Madras Agric. J., 103 (10-12): 314-319, December 2016
https://doi.org/10.29321/MAJ.10.001041

Physiological Effect of Trifloxystrobin and Tebuconazole on Nutrients Uptake in Groundnut (*Arachis hypogaea* L.)

S. Sowmya priya*, P. Boominathan P. Jeyakumar and N. Manivannan
Department of Crop Physiology and Department of Oilseeds, TNAU, Coimbatore - 641 003.

Groundnut (*Arachis hypogaea* L.) is an important oilseed cash crop for farmers of tropical and sub-tropical regions of the world. Various environmental factors affect the productivity of groundnut and one of the options available for enhancing the productivity is the use of agro-chemicals with growth promoting activity that enhance the growth and development in turn productivity. With the modern agro-chemicals such as fungicides belonging to strobilurins (trifloxystrobin) and triazoles (tebuconazole), the concept of disease control gained new perspectives, especially when it showed positive physiological effects in the plants. Field experiments were conducted in groundnut to study the effects of various combinations of trifloxystrobin + tebuconazole (*Nativo*) @ 250, 300, 350 g ha^{-1} and carbendazim @ 500 g ha^{-1} at 35 and 50 days after sowing. Among the different concentrations, *Nativo* @ 300 g ha^{-1} performed better by increasing the productivity in groundnut.

Key words: Groundnut, Trifloxystrobin, Tebuconazole, Nitrogen, Phosphorus and Potassium

Groundnut (*Arachis hypogaea* L.) is an important oilseed cash crop in tropical and sub-tropical regions of the world. Groundnut seeds contain high amounts of edible oil (43–55%) and protein (25–28%) and is a rich source of dietary fiber, minerals, calcium, iron and vitamin B complex like thiamine, riboflavin, niacin and vitamin A. Fungicides remain a vital solution to the effective control of plant diseases, which are estimated to cause yield reductions of almost 20 percent in major food and cash crops worldwide. After the launching of modern agrochemicals containing antioxidant compounds such as fungicides belonging to strobilurins and triazoles the concept of disease control gained new perspectives, especially when it showed positive physiological effects in the plants (Debashis *et al*., 2012).

Trifloxystrobin belongs to the strobilurin group of fungicide which is a mesostemic and broad-spectrum fungicide with preventive and specific curative activity. In addition to the fungicidal effect of strobilurins on the metabolism of pathogenic fungi, positive influences on physiological traits and consequently, on yield formation have been recognized in cereals (Beck *et al*., 2000). These changes in the metabolism and physiology have been studied intensively and are ultimately referred to as “the greening effect”. This comprises of enhanced chlorophyll content, higher amount of protein, increased dry matter and delayed senescence. The use of stobilurins is an alternate approach to increase and stabilize yield in crop plants (Beck *et al*., 2000). Tebuconazole is a systemic triazole fungicide which is used widely in agricultural practices and reported to kill the target organisms by disrupting the membrane functions through inhibition of sterol biosynthesis. Triazole and strobilurin treated plants showed various morphological and physiological changes including inhibition of plant growth, decrease in internodal elongation, increased chlorophyll levels, enlarged chloroplast, thicker leaf tissue, increased root to shoot ratio, delayed senescence, increased antioxidant potentials and enhancement in alkaloid production (Zhang *et al*., 2010).

*Corresponding author email: sowmya.vedha@gmail.com

Materials and Methods

The field experiment was conducted in groundnut variety CO 7 at Tamil Nadu Agricultural University, Coimbatore during October to January (S1) and December to March (S2) with five replications in factorial randomized block design. The treatments consists of control (T_1) and foliar application of *Nativo (Trifloxystrobin and Tebuconazole)* 75 WP @ 250 g ha^{-1} (T_2), 300g ha^{-1} (T_3) and Carbendazim @ 500 g ha^{-1} (T_5) at 30-35 DAS and 45-50 DAS. The Nativo 75 WP is a combination of fungicides trifloxystrobin and tebuconazole was used in this study at different concentration.

