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Selenium enrichments of Cauliflower (*Brassica oleracea* L. var. Botrytis) and Broccoli (*Brassica oleracea* L. var. Italica) grown under drip-hydroponic system hybrid 704

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ABSTRACT: Difano and Organza f1 Cauliflower cultivars and Calbrese Broccoli cultivars were enriched with Selenium, as they were irrigated with nutrient solutions containing 0, 0.5, 1 and 1.5 mg.l^{-1} Selenium by drip-hydroponic system. Our intention was to produce cauliflower and broccoli foods containing sufficient Selenium to cure some diseases including cancer. The obtained results revealed that all applied rates of Selenium were within the valid rates, where the highest accumulated Selenium on dry basis was (5.06 µg.g^{-1}) which goes to 0.5 µg.g^{-1} in fresh edible tissues. However, increases applied Se rate tended to reduce to accumulated Se in curds and adversely affected growth. Fulvic-Humic acid reduced accumulated Se in curd and improved IAA, GA_3, ABA, CK homeostasis, N, K, Cu, Zn, Fe and Ca. The best capability of Se accumulation was Difino F1 followed by Calbrese then Organza F. The lowest accumulated se (0.53 µg.g$^{-1)}$ in curd tissue found in Organza treated 1ml.l^{-1} Fulvic-Humic irrigated with 1mg.l^{-1} Se contained water, Calbrese (1.76µg.g^{-1}) treated 0ml.l^{-1} Fulvic-Humic irrigated with 1.5 mg.l^{-1} Se contained water and Difino (3.06 µg.g^{-1}) treated 2ml.l^{-1} Fulvic-Humic irrigated with 1.5 mg.l^{-1} Se contained water.

***Keywords*: :** Broccoli, Cauliflower, Selenium (Se), GA3, IAA, ABA, CK, N, K, Ca, Cu, Zn, Fe, Mineral partitioning, Drip irrigation, Hydroponic

Introduction

Brassica is one of the most important plant groups, containing species widely used in our daily life. *Brassica rapa;* (n=10), *B. nigra;* (n=8); and *B. oleracea;* (n=9) are the three basic groups with three amphidiploid species. *B. napus* (n=19), *B. juncea* (n=18) and *B. carinata* (n=17) derived from interspecific hybridization between pairs of these diploid species. Hybrids are *B. rapa* × *B. oleracea, B. rapa* × *B. nigra* and *B. nigra* × *B. oleracea*, respectively (UN, 1935). Based on chloroplast DNA (Warwick and Black, 1991), mitochondrial DNA (Palmer and Herbon, 1988), and nuclear DNA variation (Song *et al*., 1990) the phylogenetic relationships in *Brassica* and its related genera have been proposed. Brassica species divided into two evolutionary pathways: the (nigra) lineage and the (rapa/oleracea) lineage. Raphanus thought to be closely related to the *Brassica* species. However, its relation to either lineage remains unsolved. Based on chloroplast and mitochondrial DNA restriction site variation (Warwick and Black, 1991;

Palmer and Herbon, 1988), *Raphanus* proposed to be more closely related to the (rapa/oleracea.) lineage, but nuclear RFLPs and other RAPD data have suggested that Raphanus is more closely related to the (.nigra.) lineage (Song *et al*., 1990; Thormann *et al*., 1994).

Broccoli (*Brassica oleracea* L. var Italica) is an important vegetable with floral heads composed of hundreds of immature florets arranged in whorls on a fleshy stem. Each floret consists of an immature flower enclosed within chlorophyll-containing sepals. The chlorophyll degradation within these sepals that results in the rapid yellowing of the heads during storage (Tian *et al.*, 1994). There are three main types of broccoli: sprouting, Calabrese, and romanesco. Calabrese is most familiar because of its large heading portion and thick stalks. Calabrese is the most common type of broccoli grown and eaten with tight, dome shaped, green-beaded heads. Sprouting broccoli has smaller flowering heads and many thinner stalks. The romanesco type reaches maturity in the fall and is distinguished by its yellowish-green multiple heads (Renaud 2010).

The humic substance is assumed to be formed by microbial activities and chemical processes which can involve both degradation and polymerization (Hedges 1988; Stevensen 1994; McKnight and Aiken, 1998). The biopolymer-degradation model proposes that organic macromolecules such as carbohydrates and proteins partially degraded and biopolymers such as lignin transformed into humic substances. The biotic-condensation model proposes that spontaneous abiotically heteropoly condensation reactions among small reactive intermediates for example amino acids, phenols and sugars released during enzymatic breakdown of bio macromolecules can produce extremely complex assemblages of molecules that exhibit a brown colour (Calace *et al*., 2005). These macromolecules are interesting because of their structural features, which includes binding sites with different complexing strength, able to form inert and labile complexes with metals (Yamamoto and Ishiwatary, 1992).

The preferential sorption of aromatic humic moieties to aluminum (Al) and iron (Fe) oxides were detected (McKnight *et al*., 1992; Gu *et al*., 1995). Ligand exchange-surface complexation was proposed as the dominant interaction mechanism for sorption of humic substances on Fe oxide (Gu *et al*., 1994), Yoon *et al.* (2005) found that weak outer-sphere type complexes would play an important role during the interaction of humic substances with boehmite (γ-AlO(OH)). Other factors, such as the stereo chemical arrangement of the functional groups on humic substances may also lead to preferential sorption of certain humic fractions (Gu *et al.*, 1994). Strong interaction between Elliot soil humic acid (ESHA) and hydrous Al oxide (HAO) led to ESHA-promoted dissolution of HAO and surface charge reversal. The ESHA-HAO sorption–desorption isotherms were successfully described using a modified Langmuir model that accounted for the heterogeneity of HAO surface and ESHA. Ligand exchange proposed as the major interaction mechanism and the edge Al atoms on HAO surface considered as the sorption sites for ESHA macromolecules. ESHA was coated onto HAO to achieve two different organic content (*f*oc) levels of 0.81 and 1.52% (Gu and Karthikeyan, 2007). Sorption results compared for the binary ESHA-tetracycline and HAO-tetracycline systems, and the ternary ESHA-HAO tetracycline system. The coating of ESHA on HAO significantly suppressed tetracycline sorption levels, which was attributable to altered HAO surface charge characteristics and/or direct competition between ESHA and tetracycline for potential sorption sites. Higher Organic content (*f*oc) level, besides increasing the extent of sorption suppression, also resulted in greater ionic strength dependence and increased nonlinearity of sorption behavior.

The average Se concentration is much higher in sedimentary rocks, especially shales and coal, than in igneous rocks (Kruskopf, 1982). This explained, as consequence of volatile Se transfer to the atmosphere and hydrosphere during volcanic processes. It shown that sulphuric acid-rich polluted rain was an important source of Se. It had been known for a long time that the oceans via evaporation, atmospheric transport and deposition from rainwater or snow are a major source of iodine in soils, with the supply rate being much higher in humid coastal areas than inland (Goldschmidt, 1954). It demonstrated, however, that supply from the sea via rain and snow was as important for Se as it earlier had been shown to be for iodine, and the Se concentration was much higher near the coast than inland (Allen and Steinnes, 1980). The mechanism for transfer of Se from the sea to the atmosphere not known at that time. However, later it shown that it takes place by evaporation of dimethylselenide and other volatile Se compounds (Cooke and Bruland, 1987), similarly as iodine is transported from seawater into the atmosphere in the form of methyl iodide (Chaeides and Davis, 1980).

Plants accumulate varying amounts of Se; some plants accumulate Se in direct relationship to the amount available from the soil, whereas others (Se accumulators) may accumulate Se in concentrations orders of magnitude above that in the majority of species. As much as 80% of the total Se in some accumulator plants is present as methylselenocysteine SeMCYS (Whanger, 2004). The Se content and the chemical form of Se within plants altered by manipulation of plant genetics or by agricultural production conditions. Se-methionine in cereals is the major form of Se intake by humans, and its concentration increases with increasing soil Se (Schrauzer, 2000). Plants convert Se mainly into selenomethionine (Se-methionine) and incorporate it into protein in place of methionine because the genetic code and tRNA do not discriminate between the two. Se-methionine is the major selenocompound in cereal grains, grassland legumes, and soybeans, while Se methylselenocysteine (SeMCYS) is the major selenocompound in Se-enriched plants such as garlic, onions, broccoli, sprouts, and wild leeks. The seleno compounds identified in plants have been summarized by Whanger (Whanger, 1989; Whanger, 2002), to be selenate, selenite, selenocysteine, Se-methionine, selenohomocysteine, SeMCYS, Se-methionine selenoxide, gamma-glutamyl-Se-methyl cysteine, selenocysteineselenic acid, Se-proponylselenocysteine selenoxide, Se-methyl-Se-met, selenocystathione, dimethyl diselenide, selenosinigrin, selenopeptide and selenowax.

