, 2003. Comparative yield and yield components of land races and improved varieties of soybean. Sarhad J. Agric., 19: 459-461.

Nigem, S.A., Z.M.A. Mohamed and H.A. Rabie, 1983. Yields analysis in broad bean. Zagazig J. Agric. Res., 10: 125-139.

Phillips, D.V., 1971. Influence of air temperature on brown stem rot of soybean. Phytopathology, 61: 1205-1208.

Piccolo, A., S. Nardi and G. Concheri, 1992. Structural characteristics of humic substances as related to nitrate uptake and growth regulation in plant systems. Soil Biol. Biochem., 24: 373-380.

Popp, M.P., T.C. Keisling, R.W. Mcnew, L.R. Ovler, C.R. Dilion and D.M. Wallace, 2002. Planting date, cultivars and tillage system effects on dry land soybean production. Agron. J., 94: 81-88.

Pregl, F., 1945. Quantitative Organic Micro Analysis. 4th Edn., J. and A. Churchill Ltd., London, pp: 126-129.

Richards, L.A., L.E. Allison and Salinity Laboratory, 1954. Diagnosis and Improvement of Saline and Alkaline Soils. US Department of Agriculture, USA., pp: 60.

Robinson, A.P., S.P. Conty, J.J. Volenec and J. B. Santini, 2009. Analysis of high yielding, early planted soybean in India. Argon. J., 101: 131-139.

Scheuerell, S.J. and W.F. Mahaffee, 2006. Variability associated with suppression of gray mold (*Botrytis cinerea*) on Geranium by foliar applications of nonaerated and aerated compost teas. Plant Dis., 90: 1201-1208.

Schoffel, E.R., C.A. Volpe, M.L.F. Athodyd and LC. Pavani, 2003. Stability of yield components of soybean cultivars as a function of sowing date and irrigation. Sci. Brazil., 3: 167-178.

Senn, T.L., 1991. Humates in Agriculture. Acres, USA.

Shafshak, S.E., G.M.S. El-Din, M.Z. Hassan and M.S.A. Mohamed, 1997. Evaluation of six soybean genotypes under different population densities and two sowing dates. Ann. Agric. Sci. Moshtohor., 35: 115-130.

Shishodia, S.K. and S.S. Singh, 1995. Effect of different planting dates on growth parameters, yield and quality components of three soybean cultivars. Indian J. Environ. Toxicol., 5: 77-79.

Sinclair, J.B. and P.A. Backman, 1989. Compendium of Soybean Diseases. 34th Edn., American Phytopathological Society Press, USA., pp: 106.

Singh, S.R., K.O. Rachie and K.E. Dashiell, 1987. Soybean for the Tropics. John Wiley and Sons, New York, USA., pp: 230.

Snedecor, G.W. and W.G. Cochran, 1982. Statistical Methods. 7th Edn., Iowa State University Press, Ames, Iowa, USA.

Snyder, H.E. and T.W. Kwon, 1987. Soybean Utilization. Von Nostrand Reinhold Co. Inc., New York, ISBN: 9780442282165, Pages: 346.

Ulukan, H., 2008. Effect of soil applied humic acid at different sowing times on some yield components in wheat (*Triticum* sp.) hybrids. Int. J. Bot., 4: 164-175.

Yildirim, E., 2007. Foliar and soil fertilization of humic acid affect productivity and quality of tomato. Acta Agric. Scand. Sect. B-Soil Plant Sci., 57: 182-186.