Plant Nutrient analysis

Two gram of powered plant sample was taken in a 100 ml conical flask and to this 12 ml of triple acid mixture containing nitric acid, sulphuric acid and percholoric acids in the ratio of 9:2:1 was added and the mouth of conical flask was covered with a funnel. The content of the flask was digested over a sand bath till a clear solution was obtained. This solution was filtered through Whatman No.41 filter paper and filtrate was collected in a 250 ml volumetric flask. The conical flask was washed with a small amount of hot water and added to the filter paper, the residue on the filter paper was also washed with hot water. The volumetric flask containing the filtrate was cooled under tap water and the volume of the filtrate was

made up to 250 ml with distilled water. The triple acid extract was stored for the analysis of mineral constituents.From the digested solution, nitrogen content was estimated using Pelican Kelplus-Classic DXVA (Pelican Pvt. Ltd., India) instrument and expressed in kg^{-1} ha^{-1}. From the digested solution, phosphorus content was estimated colorimetrically by vanadomolybdo phosphoric yellow color method (Jackson, 1973) and expressed in kg^{-1} ha^{-1}.Potassium content of the digested solution was estimated using Flame photometer and expressed in kg^{-1} ha^{-1}.

The calcium and magnesium content of the plant samples were analyzed by Atomic Absorption Spectrophotometry (Perkin Elmer Model 900Z) method (Jackson, 1973) and expressed as percentage on dry weight basis. The data collected on the different characters from field experiments were statistically analyzed in a FRBD (Factorial Randomized Block Design) as suggested by Gomez and Gomez (1992).

Results and Discussion

Effect of trifloxystrobin and tebuconazole on root length

Growth characters *viz*., root length, nutrient uptake as influenced by different concentrations of *Nativo* treatments were determined at pre flowering, flowering, pegging, pod filling and maturity stages of crop growth in groundnut.Root length and its distribution helps in divulging the pattern of water use and nutrient uptake by the crop.

Table 1. Effect of *Nativo* on root length (cm $plant^{-1}$) at different growth stages of groundnut

Treatments	Pre flowering stage (25 DAS)			Flowering stage (45 DAS)			Pegging stage (60 DAS)			Pod filling stage (75 DAS)			Maturity stage (90 DAS)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	8.31	9.43	8.87	14.86	15.69	15.28	18.92	19.48	19.20	20.34	21.43	20.89	20.43	21.54	20.98
T_2	7.36	7.51	7.44	16.43	17.76	17.10	20.75	20.88	20.52	21.98	23.52	22.75	22.31	22.97	22.64
T_3	6.89	6.54	6.72	17.12	18.70	17.91	20.54	21.95	21.25	23.22	24.10	23.66	23.79	24.89	24.34
T_4	6.76	8.08	7.42	17.21	18.51	17.86	20.64	21.42	21.03	22.10	23.73	22.92	23.48	23.66	23.57
T_5	7.87	7.77	7.82	16.42	16.87	16.65	20.13	19.80	19.97	21.46	21.78	21.62	21.92	22.11	22.02
Mean	7.44	7.87	7.65	16.41	17.51	16.96	20.20	20.71	20.39	21.82	22.91	22.37	22.39	22.83	22.61
	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S
SEd	1.080	0.689	1.541	0.106	0.067	0.150	0.127	0.080	0.180	0.136	0.086	0.192	0.143	0.090	0.202
CD (P = 0.05)	NS	1.414	NS	0.218	0.138	0.309	0.261	0.165	0.369	0.278	0.176	0.393	0.293	0.186	0.415

With regard to effect of different concentrations *Nativo* on root length, significant increase in root length was noticed at different stages. Among the treatments, 300g ha^{-1} (T_3) recorded highest root length (cm) at pegging (21.3), pod filling (23.7) and maturity (24.3) and lowest root length was registered in control T_1 (19.2, 20.9, 20.0) in respective stages. In the present study, *Nativo* @ 300g ha^{-1} registered maximum effect in groundnut by improving the root length by 18.8 per cent over control (Table.1). This could be due to inhibition of gibberellin biosynthesis by triazoles as studied by Kavina, 2012 .