Selenium (Se) is an essential micronutrient for animals and humans, although it was known only for its toxicity (Draize and Beath, 1935; Schwarz and Foltz, 1957). The reduction of selenate and selenite to selenide and subsequent coupling with O-acetylserine result in the formation of selenocysteine and selenomethionine. Both of these selenoamino acids nonspecifically incorporated into proteins in place of Cys and Methionine, which contributes to Selenium toxicity in Se non-accumulators (Brown and Shrift, 1982). It is a component of many enzymes and proteins in mammals (Kryukov *et al*., 2003). It found that a cDNA encoding selenocysteine Se-methyltransferase, the key enzyme responsible for SeMSC formation, cloned from broccoli using a homocysteine S-methyltransferase gene probe from Arabidopsis (*Arabidopsis thaliana*). This clone, designated as BoSMT, functionally expressed in *Escherichia coli*, and its identity confirmed by its substrate specificity in the methylation of selenocysteine. The BoSMT gene represents a single copy sequence in the broccoli genome. Examination of BoSMT gene expression and SeMSC accumulation in response to selenate, selenite, and sulfate treatments showed that the BoSMT transcript and SeMSC synthesis were significantly upregulated in plants exposed to selenate but were low in plants supplied with selenite. Simultaneous treatment of selenate with selenite significantly reduced SeMSC production. In addition, high levels of sulfate suppressed selenate uptake, resulting in a dramatic reduction of BoSMT mRNA level and SeMSC accumulation (Lyi *et al.,* 2005). SeMSC accumulation closely correlated to BoSMT gene expression, and total Se status in tissues, besides providing important information for maximizing the SeMSC production in this beneficial vegetable plant.

Broccoli has the ability to accumulate high level of Se-methylselenocysteine (SeMCys) and selenomethionine (SeMet) when grown on seleniferous soil (Cai *et al.,* 1995). These selenoamino acids shown to be potent chemo protective agents against cancer (Ip *et al.,* 2000; Whanger, 2002). Other plant foods, such as garlic and Brazil nuts, enriched with Se and marketed as dietary Se supplements (Dumont *et al*., 2006). SeMSC synthesized from selenocysteine and S-methyl methionine by the enzyme, selenocysteine Se-methyltransferase (SMT). A gene encoding SMT from *A. bisulcatus* (AbSMT) was successfully cloned (Neuhierl *et al*., 1999). This SMT enzyme belongs to a class of methyltransferases involved in metabolism of S-methyl methionine. It shares significant primary sequence homology with homocysteine S-methyltransferases (HMT) from Arabidopsis (*Arabidopsis thaliana*). Ranocha *et al.,* (2000). Although both SMT and HMT catalyze methyl transfer using S-methyl methionine as the methyl donor, they exhibit remarkable Se-containing (for SMT) and S-containing (for HMT) substrate preference as a methyl acceptor in vitro (Neuhierl and Bock, 1996; Ranocha *et al*., 2000). SeMSC is one of the most effective anticarcinogenic Se compounds (Ip *et al*., 1991; Ganther, 1999; Ip *et al*., 2000; Whanger, 2002). It is the major form of selenoamino acids found in Se-enriched broccoli and broccoli sprouts (Cai *et al*., 1995; Finley *et al.,* 2001; Sugihara *et al*., 2004). Thus, identification of a broccoli cDNA encoding SMT, the key enzyme involved in the formation of SeMSC, permits a comprehensive study of gene expression in relation to SeMSC production in plants. SeMSC constitutes the major peak of selenoamino acids in Se-enriched broccoli (Cai *et al.,* 1995) and is the primary form of Se found in Se-enriched broccoli sprouts (Finley *et al*., 2001; Sugihara *et al.,* 2004). Studies provided convincing evidence for the role of high Se broccoli in reducing cancer risk (Finley *et al*., 2000; Finley and Davis, 2001; Davis *et al*., 2002). Thus, development of approaches to increase the accumulation of SeMSC in broccoli may greatly enhance its health-promoting properties (Finley, 2003). The objective of this study as to enrich broccoli and two cauliflower cultivars with four Selenium rates namely 0, 0.5, 1, 1.5 mg.l^{-1} ameliorating the insertion by 0, 1, and 2mg.l^{-1} fulvic – Humic acid, using drip-hydroponic techniques.

Materials and methods

A. Experimental location

This investigation was carried out during the period July 27th, 2012-Feberuary 2nd, 2013 at the field of Horticulture Department, Agriculture College, Dohuk University, Dohuk which is located at (36°51"38')North Latitude and (42°52"02')East longitude, and with altitude of 473 m.

B. Cultivar sources

Calbrese broccoli (*Brassica oleracea* var. Italica) and two cauliflower (*Brassica oleracea* var. botrytis) cultivars namely Difano and Organzaf1seed pockets purchased from Agricultural Bureau in Dohuk. The investigated cultivars were Calbrese produced by HORTUS in 2012- 2013, expire date 2015. Difano cauliflower cultivars produced by

HORTUS Seed Company on 2011-2012, expire date in 2014. Organza f1 was produced by CLAUSE vegetable Seed Company on 2012, expire date in 2014.

C. Experimental design

Split plot within Factorial Complete Randomized Block Design (Split- F-CRBD) selected for this experiment. The main plot (A) represented by Selenium rates including 0 mg.l-1 (a1), 0.5 mg.l-1(a2), 1 mg.l-1(a3) and 1.5 mg.l-1(a4). Whereas the sub main plot (B) was represented by Fulvic-Humic acid rates including 0 ml.l-1(b1), 1 ml.l-1(b2), and 2 ml.l-1(b3). The sub-sub main plots (C) introduced by Calbrese broccoli cultivar (c1), Difano cauliflower cultivar (c2) and Organza f1 cauliflower cultivar (c3). Therefore, the trail was contained 36 treatments; a treatment replicated 3 times. Each replicate represented by a row of 1 x 3m with plant intra space of 25 cm.

Figure (1): The Calbrese Broccoli, Organza F1 and Difano Cauliflower cultivars.

D. Experimental constructions

Four main plots were prepared according to experimental design. Land area of 3.5 x 36 m-2of each main plot was dig by digger machine to a depth of 0.75m. Basins covered with double layers of clear polyethylene to avoid outcome and in come moisture seepage to the growing media. Then plots filled with pure building sands (approach 90 m3). Finally, sand leveled and dissected to 36 x4 rows.

Four water reservoirs each of $2m^3$ positioned at 0.75 m above the experiment level. Each reservoir was separately equipped with dripper tube connected to tank valve fixed on the pot rows, where two emitters left to irrigate each plant.

Figure (2): Experimental construction and design

Selenite dissolved in cultural solutions to match the desired rates (Table, 1). Four tanks was filled by the nutrient solutions, then a reservoir was connected through valves to the drip irrigation polyvinyl chloride (PVC) tubes to conduct solutions to individual plant where two emitters were allocated for each plants. During the growing season each main plots consumed 10 m3 of nutrient solution. Subsequently, the water consumptive use was 92.593 mm besides rainfall. It is worthy to mention that accumulated rainwater pumped out the experiment.

E.

Table (1): Nutritional solution included Macro and trace elements, besides well water content of mineral. (*), (**)

	Macronutrients	Trace elements	Initial content of well water	
Chemicals components of reservoir solutions	Nitrogen 20 Phosphorous 20 Potassium 20 Sulfur 0.4	Iron20 Zinc 14 Cupper 16 Manganese12 Boron 12 Molybdenum 11	N = 0.11 Zn=0.001 Ca=54.72 Cu=1.257 K= ND	Besides solution Se(1.5)mg.l-1, Se(1)mg.l-1, Se(0.5)mg.l-1 , and Se(0)mg.l-1 were added , respectively in Reservoirs 1, 2, 3, and 4.

(*): Selenite SeO3.H2o given rates added to individual reservoir.
(**) Chemicals added five times, first time (500g/each reservoir), three times (1000g/each reservoir) and last time (1500g /each reservoir).

Cultural practices

Seeds of broccoli and cauliflower cultivars were sown in plastic trays previously filled with peat moss on July 27th, 2012. Seedlings were transplanted in the prepared fields on August 8th, 2012. Drip irrigation applied immediately after transplanting. On September1st plant were sprayed with the proposed rates of fulvic-humic acids and repeated once more on January 5th 2013. Plants sprayed by Trigard at rate $1ml.l^{-1}$ to control leaf cutter on September10th 2012. Finally, plants were harvested on 2nd, February 2013. Samples kept in polyethylene bags for laboratory measurements. Meteorological data (Table, 2) obtained from the meteorological station, Agriculture College, Dohuk University, Sumel.

Table (2). The average of maximum and minimum temperature, relative humidity and rainfall during study season (2012-2013)*

Month	2012-2013			
	Temperature(C)		Rainfall(mm)	Relative humidity
	Max.	Min.		
November	20.95	9.77	3.01	67.72
December	13.39	4.85	6.18	77.49
January	11.45	2.25	14.43	77.88
February	14.86	4.92	6.28	77.9
March	18.41	6.36	6.36	66.8

* Data collected from (Agro – metrological station at college the nearest station to the research location).