Table 2. Effect of *Nativo* on nitrogen uptake (kg/ha) at different growth stages of groundnut

Treatments	Pre flowering stage (25 DAS)			Flowering stage (45 DAS)			Pegging stage (60 DAS)			Pod filling stage (75 DAS)			Maturity stage (90 DAS)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	15.32	16.09	15.71	60.53	71.07	65.80	110.95	123.86	117.40	100.22	107.64	103.93	80.33	81.86	81.09
T_2	16.14	16.80	16.47	67.92	83.84	75.88	119.49	138.66	129.08	105.70	118.38	112.04	96.07	92.25	94.16
T_3	15.38	15.91	15.64	85.19	96.45	90.82	135.35	155.69	145.52	120.66	139.31	129.98	102.43	111.80	107.11
T_4	16.84	17.26	17.05	80.54	93.00	86.77	130.96	148.13	139.54	116.75	127.03	121.89	98.65	110.37	104.51
T_5	15.52	16.05	15.78	67.45	77.33	72.39	116.03	130.13	123.08	103.54	112.61	108.07	85.24	90.18	87.71
Mean	15.84	16.42	16.13	72.33	84.34	78.33	122.56	139.29	130.92	109.37	120.99	115.18	92.54	97.29	94.92
	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S
SEd	0.139	0.088	0.197	0.015	0.010	0.021	0.016	0.010	0.023	0.014	0.009	0.020	0.008	0.005	0.011
CD (P = 0.05)	NS	0.181	NS	0.031	0.020	0.044	0.033	0.021	0.047	0.029	0.018	0.055	0.017	0.011	0.023

Effect of trifloxystrobin and tebuconazole on nutrient uptake

The increase in nutrient uptake in general has been considered as increased efficient root characters which may facilitate nutrient absorption from soil. The increase in root length may be due to inhibition of gibberellic acid (GA) synthesis by strobilurin causing reduced shoot length (Sankhla and Davis, 1999) and increased partitioning of assimilates towards roots. The increased root length by Nativo treated plants could have facilitated the water and nutrient absorption from the soil, which are the crucial factors for determining crop growth.

Nitrogen is an essential macronutrient needed by all plants and is an important component of many structural, genetic and metabolic compounds in plant cells. It is also one of the basic components

Table 3.Effect of *Nativo* on phosphorus uptake (kg/ ha) at different growth stages of groundnut

Treatments	Pre flowering stage (25 DAS)			Flowering stage (45 DAS)			Pegging stage (60 DAS)			Pod filling stage (75 DAS)			Maturity stage (90 DAS)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	1.18	1.27	1.23	7.74	9.29	8.52	14.68	15.79	15.24	13.60	14.62	14.11	9.16	9.88	9.52
T_2	0.95	1.33	1.14	9.37	11.81	10.59	16.94	19.59	18.27	15.50	16.95	16.22	12.05	12.01	12.03
T_3	1.06	1.26	1.16	11.91	13.39	12.65	18.00	20.45	19.65	16.56	18.21	17.89	13.71	15.75	14.43
T_4	1.10	1.50	1.30	11.74	12.96	12.35	18.11	20.68	19.22	17.14	18.34	17.39	13.53	15.23	14.38
T_5	1.12	1.42	1.27	8.80	10.50	9.65	15.67	16.66	16.17	14.19	15.51	14.85	10.72	11.29	11.01
Mean	1.08	1.36	1.22	9.91	11.59	10.75	16.78	18.63	17.71	15.42	16.76	16.09	11.91	12.63	12.27
	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S
SEd	0.131	0.079	0.178	0.012	0.009	0.018	0.011	0.008	0.021	0.010	0.007	0.011	0.007	0.004	0.009
CD (P = 0.05)	NS	0.163	NS	0.025	0.019	0.037	0.023	0.016	0.043	0.021	0.014	0.023	0.014	0.008	0.019