F. Measurements

i. Vegetative measurements

Leaf fresh weight, stem fresh weight, root fresh weight, curd fresh weight were measured by metler balance of two decimal, whereas leaf number was counted. Plant height measured by ruler. Curd, leaf, and root samples of each replicate were weight and the oven-dried at 55^0 C for 72 hrs. Dry samples reweighed to calculate the dry matter content of leaves and roots. Finally, Exceeding percentage = (high value – low value)/ low value100x.

ii. Stomata components dimensions

Upper and lower leaf surfaces smeared by clear nail varnished and left to dry for 15 mints then peeled and mounted over slides and it covered with cover slide. Graded eye lens of 7 x magnitude and objective lens of 40 x magnitude were calibrated by micro metric slides of 1/100mm, where calibration reveals that each grade out of total 100 grades 2.22 micron. The dimensions of stomata length, stomata aperture length, stomata width, and stomata aperture width and stomata population of both upper and lower leaf surfaces measured for each replicate.

iii. Digestion and determination of curd, leaf, and root minerals

0.5 g powder dry weight sample was digested by adding 10ml concentrated sulfuric acid (H_2SO_4) then 10 ml of H_2O_2 was added then the samples were heated until being clear and thereafter transferred to 50ml volumetric flask the final sample was brought to 50ml with adding of distilled water. Iron, copper, and calcium determined by Atomic Absorption Spectrophotometer (GBC 932 AA, Avanta Ver 1.32). Sodium and potassium determined by Flame Photometer (Jenewa type). While, Total Nitrogen percentage determined by Kjeldahl Apparatus according to (A.O.A.C, 1980).

iv. Selenium determination

Selenium was determined in accordance to West and Ramakrishna (1968). The following steps adopted:

Reagents

a. Conditioner solution was prepared by dissolve 6.25 g of Na2EDTA·2H_2O, 0.10 g of $FeCl_3$, and 13 mL of triethanolamine in reagent water and dilute to 250 ml in a volumetric flask.

b. Alkaline sodium sulfide solution prepared by 50 mL aqueous solution that contains 2.4 g of Na2S·9H2O, 2.4 g of Na2SO3, and 4.0 g of solid NaOH solution in a volumetric flask. Dissolve each reagent first rather than adding all solid material to the flask at once.

c. Methylene blue (FW = 373.90) solution. Prepare a 0.07 mM aqueous solution in a 50 mL volumetric flask by dilution of the 0.7 mM stock solution (0.026 g in 100 mL).

d. Standard Se solutions (CAUTION: Se is a **toxic** element). From the 1000 mg.l^{-1} stock solution provided by the instructor, prepare a 2 mg.l^{-1} solution in a 100 mL volumetric flask. This will require a two-step dilution procedure. Dilute with distilled water. Prepare four calibration standards that span the 0.25-1.5 ppm range. Use 25 mL volumetric flasks for these standards.

Procedure

a. The UV-Vis measurements were 513 and 420 nM type (Jenewa Type). Use distilled water as the spectroscopic blank. Determine λmax of methylene blue; obtain separate spectra for the other components of the reaction also. Plots of A vs. λ to obtain peak table.

b. Caution: Wear gloves during the handling of these solutions. Into the (clean and dry) cuvette, (i). Add (with a micropipette) 400 µl of alkaline sulfide solution, (ii). Add 800 µl of conditioner solution, and (iii). 800µL of formaldehyde. Then, add 800 µl of sample (standard or unknown) to the cuvette. (iv). add 800 µl of the 0.07 mM methylene blue solution to the cuvette and start the timer. Cap the cuvette, invert it several times, and place it in the sample compartment of the spectrometer.

v. Hormonal extractions and determinations

IAA, ABA, GA_3, and CK were determined according to (Ergun *et al*., 2002).

vi. Chlorophyll

Chlorophyll percentage out of the gross pigments of folded and unfolded leaves measured by Chlorophyll Meter (model Spad 502).

Table (3). Experimental detected traits and their symbol and units			
Stomata population at upper leaf surface no/mm^2	St. Pop stoma.mm^{-2}	Leaf Number	LNo
Stomata length at upper leaf surface Micron	St.lup µm	Leaf fresh weight g	L fwt g
Stomata aperture length at upper leaf surface Micron	St.alup µm	Leaf dry weight g	Leaf dwt. g
Stomata width at upper leaf surface Micron	St.wup µm	Plant high cm	Pht cm
Stomata aperture width at upper leaf surface Micron	St.awup	root fresh weight g	Rfw g
Stomata population at lower leaf surface no/mm^2	St. Pop stoma.mm^{-2}	root dry weight g	Rdw g
Stomata length at lower leaf surface Micron	St.llo µm	Stem fresh weight g	Sfw g
Stomata aperture length at lower leaf surface Micron	St.allo µm	Stem dry weight g	Sdw g
Stomata width at lower leaf surface Micron	St.wlo µm	Curd fresh weight g	Cfw g
Stomata aperture width at lower leaf surface Micron	St.awlo µm	Curd dry weight g	Cdw g
Selenium mg.l^{-1} or µg.g^{-1}	Se µg.g^{-1}	indole-3-acetic acid µg.g^{-1}	IAA µg.g^{-1}
Iron mg.l^{-1} or µg.g^{-1}	Fe µg.g^{-1}	Gibberellic acid µg.g^{-1}	GA3 µg.g^{-1}
Potassium mg.l^{-1} or µg.g^{-1}	K µg.g^{-1}	Abscisic acid µg.g^{-1}	ABA µg.g^{-1}
Calcium mg.l^{-1} or µg.g^{-1}	Ca µg.g^{-1}	Zeatin µg.g^{-1}	Z µg.g^{-1}
Zinc mg.l^{-1} or µg.g^{-1}	Zn µg.g^{-1}	Nitrogen %	N %

Results and Discussion

A. The influence of Selenium rates

i. Influence of Se on vegetative growth

The obtained results (Table, 4) showed that selenium application resulted in plant growth promotions accept in term of curd fresh weight, which revealed gradual reductions as selenium rates were increased. However, these reductions were not significant. The highest leaf fresh weight (177.51g) confined to 1.5 mg.l^{-1} rate. It highly surpassed check (38.4%), 0.5 mg.l^{-1} (19.1%) and 1 mg.l^{-1} (37.79%) in term of leaf fresh weight. Moreover, this treatment manifested the highest leaf dry weight (41.91 g), which significantly exceeded untreated leaf dry weight (40.9%), leaf number per plant (15.4%) and root fresh weight (34.8%). It is worthy to manifest that this treatment was superior over 0.5 mg.l^{-1} in term of root dry weight (23.8%). The worst treatment was the untreated, since it gave the lowest values in terms of leaf fresh weigh (128.23g), leaf dry weight (29.74g), leaf number (21.93), root fresh weight (31.8g) and chlorophyll content (57.8% chlorophyll out of other leaf pigments). Other treatments engage the gap between the best and worst treatments. It can be inferred that Se promote plant growth through the involvements of Se-mediated changes in the antioxidant capacity of plants in growth promotion by Se, the activity of antioxidant enzymes including ascorbate peroxidase (APX), catalase (CAT), peroxidase (POD), superoxide dismutase (SOD) and glutathione reductase (GR) and the concentration of H_2O_2 and glutathione were confirmed (Haji Boland and Amjad, 2007). The growth improvement that comes from fulvic-humic acids might be due its effects on cellular membranes. Where, increase the permeability of plant membranes due to humate application resulted in improve growth of various groups of beneficial microorganisms, accelerate cell division, increased root growth and all plant organs for a number of horticultural crops and turf grass, as well as, the growth of some trees, (Russo and Berlyn, 1990; Poincelot,1993).

Table (4). The influence of selenium rates ($mg.l^{-1}$) on growth of broccoli and two cauliflower cultivars (*), (**).

Se	lfwt	ldwt	lno	sfwt	sdwt	rfwt	rdwt	cfwt	cdwt	plh	chol
0	128.23 b	29.744 b	21.926 b	81.759 a	18.644 a	31.804 b	14.085 ab	148.13 a	31.19 a	57.796 c	63.993 a
0.5	149.03 b	35.611 ab	26.148 a	78.881 a	17.415 ab	38.559 a	13.437 b	121.01 a	24.49 b	66.819 a	64.54 a
1	128.82 b	37.419 a	25.481 a	71.856 a	15.104 bc	38.026 ab	16.359 ab	127.88 a	28.28 ab	60.959 bc	63.433 a
1.5	177.51 a	41.907 a	25.296 a	79.233 a	13.378 c	42.881 a	16.63 a	129.89 a	23.8b	64.181 ab	63.07 a

(*):lfwt=leaf fresh weght (g); ldwt=leaf dry weight (g); lno=leaf number per plant; sfwt stem fresh weight (g); sdfwt=stem dry weight (g); rfwt=root fresh weight (g); rdwt=root dry weight (g); cfwt=curd fresh weight (g); cdwt=curd dry weight (g); plh=plant height (cm); chol= Chlorophyll percentage out of other pigments.
(**): Figures of unshared characters are significant at 0.05 level, Duncan test.

ii. The influence of Selenium rates on leaf hormonal homeostasis

Selenium application resulted in plant growth promotions (Table, 5). The highest bounded (6000 $\mu g.g^{-1}$) and total (1011$\mu g.g^{-1}$) IAA confined to 1$mg.l^{-1}$ Se. This treatment profoundly overwhelmed 0.5$mg.l^{-1}$ Se (273.4 and 173.7%, respectively). Furthermore, this treatment exhibited apparent prevalence on untreated (222.5 and 171.5%, respectively). The highest free Abscisic acid (ABA) accumulation (9373 $\mu g.g^{-1}$) was coincided with 1 $mg.l^{-1}$ Se rate. It significantly exceeded 1.5 $mg.l^{-1}$ Se rate by (125.9%). The highest free Zeatin content of leaves (3660.7 $\mu g.g^{-1}$) confined to 0.5 mgl^{-1}, which substantially bypassed untreated (26.88%). Se acts as antioxidants. Subsequently it participate in oxidants homeostasis for the benefits of growth through hormonal regulations. Selenium (Se) is an essential micronutrient necessary for antioxidation and hormone balance in human and animal cells (Ellis and Salt 2003). However, according to current knowledge, higher plants do not require Se and it is toxic at high concentrations (Marschner, 1995).