of chlorophyll, the compound by which plants use sunlight energy to produce sugars during the process of photosynthesis. Therefore, nitrogen deficiency rapidly inhibits plant growth. In the present study, it was found that the uptake of nitrogen was significantly increased by application of trifloxystrobin in combination with tebuconazole, at all growth stages, in both seasons. Increasing the levels of nitrogen during the vegetative stage could have strengthened and supported roots, enabling plants to absorb more water and nutrients. A maximum increase of 23.9 per cent in 300 g/ha and 18.8 per cent in 350 g/ha of N content (Table 2.) over control was observed due to fungicide treatment. The present findings are strongly supported by the report of Han and Yang (2009) who observed uniconazole

Table 4. Effect of *Nativo* on potassium uptake (kg/ ha) at different growth stages of groundnut

Treatments	Pre flowering stage (25 DAS)			Flowering stage (45 DAS)			Pegging stage (60 DAS)			Pod filling stage (75 DAS)			Maturity stage (90 DAS)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	3.79	4.82	4.31	20.14	21.82	20.98	36.75	39.84	38.30	29.19	33.26	31.22	26.32	31.05	28.69
T_2	4.00	4.48	4.24	24.22	27.00	25.61	42.35	50.49	46.42	35.60	52.43	44.02	32.19	35.79	33.99
T_3	4.56	5.70	5.13	28.01	35.17	31.59	53.54	62.97	58.26	48.17	60.99	54.58	45.29	48.80	46.64
T_4	3.69	5.03	4.36	28.65	34.49	31.57	51.43	58.47	54.95	47.02	55.07	51.04	44.10	48.17	46.55
T_5	3.24	4.12	3.68	23.54	24.39	23.96	40.25	46.48	43.36	33.50	41.47	37.49	29.27	35.73	32.50
Mean	3.86	4.83	4.34	24.91	28.57	26.74	44.86	51.65	48.26	38.69	48.65	43.67	35.44	39.91	37.67
	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S
SEd	0.112	0.071	0.178	0.012	0.007	0.015	0.013	0.008	0.020	0.009	0.005	0.016	0.008	0.004	0.012
CD (P = 0.05)	NS	0.151	NS	0.025	0.015	0.032	0.028	0.017	0.042	0.019	0.011	0.034	0.017	0.008	0.025

increased the uptake of nitrogen in wheat. The increment in nitrogen uptake by application of different levels of trifloxystrobin combined with tebuconazole might be attributed to enhanced cytokinin. Saurez *et al*., (2002) reported that amount of photosynthetic pigments is related to the rate of nitrogen uptake by plants. Nitrogen was reported to increase photosynthesis through enhanced carbonic anhydrase activity (Mohammed *et al.,* 2009). A decline in the supply of nitrogenor phosphorus

results in an immediate decline in photosynthetic activity, but increasing N and P supply also stimulates photosynthetic activity by increasing down-stream utilization of calvin cycle end-products (Paul and Pausas, 2011). Application *Nativo* @ 300 g/ha resulted in increased N content by 23.9 % and it was also reflected in yield. The increased uptake of N due to *Nativo* may be useful for the plants grown under soil with low nitrogen.

Phosphorus (P) is vital to plant growth and involved in several key plant functions, including energy transfer, photosynthesis, transformation of sugars and starches and nutrient movement within the plant. Analysis of the data on the effect of different levels of *Nativo* revealed significant differences with higher P uptake in 300g ha^{-1} T_3 (19.6) on 60 DAS followed by T_4 (19.2) and T_2 (18.3). The values of T_3 and T_4 were on par with each other at both the stages.