Table (5). Hormone accumulation in leaves as influenced by Se rates ($\mu g.g^{-1}$)

Se	IAA Free	IAA Bound	IAA Total	GA_3 Free	GA_3 Bound	GA_3 Total	ABAFree	ABA Bound	ABA Total	Zeatin Free	Zeatin Bound	Zeatin Total
0	1866 a	1860 b	3726 b	35504 a	21694 a	57038 a	5340 ab	27671 a	3295.7 a	2885.1 ab	2624.3 a	5509.4 ab
0.5	2101 a	1609 b	3696 b	24656 a	20342 a	44997 a	5952 ab	4472 a	1042.4 a	3660.7 a	2767 a	6427.7 ab
1	4116 a	6000 a	10116 a	35275 a	1921 a	54485 a	9373 a	3803 a	13176 a	23437 b	2566.8 a	4910.5 b
1.5	3767 a	4083ab	7849 ab	29178 a	28761 a	57939 a	4148 b	4234 a	8381 a	2900.5ab	2192.6 a	5093.1 ab

(*): Figures of unshared characters are significant at 0.05 level, Duncan test.

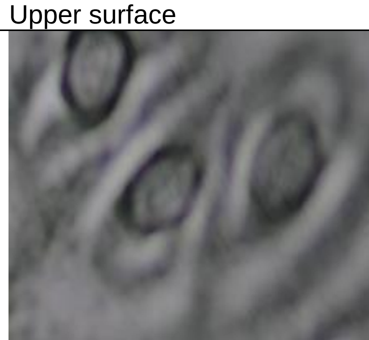
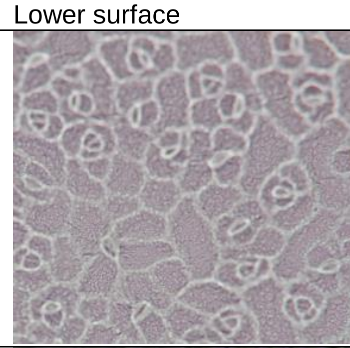
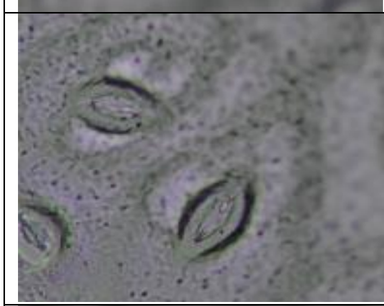
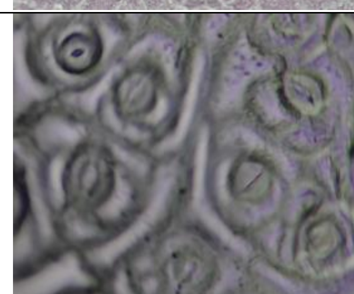
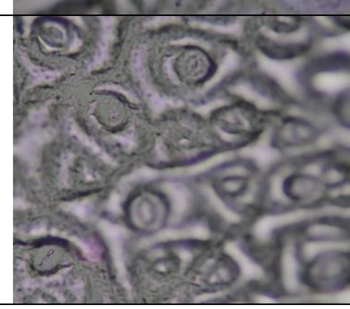
iii. The influence of selenium rates on stomata behaviour

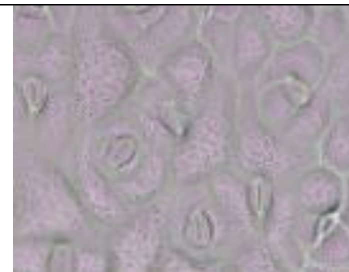
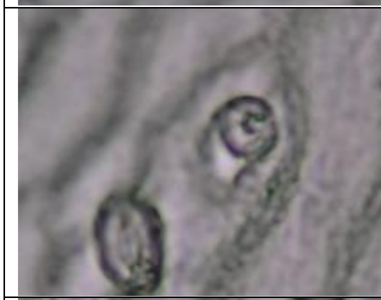
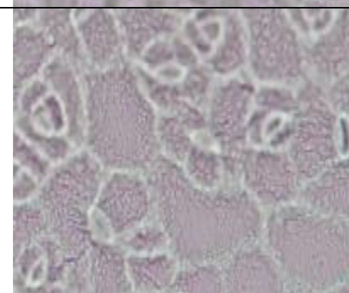
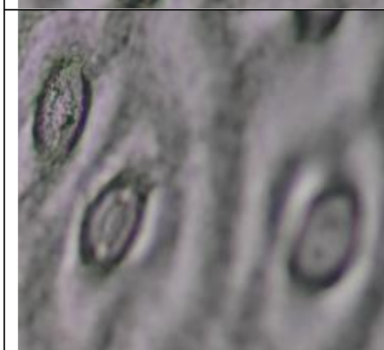
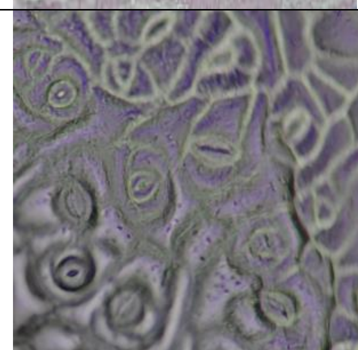
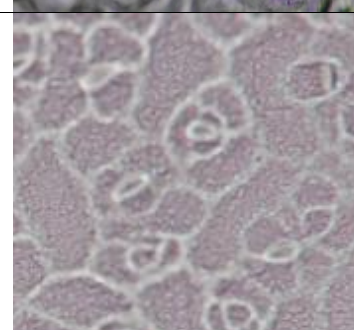
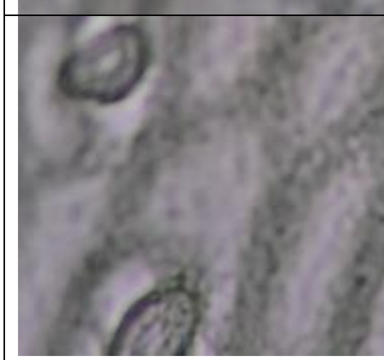
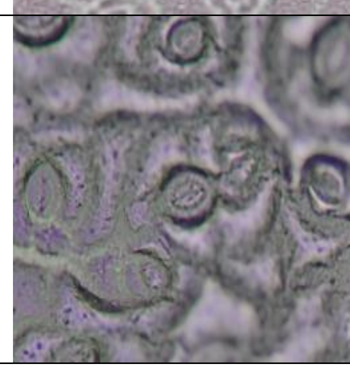
Untreated plants (Table, 6 and Figure, 3) revealed the lengthiest stomata aperture (5.32 micron) at upper leaf surface. It substantially exceeded 0.5 $mg.l^{-1}$ treatment (19.53%). Whereas, the widest stomata aperture width (3.79 micron) at the upper leaf surface was confined to 1 $mg.l^{-1}$. It profoundly overwhelmed 0.5 $mg.l^{-1}$ (42.32%). Untreated plants showed the highest stomata width (7.82 micron) at the lower leaf surface; it substantially overwhelmed 0.5 $mg.l^{-1}$ treatment by (17.3%). The lowest stomata population (1180.79 $st.mm^{-2}$) at the lower leaf surface observed in 0.5 $mg.l^{-1}$ treatment. 1.5 $mg.l^{-1}$ Se treatment exceeded 0.5 $mg.l^{-1}$ by (9.6%) in term of stomata population. These results suggested that Se rates in particular 1.5 $mg.l^{-1}$ Se treatment highly improved leaf growth, which reflected on stomata populations, as this treatment gave the lowest population. The lowest stomata population usually accompanied with leaves of maximum growth (Abdel, 2009). There are some indications that Se can exert beneficial effects on plants at low concentrations (Hartikainen *et al*. 2000; Simojoki *et al.* 2003).

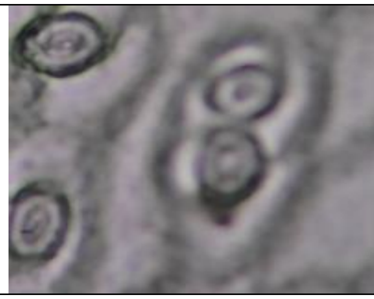
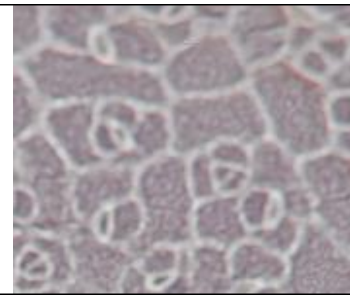
Table (6): The influence of Se rates on stomata behaviour of broccoli and cauliflower cultivar leaves (*), (**)										
	Stomata dimensions of upper leaf surface					Stomata dimensions of upper leaf surface				
Sea	Stl	stw	stal	stawl	St Popul.	Stl	Stw	Stal	stawl	St Popul.
0	10.1a	7.82a	5.32a	3.36ab	1232.34a	10.65a	7.9a	5.68a	3.33a	1228.52ab
0.5	9.51a	6.67b	4.44b	3.06b	1254.3a	10.19a	7.82a	5.18a	3.42a	1180.79b
1	10.16a	7.41ab	5.36a	3.79a	1272.43a	9.99a	7.24a	5.39a	3.58a	1250.48ab
1.5	10.12a	7.24ab	5.36a	3.78a	1237.11a	10.26a	7.90a	5.84a	3.83a	1294.39a

(*) . popup = stomata population at upper leaf surface; poplo = stomata population at lower leaf surface; stlup = stomata length at upper leaf surface; stalup = stomata aperture length at upper leaf surface; stwup= stomata width at upper leaf surface; stwup= stomata width at upper leaf surface; stllo= stomata length at lower leaf surface; stallo =stomata aperture length at lower leaf surface; stwlo= stomata width at lower leaf surface; stawlo= stomata width at lower leaf surface

(**): Figures of unshared characteristics are significant at 0.05 level Duncan test

Se rates	Fu-H	Cultivars	Upper surface	Lower surface
Se(0)	0	Calbrese		
	1			
	2			

	0	Difano		
	1			
	2			
	0	Organza F1		
	1			

	2			
Figure (3): Stomata behaviour of lower and upper leaf surfaces of cauliflower and broccoli				

iv. The influence of Se on mineral accumulations in Curd, leaf and root

The highest Nitrogen contents of curd, leaf and root dry matters were 2.77, 3.37 and 3.05 %), respectively in control plants. Furthermore, the highest N contents of leaf was confined to 0 $mg.l^{-1}$ Se, which was highly exceeded 0.5 and 1 $mg.l^{-1}$ Se by 30.1 and 31.64%. The highest Potassium contents of curd, leaf and root dry matters were 33.43, 31.39, and 30.76 $\mu g.g^{-1}$, respectively in plants irrigated by 0.5 $mg.l^{-1}$ Se. It profoundly exceeded 1.5 in curd (31.1%), in leaf (16.9%) and in root 12.79%). Moreover, it substantially overwhelmed 1 $mg.l^{-1}$ Se in leaf contents of potassium (19.7%). 1$mg.l^{-1}$ Se treatment revealed the highest Zn accumulation in curds (199.97 $\mu g.g^{-1}$) as, compared to other treatments. It highly exceeded 1.5 $mg.l^{-1}$ Se by (19.9%). Plants treated with 1$mg.l^{-1}$ Se exhibited the highest Zn content in laves (200.7 $\mu g.g^{-1}$). The highest Zn content (197.7$\mu g.g^{-1}$) of roots found in root of 1.5 $mg.l^{-1}$ Se treated plants. It substantially overwhelmed 0.5 and 1 $mg.l^{-1}$ Se by 50.9 and 59%, respectively. Moreover, this treatment possesses the highest root content of calcium (2683.4 $\mu g.g^{-1}$). The highest Calcium content (3300.2 $\mu g.g^{-1}$) of leaves was confined to untreated plants, which was highly bypassed, 0.5 $mg.l^{-1}$ Se (30.95%), 1 $mg.l^{-1}$ Se (41.5%) and 1.5 $mg.l^{-1}$ (43.4%). Moreover, 1.5 $mg.l^{-1}$ Se gave the highest calcium content in root dry mattes (2683.4 $\mu g.g^{-1}$), which was confined to 1.5 $mg.l^{-1}$ Se. It highly exceeded untreated (47.3%), 0.5 $mg.l^{-1}$ Se (64%), 1 $mg.l^{-1}$ Se (58.4%). The highest curd Selenium content (4.59 $\mu g.g^{-1}$) accompanied with 0.5 $mg.l^{-1}$Se treatments. It significantly exceeded 0, 1 and 1.5 $mg.l^{-1}$ Se by 245, 22.7 and 33.8%, respectively. 0.5 $mg.l^{-1}$ Se revealed the highest Se content of leaves (5.06 $\mu g.g^{-1}$). Significant differences not detected in leaf contents of Se (Table, 7). Sulfur concentration of leaves increased in response to Se treatment at both sulfur deficient and sufficient plants, but the opposite observed on the Se concentration in response to sulfur treatment. Selenium concentration was higher in sulfur deficient plants and particularly two varieties of *Brassica* accumulated large amounts of Se, e.g. 9 mg/g dry weight for kohlrabi. Reduction of Se uptake in sulfur sufficient plants could be the result of a reduced activity of selenate ion in the presence of sulfate and/or competition between sulfate and selenate for carriers (White *et al.* 2004) in favor of sulfate. A high Se accumulation capacity of some *Brassica* species found applications in phytoextraction of Se-contaminated soils (Simon *et al*. 2006).

Table (7). Mineral accumulation in curd, leaf and root as influenced by selenium rates ($mg.l^{-1}$) (*)

M/Se	(0)se	(0.5)se	(1)se	(1.5)se
Zn/curd	186.87ab	196.22a	199.97a	166.84b
Zn/leaf	197.53a	200.72a	193.57a	193.93a
Zn/root	184.96a	124.46b	124.32b	197.71a
Fe/curd	574.3a	400.6a	352.8a	532.5a
Fe/leaf	314.17a	243.91a	209.71a	239.97a
Fe/root	265.45a	196.53a	212.49a	271.84a
Ca/curd	4407.5a	3601.9a	3343.9a	4164.1a
Ca/leaf	3300.2a	2520ab	2332.8b	2301.1b
Ca/root	1821.4b	1635.9b	1693b	2683.4a
Se/curd	ND	4.59a	3.74ab	3.43b
Se/leaf	ND	5.06a	5.02a	4.62a
Se/root	ND	5.80a	4.64a	4.65a
N/curd	2.77a	2.71a	2.56a	2.48a
N/leaf	3.37a	2.59b	2.56b	2.93ab
N/root	3.05a	2.65a	3.01a	2.59a
k/curd	32.67a	33.43a	29.86ab	25.50b
k/leaf	27.44ab	31.39a	26.23b	26.85b
k/root	30.21ab	30.76a	28.93ab	27.27b

(*): Figures of unshared characters are significant at 0.05 level, Duncan test.

B. Plant responses to Fulvic-Humic acids

i. Growth responses to Fulvic-Humic acids

The results of fulvic-humic acids application rates (Table, 8) confirmed that the highest curd fresh weight (145.9g) and leaf number per plant (25.67) dedicated to untreated check, which apparently exceeded 2g.l^{-1} treatment by 22.9 and 8.8%, respectively. 1g.l^{-1} fulvic-humic was significantly exceeded 2g.l^{-1} treatment in term of root fresh weight and root dry weight 24.3 and 25.2%, respectively. In addition to that, 1g.l^{-1} treatment showed superiority over control in root fresh weight (24.3%). These results exhibited the potent influence of fulvic-humic acids on broccoli and cauliflower plants. Growth improvements might be attributed to the influence of fulvic-humic acids on microorganism. Since, it was found in the previous decade has witnessed an increasing number of publications documenting the presence of antibiotics, potential contaminants, in the environment. For example, members of the tetracycline family of compounds, among the most widely used antibiotics, have been detected in soils (Hamscher *et al*., 2002), surface waters (Lindsey *et al*., 2001; Kolpin *et al*., 2002) and even ground water (Lindsey *et al*., 2001; Karthikeyan and Meyer, 2006). It, therefore, appears that the presence of humic substances, in both dissolved and mineral-bound forms, is likely to increase the environmental mobility of tetracycline compounds (Gu *et al.,* 2007). Tetracyclines known to persist and accumulate in soils after repeated usage of liquid manure as fertilizers (Hamscher *et al*., 2002). However, there is limited information on the retention mechanisms for tetracyclines in subsurface environments. Results from binary humic-antibiotic and mineral-antibiotic systems may not be simply combined or extrapolated to understand the reactivity of antibiotics in a complex humic-mineral-antibiotic ternary system.

Table (8). The influence of fulvic-Humic acids rates (g.l^{-1}) on plant growth (*), (**).