Table 5. Effect of *Nativo* on calcium content (%) at different growth stages of groundnut

Treatments	Pre flowering stage (25 DAS)			Flowering stage (45 DAS)			Pegging stage (60 DAS)			Pod filling stage (75 DAS)			Maturity stage (90 DAS)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	0.87	0.96	0.92	1.25	1.67	1.46	2.11	2.35	2.23	1.35	1.41	1.38	1.12	1.22	1.17
T_2	0.94	0.91	0.93	1.32	1.98	1.65	2.50	2.58	2.54	1.42	1.66	1.54	1.25	1.40	1.33
T_3	0.82	0.96	0.89	1.98	2.24	2.06	2.94	2.96	2.95	1.79	1.94	1.87	1.64	1.68	1.66
T_4	0.85	0.75	0.8	1.76	2.14	2.00	2.78	2.88	2.83	1.67	1.74	1.71	1.47	1.55	1.51
T_5	0.79	0.86	0.83	1.29	1.79	1.54	2.32	2.40	2.36	1.38	1.53	1.46	1.19	1.31	1.25
Mean	0.85	0.89	0.87	1.52	1.96	1.74	2.53	2.63	2.58	1.52	1.64	1.58	1.33	1.43	1.38
	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S
SEd	0.111	0.068	0.167	0.012	0.008	0.017	0.010	0.007	0.014	0.011	0.006	0.017	0.006	0.004	0.010
CD (P = 0.05)	NS	0.142	NS	0.025	0.017	0.035	0.021	0.015	0.029	0.023	0.013	0.035	0.013	0.009	0.022

The effect of fungicide (*Nativo*) on phosphorous uptake showed significant increase irrespective of the stages. The increment in phosphorus uptake due to fungicide application was earlier reported by Schweiger *et al*. (2001) in peas. In general, plants appear to be remarkably efficient in their internal recycling of phosphorus. Phosphorus uptake by the plants was found increased due to the enhanced activity of acid phosphatase (Djanaguiraman, 2003) by solubilising organic phosphates in the rhizosphere (Goldstein *et al*., 1989). Significant increase in phosphorus uptake was observed by Mohamed *et al*. (2011) in tomato in response to triazole application. Phosphorus supply can modulate the content of activated RuBISCO either directly (Marcus and Gurevitz, 2000) or indirectly (Pieters *et al.,* 2001) and there is a tight coupling between the effects of P and N on photosynthesis and plant growth.

Table 6. Effect of *Nativo* on magnesium content (%) at different growth stages of groundnut

Treatments	Pre flowering stage (25 DAS)			Flowering stage (45 DAS)			Pegging stage (60 DAS)			Pod filling stage (75 DAS)			Maturity stage (90 DAS)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	0.57	0.65	0.61	0.98	1.05	1.01	1.11	1.14	1.13	0.96	0.98	0.97	0.77	0.78	0.77
T_2	0.79	0.78	0.78	1.09	1.21	1.15	1.26	1.29	1.28	0.99	1.06	1.03	0.80	0.87	0.83
T_3	0.83	0.77	0.80	1.44	1.46	1.45	1.61	1.72	1.67	1.24	1.21	1.23	0.98	0.99	0.99
T_4	0.75	0.90	0.83	1.23	1.34	1.29	1.48	1.55	1.52	1.12	1.14	1.13	0.91	0.93	0.92
T_5	0.53	0.90	0.71	0.99	1.11	1.05	1.18	1.15	1.17	0.98	0.99	0.98	0.79	0.79	0.79
Mean	0.69	0.80	0.75	1.15	1.23	1.19	1.33	1.37	1.35	1.06	1.08	1.07	0.85	0.87	0.86
	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S	T	S	T × S
SEd	0.109	0.053	0.138	0.009	0.004	0.015	0.011	0.005	0.015	0.010	0.006	0.012	0.005	0.003	0.008
CD (P = 0.05)	NS	0.114	NS	0.019	0.009	0.032	0.024	0.011	0.032	0.021	0.013	0.026	0.011	0.006	0.017

The main role of potassium is to provide the appropriate ionic environment for metabolic processes in the cytosol and serves as a regulator of various processes including growth regulation. Plants require potassium ions (K^+) for protein synthesis and opening and closing of stomata, phloem solute

transport of photoassimilates into source organs, and maintenance of cation:anion balance in the cytosol and vacuole. Application of *Nativo*@ 300g/ha improved the K uptake by 52.1% over the control at the time of pegging stage (Table 4). Similar results of significant increase in potassium uptake were observed by Mohamed *et al*. (2011) in tomato in response to triazole application. Manal *et al.* (2010) also observed that application of uniconazole increased the uptake of macro-nutrients such as N, P, K as well as micro-nutrients such as Fe and Mn in control and salt stressed plants in wheat.

Calcium plays a vital nutritional and physiological role in plant metabolism. It is essential for processes that preserve the structural and functional integrity of plant membranes (Hanson, 1984), stabilize cell wall structure, regulate ion transport and control ion exchange behavior as well as cell wall enzyme activities (Demarty *et al*., 1984). Analysis of trend on calcium content, with the application of *Nativo* showed a significant differences with a maximum value recorded at 60 DAS in T_3 (2.9) followed by T_4 (2.83) and the lowest calcium content in T_1 (2.23). In this study *Nativo* @ 300 g/ha showed its effectiveness in raising the calcium concentration in leaf by about 32.3 per cent particularly at the time of pod filling stage. A considerable reduction in leaf calcium at maturity also indicates the efficient utilization of calcium for the development of reproductive structures.

Magnesium plays pivotal role on pigment synthesis and act as co-factor for many metabolic reactions. Calcium strongly competes with Mg+ under normal soil condition, increase in salinity, associated with reduction of both Ca and Mg concentration in a number of crops (Salama, 2001) *Nativo* @ 350g/ha, treated plants showed 47.7 per cent increase in magnesium content over control in groundnut leaves at pegging stage (Table 6). Since magnesium occupies the central atom in chlorophyll, high magnesium content found in triazole treated leaves could mean that some shade-induced alteration had occurred in chloroplasts. Pyraclostrobin belongs to strobilurin also has been reported to cause physiological changes such as increased leaf greenness, chlorophyll content, photosynthetic rates, and water use efficiency, combination with delayed senescence (Bryson *et al.,* 2000). Increase in chlorophyll content due to application of Nativo might have also associated with high magnesium content in leaves since magnesium is the major component part of chlorophyll.

Conclusion

The foliar applications of *Trifloxystrobin and Tebuconazole* @ 300 g ha^{-1} is identified as the best treatment in terms of increase the uptake of nutrient N, P, K, Ca, Mg and inturn yield components. Synthesis of protein, enzymes and nucleic acids was promoted by the increased uptake of N while K and Ca uptake was associated with increased cell division and growth. However, increased Mg content play a vital role on pigment synthesis including chlorophyll and also as a co-factor for many metabolic reactions. Thus, optimization of concentration of trifloxystrobin and tebuconozole is extremely important for maximizing the production of groundnut through enhanced uptake of nutrients.

References

Beck, C., Koch, H., Oerke, E.C. and H. W. Dehne. 2000. Einfluss von Strobilurinen auf Physiologie und Ertrag von Winterweizen.Mitt. Biol. Bundesanst. *Land-Forstwirtsch*., **376:** 479-480.

Bryson, R.J., Leandro, L.and Jones, D.R. 2000. The physiological effects of kresoxim-methyl on wheat leaf greenness and the implications for crop yield. p. 739–749. In: The Proc. of the BCPC Conf., Brighton, UK. 13–16. British Crop Production Council, Hampshire, UK.

Debashis, D., Supradip, S., Prasad, R.D. and Kumar, B.M. 2012. Effect of different active fungicides molecules on the management of rice blast disease. *Int. J. Agric. Environ. Biotechnology*, **5(3):** 247-251.

Demarty, M., Morvan, C. and Mothellier. 1984. Calcium and the cell wall. *Plant Cell Environ*., **7**: 441-448.