F-H	lfwt	ldwt	lno	sfwt	sdwt	rfwt	rdwt	cfwt	cdwt	plh	Chol
0	9.81ab	7.2832ab	5.1a	3.3a	1256.44a	10.3261a	7.6536a	5.5241a	3.7033a	1229.24ab	3954a
1	10.43a	7.6536a	5.22a	3.7651a	1227.81a	10.2768a	7.8387a	5.8328a	3.6725a	1203.47b	3788a
2	9.66b	6.9129b	4.91a	3.3330a	1262.89a	10.2150a	7.6536a	5.2155a	3.2404a	1282.93a	2402a

(*): lfwt=leaf fresh weght (g); ldwt=leaf dry weight (g); lno=leaf number per plant; sfwt stem fresh weight (g); sdfwt=stem dry weight (g); rfwt=root fresh weight (g); rdwt=root dry weight (g); cfwt=curd fresh weight (g); cdwt=curd dry weight (g); plh=plant height (cm); chol= Chlorophyll percentage out of other pigments. (**): Figures of unshared characters are significant at 0.05 level, Duncan test.

ii. Leaf hormonal homeostasis as influenced by Fulvic-Humic acids

The obtained results (table, 9) revealed that the highest bounded GA_3 (27973 µg.g^{-1}) was accompanied to untreated check, which was highly exceeded 2g.l^{-1} fulvic-humic treatment by (51.9%). The highest free Zeatin (3000.4 µg.g^{-1}) was confined to 2g.l^{-1} fulvic-humic treatment, which insignificantly differed from untreated treatment (2.11%). It seems that hormonal homeostasis slightly affected by fulvic-humic acids, where significant differences not detected except with Zeatin.

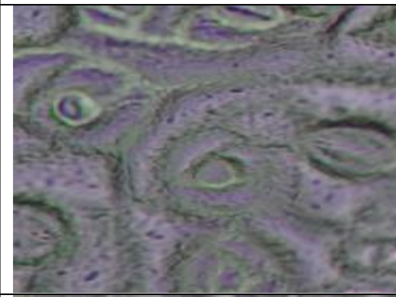
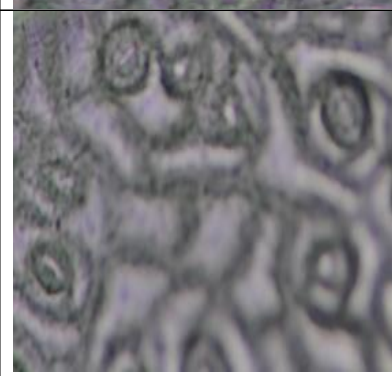
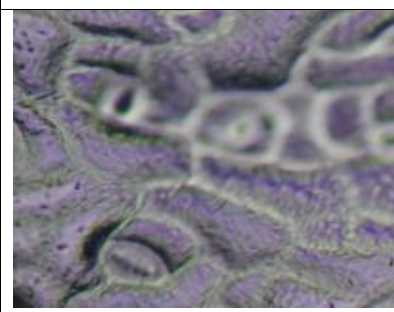
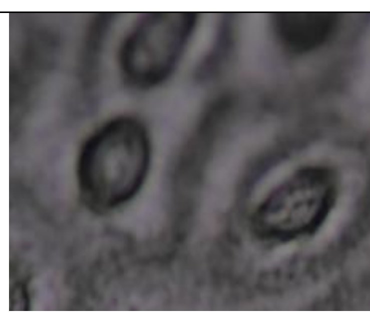
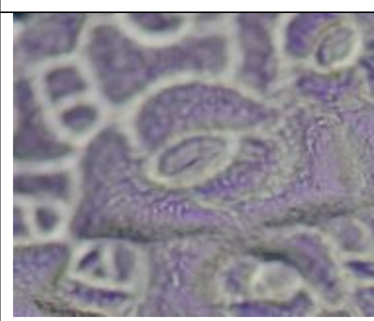
Table (9). Leaf hormonal homeostasis (µg.g^{-1}) as influenced by fulvic-humic rates (g.l^{-1}) (*).

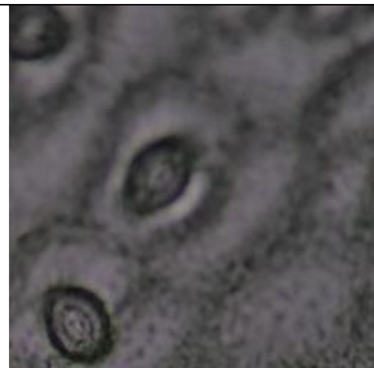
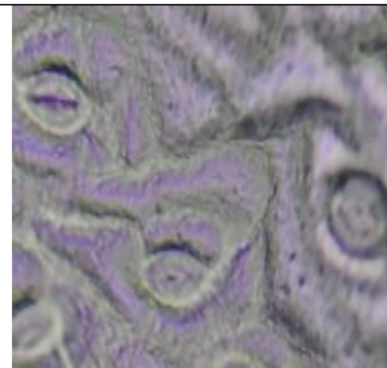
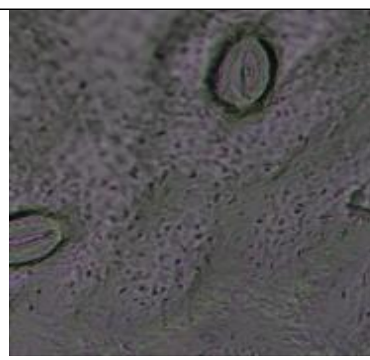
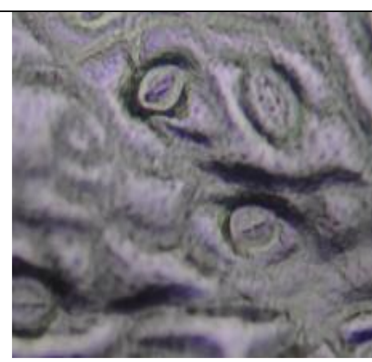
Ful	IAA Free	IAA Bound	IAA Total	GA_3 Free	GA_3 Bound	GA_3 Total	ABA Free	ABA Bound	ABA Total	Zeatin Free	Zeatin Bound	Zeatin Total
0	2797a	3954 a	675a	34336a	27973a	62309a	8312a	21816a	30129a	2938.4a	1297.1b	4987a
1	2245a	3788 a	6033a	29748a	21126ab	50874a	4579a	3904a	8483a	2.9037a	1922.3a	5915a
2	3847a	2445 a	6258a	29202a	18405b	47662a	5718a	4374a	10092a	3000.4a	1626ab	5553a

(*): Figures of unshared characters are significant at 0.05 level, Duncan test.

iii. Stomata dimensions as influenced by Fulvic-Humic acids

Stomata dimension results (Table, 10 and Figure, 4) manifested that plants treated with 1 mg.l^{-1} fulvic-humic acids possesses the highest upper surface stomata length (10.43 micron) and upper stomata width (7.65 micron). It highly exceeded these of 2mg.l^{-1} by 7.99% and 10.7%, respectively. The lowest stomata population at the lower leaf surface was found in 1 mg.l^{-1} fulvic-humic acids (1203.47 st.mm^{-2}), which showed substantial reduction as compared 2 mg.l^{-1} fulvic-humic acids (6.6%). Significant differences not detected between other treatments. Stomata behavior was highly influenced by the application of fulvic-humic owing to its capability to make moisture and many minerals available to plants. Subsequently leaf performance well established. Bama *et al*. (2003) showed that, with increasing dose of humic acid, the available nutrients, organic carbon, and cation exchange capacity is increased. A linear trend in the release of N, P and K was observed for the application of humic acid. The release of N was significant up to 20 kg of HA ha^{-1}, whereas for P and K it extended up to 40 kg ha^{-1}. The N and P were released for a longer period of 60 days, while K release attained a plateau on45 DAI. At the end of incubation period, there was a steep and significant increase of organic carbon and CEC up to 40 kg HA ha^{-1}. With increasing dose of humic acid from 10 to 40 kg ha^{-1}, the soil fertility parameters also enhanced. Nitrogen is one of the most essential nutrients for plants and is involved in the building of the fundamental bricks of life: nucleotides, amino acids, and proteins. Legumes plant species are able to use atmospheric nitrogen due to their capacity of a symbiotic relationship with specific microorganisms. The other species find their resources in the soil where nitrogen is present in different forms. For example, the soil solution may contain different organic N forms such as soluble proteins or amino acids derived from proteolytic processes. In particular, ecosystems, some plant species are able to use these organic N forms, as described in a recent review. In temperate climatic conditions, inorganic N forms are predominant and fertilizers often supplied as nitrate, ammonium, or urea.

Se	Fu	Cultivars	Upper surface	Lower surface
Se(0.5)	0	Calbrese		
	1			
	2			
	0	Difano		

	1			
	2			
	0	Organza F1		
	1			

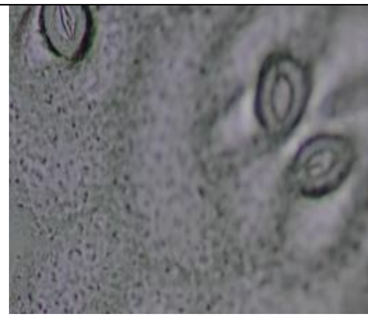
	2			

Figure (4): Stomata behaviour of lower and upper leaf surfaces of cauliflower and broccoli

Table (10). Stomata population and dimensions of upper and lower leaf surfaces as influenced by fulvic-Humic acids rates (g.l^{-1}) (*); (**); (***)

Fulv.	Stomata dimensions of upper leaf surface					Stomata dimensions of upper leaf surface				
	stl	stw	stal	stawl	St Popul.	stl	stw	stal	stawl	St Popul.
0	9.81ab	7.28ab	5.0921a	3.3021a	1256.44a	10.3261a	7.6536a	5.5241a	3.7033a	1229.24ab
1	10.43a	7.65a	5.2155a	3.7651a	1227.81a	10.2768a	7.8387a	5.8328a	3.6725a	1203.47b
2	9.66b	6.9b	4.9069a	3.3330a	1262.89a	10.2150a	7.6536a	5.2155a	3.2404a	1282.93a

(*). popup = stomata population at upper leaf surface; poplo = stomata population at lower leaf surface; stlup = stomata length at upper leaf surface; stalup = stomata aperture length at upper leaf surface; stwup= stomata width at upper leaf surface; stwup= stomata width at upper leaf surface; stllo= stomata length at lower leaf surface; stallo =stomata aperture length at lower leaf surface; stwlo= stomata width at lower leaf surface; stawlo= stomata width at lower leaf surface
(**): Figures of unshared characters are significant at 0.05 level, Duncan test.

iv. Mineral accumulation in curd, leaf, and root as influenced by Fulvic-Humic acids

The highest Nitrogen contents of curd, leaf and root dry matters were 2.77, 3.09 and 3.04%), respectively in control plants. The highest Potassium contents of curd, leaf and root dry matters were 32.43, 28.64, and 30.10 µg.g^{-1}), respectively in control plants. The highest Zinc contents of curd, leaf and root dry matters were 199.1, 199.98, and 169.95 µg.g^{-1}), respectively in control plants, Control, and 2ml^{-1} f-h. Check plant substantially bypassed 2ml.l^{-1} f-h in Zn content of curd (10.5%). The highest Zinc contents of curd, leaf and root dry matters were 199.1, 199.98, and 169.95 µg.g^{-1}), respectively in control plants, control, and 2 ml^{-1} f-h. The highest Iron contents of curd, leaf and root dry matters were 513.3, 270.07 and 243.37 µg.g^{-1}), respectively in 1 ml^{-1} f-h sprayed plants, 1 ml^{-1} f-h sprayed plants and in control and 0 ml^{-1} f-h. The highest Calcium contents of curd, leaf and root dry matters were 4200, 2666.4 and 2023.7 µg.g^{-1}), respectively in 2 ml^{-1} f-h sprayed plants, 0 ml^{-1} f-h and 0 ml^{-1} f-h. The highest Selenium contents of curd, leaf and root dry matters were 3.18, 4.07, and 3.92 µg.g^{-1}), respectively in control plants, 1ml.l^{-1}f-h, and control (Table, 11). These results suggested that Selenium accumulation was highest in leaves, roots, where the lowest observed in curd. Sulfur concentration of leaves increased in response to Se treatment at both sulfur deficient and sufficient plants, but the opposite observed on the Se concentration in response to sulfur treatment. Selenium concentration was higher in sulfur deficient plants and particularly two varieties of *Brassica* accumulated large amounts of Se, e.g. 9 mg/g dry weight for kohlrabi. Reduction of Se uptake in sulfur sufficient plants could be the result of a reduced activity of selenite ion in the presence of sulfate and/or competition between sulfate and selenate for carriers (White *et al*., 2004) in favor of sulfate. A high Se accumulation capacity of some *Brassica* species, for instance in cabbage 22.2µg.g^{-1}, and in Kohlarabi 22.122.2µg.g^{-}1 were found in phytoextraction of Se-contaminated soils (Simon *et al*., 2006). The obtained results manifested paramount effects on mineral accumulation where the highest nitrogen, zinc, potassium, and Calcium substantially accumulated in leaves. However, the highest Iron confined to curd found, owing to its mobility as its deficiency appears on newly formed leaves. These results might be due to humic-fulvic potency in cation exchange capacity. The profound increase in CEC due to HA in the present study highlighted the beneficial effect of HA on CEC. There was a steady increase in CEC with increased levels of HA. However, significant increase was up to 60 kg of HA ha^{-1}. The HA was found to contain functional groups, that would form the source of negative charge and they could have contributed towards the CEC of the soil (Bama *et al*., 2003). This charge might be due in part to the dissociation of hydrogen ions from carboxyl groups and probably in part to their dissociation of hydrogen ions from carboxyl groups and also probably in part to their dissociation from phenolic hydroxyls and particularly from groups of the hydroxyls. Similar reports reported earlier by Lax (1991), who observed that the incorporation of soil organic matter induced the exchange capacity due to the various functional groups namely carboxyl, phenolic etc. present in the humic substances of soil organic substances.

Table (11). Mineral partitioning (µg.g^{-1}; %) in curd, root and leaves of broccoli and two cauliflower cultivars (*), (**).			
	(0)Fu-H	(1)Fu-H	(2)Fu-H
Zn/curd	199.10a	183.30ab	180.11b
Zn/leaf	199.98a	193.68a	195.66a
Zn/root	153.81a	149.83a	169.950a
Fe/curd	477.40a	513.30a	404.50a
Fe/leaf	242.81a	270.07a	242.94a
Fe/root	243.37a	243.37a	229.56a
Ca/curd	4200a	3466.70a	3871.30a
Ca/leaf	2666.40a	2618.80a	2555.40a
Ca/root	2023.70a	1849.40a	2002.10a
N/curd	2.77a	2.65a	2.46a
N/leaf	3.09a	2.80a	2.71a
N/root	3.04a	2.69a	2.74a
K/curd	30.88a	32.43a	27.79a
K/leaf	28.02a	27.27a	28.64a
K/root	30.10a	29.29a	28.49a
Se/curd	3.18a	2.60a	2.6a
Se/leaf	3.80a	4.07a	3.16a
Se/root	3.92a	3.72a	3.69a
(*): Figures of unshared characters are significant at 0.05 level, Duncan test.			

C. Cultivar responses

i. Growth responses of cultivar

Calbrese broccoli showed superiority over organza f1 cauliflower cultivar in root fresh weight (21.26%) and root dry weight (28.4%). Moreover, this cultivar exceeded Difano f1 and organza cauliflower cultivars in chlorophyll percentage out of other leaf pigment by 7.1 and 21.7%, respectively, (Table, 12). It appears that growth responses of Calbrese broccoli cultivars could match best than cauliflowers. Differences between species and cultivars are usually varied in response to any investigate materials applications. These differences could be referred to the gene diversity of a given cultivars (Abdel, 2007).

Table (12). Growth responses of Broccoli and two Cauliflower cultivar.											
CV	lfwt	ldwt	lno	sfwt	sdwt	rfwt	rdwt	cfwt	cdwt	plh	Chol
Calibers	148.69a	34.7a	24.83a	76.03a	16.01a	41.41a	17.17a	143.35a	29.14a	62.92a	69.44a
di-fano f1	151.74a	37.342a	24.78a	78.79a	16.59a	37.9ab	14.8ab	128.13a	26.28a	62.09a	57.06b
organza f1	136.99a	36.47a	24.53a	78.97a	15.8a	34.15b	13.38b	123.71a	25.39a	62.31a	64.78a
(*):lfwt=leaf fresh weght (g); ldwt=leaf dry weight (g); lno=leaf number per plant; sfwt stem fresh weig2666.4aht (g); sdfwt=stem dry weight (g); rfwt=root fresh weight (g); rdwt=root dry weight (g); cfwt=curd fresh weight (g); cdwt=curd dry weight (g); plh=plant height (cm); chol= Chlorophyll percentage out of other pigments. (**): Figures of unshared characters are significant at 0.05 level, Duncan test											

ii. Cultivar responses to hormonal homeostasis

Significant differences between cultivars were not detected (Table, 13). However, the highest free, bounded, and total IAA confined to Difano f1 (4056, 3970, and 7949 µg.g, respectively). Whereas, the highest values for free, bounded and total GA_3 was detected in Difano f1 (32017 µg.g), Calbrese broccoli cultivar (24858 µg.g) and Difano f1 (56483 µg.g), respectively. The paramount concentration of free, bounded and total Zeatin found in Difano f1 (1947, 1651, and 3598 µg.g, respectively). The most potent values of free, bounded, and total Abscisic acid (ABA) detected in organza (726.5, 2031.4, and 2757.9 µg.g, respectively). The best hormonal homeostasis revealed in Difano cauliflowers, particularly free, bound, and total growth-promoting hormones. Whereas, the highest free, bounded and total ABA detected in Organza cauliflower cultivars. Such differences that showed between cultivars might dedicated to the precise means that applied by producing companies (Abdel, 2009a).