Djanaguiraman, M. 2003. Physiological effects of nitrophenol on cotton and tomato. Ph.D. Thesis submitted to Tamil Nadu Agricultural University, Coimbatore.

Goldstein, A.H., Baertlein, D.A. and Danon, A. 1989. Phosphate starvation stress as an experimental system for molecular analysis. Plant Mol. Biol. Rep., **7**: 7-16.

Gomez, K.A. and Gomez. A.A. 1992. Statistical procedure for agricultural research. New York, Wiley Inter-Science Publications.

Han, H. and Yang, W. 2009. Influence of uniconazole and plant density on nitrogen content and grain quality in winter wheat in South China. *Plant Soil Environ.,* **55(4):** 159-166.

Jackson, M.L. 1973. Soil chemical analysis.Prentice Hall of India Pvt Ltd., New Delhi, India.

Kavina, J., Gopi, R., Panneerselvam, R. 2012. Plant Growth Regulators and Fungicides alters Growth and Biochemical contents in *Mentha piperitaLinn.*Int. J. Environ. Sci., **1(7):** 189-214

Manal, F., Mahmed, Thalooth, A.T. and Khalifa, R.M. 2010. Effect of foliar spraying with uniconazole and micronutrients on yield and nutrient uptake of wheat plants grown under saline condition. *J. American Soc. Hort. Sci.,* **6(8):** 398-404.

Marcus, Y. and Gurevitz, M. 2000. Activation of cyanobacterial RuBP carboxylase oxygenase is facilitated by inorganic phosphate via two independent mechanisms. *Eur. J. Biochem.,* **267**: 5995-6003.

Mohamed G.F., Agamy, R.A. and Rady, M.M. 2011. Ameliorative effects of some antioxidants on water-stressed tomato (*Lycopersicon esculentum* Mill.) plants. J. Applied Sciences Research, **7(12):** 2470-2478.

Mohamed, G.F., 2009. The effect of some amino acids and antioxidants on morphological, anatomical characters, chemical constituents and yield of canola plant (*Brassica napus* L.). PhD Thesis submitted to Fac. of Agric., Fayoum University.

Paula S. and Pausas, J.G. 2011. Root traits explain different

foraging strategies between resprouting life histories. *Oecologia,* **165**: 321-331.

Pieters, A., Paul, M.J. and Lawlor D.W. 2001. Low sink demand limits photosynthesis under P_i deficiency. *J. Exp. Bot.,* **52**: 1083-1091.

Salama, Z.A. 2001. Mineral content, in shoots and roots of maize and soybean seedlings as affected by NaCl and their relation to changes is chlorophylls and catalase activity. *Egyptian J. Plant Physiol. Sci*., **23 (3):** 317-333.

Sankhla, N. and Davis, T.D. 1999. Use of biosynthesis inhibitors for controlling woody plant growth.Proce. Plant Growth Regul. *Soc. Amer.,* **26**: 97-104.

Saurez, M. F., Avila, C., Gallardo, F., Canton, F.R., Garcia-Gutierrez, A., Claros, M.G. and Canovas, F.M. 2002. Molecular and enzymatic analysis of ammonium assimilation in woody plants*. J. Exp. Bot.,* **53**: 891-904.

Schweiger P.F., Spliid, N.H. and Jakobsen, I. 2001. Fungicide application and phosphorus uptake by hyphae of arbuscular mycorrhizal fungi into field-grown peas. *Soil Biol. Biochem*., **33**: 1231-1237.

Zhang, Y.J., Zhang, X., Zhou, M.G., Chen, C.J., Wang, J.X., Wang, H.C. and Zhang, H. 2010. Effect of fungicides JS399-19, azoxystrobin, tebuconazole, and carbendazim on the physiological and biochemical indices and grain yield of winter wheat. *Pestic. Biochem. Physiol.,* **98**: 151-157.

Received after revision : December 28, 2016; Accepted : December 30, 2016