Table (13). Growth of broccoli and two cauliflower cultivars (*)												
CV	IAA-F	IAA-B	AAA-T	GA3-F	GA3-B	GA3-T	ABA-F	ABA-B	ABA-T	Z-F	Z-B	Z-T
Calibers	243.3a	229.4a	472.7a	3021.8a	2485.8a	5507.6a	488.6a	481.2a	969.8a	1883a	1606a	3498a
Di fano	405.6a	397.0a	794.9a	3201.7a	2448.9a	5648.3a	646.0a	496.8a	1142.8a	1947a	1651a	3598a
Organza	239.9a	396.5a	636.4a	3112.8a	1815.8a	4928.6a	726.5a	2031.4a	2757.9a	1805a	1593a	3398a
(*): Figures of unshared characters are significant at 0.05 level, Duncan test.												

iii. Cultivar responses to stomata behaviours

Organza cauliflower cultivar (Table, 14 and Figure, 5), showed superiority over Calbrese broccoli cultivar and Difano f1 cauliflower cultivar in stomata population on the lower leaf surface (7.5 and 5.44%, respectively). Significant differenced not found among cultivars in all detected traits. However, the highest lower leaf surface stomata length, stomata width, stomata aperture length and stomata aperture width accompanied with Calbrese broccoli (10.46, 7.81, 5.8, 3.58 micron, respectively). Whereas, the highest upper surface stomata length (10.1 micron), stomata width (7.49 micron), stomata aperture length (5.09 micron) were concomitant with broccoli. While, stomata aperture width (3.67 micron) were coincided to organza. However, the stomata population at lower leaf surface (1200.6 st.mm^{-2}) found in Calbrese, which was significantly lower than that in Organza (7.5%). These differences are due to the gene diversity and its expression capabilities between investigated cultivars.

Table (14). Growth of broccoli and two cauliflower cultivars (*), (**)

	Stomata dimensions of upper leaf surface					Stomata dimensions of upper leaf surface				
CV	stl	Stw	stal	stawl	St Popul.	stl	stw	stal	stawl	St Popul.
Calibers	10.1a	7.49a	5.09a	3.27a	1250a	10.46a	7.81a	5.8a	3.58a	1200.60b
Di fano	9.84a	7.22a	5.06a	3.46a	1234.97a	10.14a	7.78a	5.43a	3.55a	1224.23b
Organza	9.99a	7.13a	5.06a	3.67a	1262.17a	10.21a	7.56a	5.34a	3.48a	1290.81a

(*) popup = stomata population at upper leaf surface; poplo = stomata population at lower leaf surface; stlup = stomata length at upper leaf surface; stalup = stomata aperture length at upper leaf surface; stwup= stomata width at upper leaf surface; stwup= stomata width at upper leaf surface; stllo= stomata length at lower leaf surface; stallo =stomata aperture length at lower leaf surface; stwlo= stomata width at lower leaf surface; stawlo= stomata width at lower leaf surface
(**): Figures of unshared characteristics are significant at 0.05 level Duncan test

iv. Cultivar responses to mineral accumulation in dry weight of curd, leaf, root

The highest Potassium contents of curd, leaf, and root dry matters were 32.07, 29.21, and 29.42 µg.g^{-1}), respectively in Organza, Calbrese and Difano cultivars. Cultivar responses to Zn accumulation (Table, 15) in curd of organza substantially exceeded Calbrese (11.5%). Significant differences in leaf and root Zn content of cultivars not observed. The highest Iron contents of curd, leaf and root dry matters were 580.1, 271.06, and 285.35 µg.g^{-1}), respectively in Calbrese, Difano f1, and Organza. Calcium content of Difano f1 apparently exceeded these of organza (46.89%). Slight differences detected among cultivars in iron contents of dry matter of curds, leaves, and roots. The highest Selenium contents of curd, leaf, and root dry matters were 3.55, 4.31, and 4.04 µg.g^{-1}), respectively in Difano, Organza F1, and Difano cultivars (Table, 15). The highest Nitrogen contents of curd, leaf and root dry matters were 2.78, 2.95 and 2.89%), respectively in Organza, Difano and Organza F1 cultivars. These results revealed the differences in varying cultivar responses. However, these cultivars seem to be insusceptible to Selenium, since they belong to *Brassicas,* which possesses high tendency to Sulfur accumulations as cyanothiosulfute and other sulfur containing compounds, owing to its ability to convert inorganic Selenium to organic ones. It could be the cause of higher susceptibility of alfalfa plants to Se toxicity under sulfur deficiency. Hence, a greater proportion of Se excluded from protein fraction in cabbage and kohlrabi than in alfalfa. The accumulation of non-toxic species of Se-amino acids suggested being the basis of Se tolerance in some species (Neuhierl *et al.*, 1999). Another explanation is that in cabbage and kohlrabi the majority of Se taken up was associated with organic molecules other than proteins, e.g. glucosinolates, therefore remaining out of protein fraction. Members of Crucifereae contain high concentrations of glucosinolates. There are indications on the association of Se with glucosinolates in *Brassica* species. For example, an effect of aqueous extracts of Se-fertilized broccoli on animals against oxygen free radicals hypothesized to be due to ingestion of bioactive isothiocyanate derived from glucosinolates (Keck and Finley 2006). Similarly, onion (*Allium cepa*) and garlic (*Allium sativum*) shown to have the ability to readily uptake Se from the soil and new analytical methods indicated the presence of Se-alliins, a class of second metabolites in genus *Allium* (Arnault and Auger 2006).

Table (15). Mineral partitioning between curd, leaves and roots of broccoli and two cauliflower, as influenced by Fulvic-Humic acid (*)

Se/cv	Calbrese	Difano F1	Organza F1
Zn/curd	178.48b	184.95ab	199.09a
Zn/leaf	201.78a	182.71a	204.82a
Zn/root	158.85a	158.22a	156.52a
Fe/curd	580.10a	458.10a	356.90a
Fe/leaf	243.12a	271.06a	241.64a
Fe/root	215.53a	208.86a	285.35a

Ca/curd	4029.80a	3500.90a	4107.3a
Ca/leaf	2466.8ab	3193a	2180b
Ca/root	1870a	1994.90a	2010.4a
N/curd	2.68a	2.42a	2.78a
N/leaf	2.75a	2.95a	2.90a
N/root	2.78a	2.81a	2.89a
K/curd	29.81a	29.21a	32.07a
K/leaf	29.21a	28.54a	26.17a
K/root	29.08a	29.42a	29.37a
Se/curd	2.68a	3.55a	2.73a
Se/leaf	3.57a	3.14a	4.31a
Se/root	3.77a	4.04a	3.51a
(*): Figures of unshared characters are significant at 0.05 level, Duncan test.			

D. Responses to Selenium rate and Fulvic-Humic acids rate combinations

i. Growth responses to Selenium rate and Fulvic-Humic acids rate combinations

Untreated plants (Table, 16), showed the highest curd fresh weight (166.63 g), which confined to untreated. While the lowest curd fresh weight (103.3 g), observed plants irrigate with 0.5 $mg.l^{-1}$ Se sprayed with $1g.l^{-1}$ fulvic-humic acids. These results suggested that the adverse effects of Se on curd performance mitigated by the application of $1g.l^{-1}$ fulvic-humic acids. The highest leaf fresh weight (197.07 g) and leaf dry weigh (44.19) confined to plants irrigated with 1.5 $mg.l^{-1}$ Se sprayed with $2g.l^{-1}$ fulvic-humic acids. The higher rates of fulvic-humic acids was capable to ameliorate the risk of Se and negatively affected Selenium-free irrigation water. Irrigated plants with 1.5 $mg.l^{-1}$ Se sprayed by 0 $g.l^{-1}$ f-h showed the highest leaf number per plant (30.22). The highest stem fresh weight (93.9 g;), stem dry weight (19.29 g), root fresh weight (47.49 g), observed in plants 1.5 $mg.l^{-1}$ sprayed with $1g.l^{-1}$ f-h, $0mg.l^{-1}$ Se sprayed $2g.l^{-1}$ f-h, $1mg.l^{-1}$ Se sprayed with $1g.l^{-1}$ f-h, Se $1mg.l^{-1}$. The highest root dry weight (20.91 g), plant height (69.49 cm), and chlorophyll percentage (70.3) out of other leaf pigments detected in in plant sprayed with $1g.l^{-1}$ f-h, $0.5mg.l^{-1}$ Se sprayed with $1g.l^{-1}$, $0mg.l^{-1}$ sprayed with $1g.l^{-1}$, respectively. It seems that both Se and fulvic-humic acids were potent to improve the vegetative growth of plants. However, Se was adversely depressed curd performance where fulvic-humic applications were not capable to overcome this adversity. It demonstrated that sulfur sufficient cabbage and kohlrabi plants concomitant with growth stimulation in response to Se addition expressed a progressive oxidative stress as judged by a lower activity of antioxidant enzymes and accumulation of oxidants. Results imply that the function of antioxidant system of plants could not explain either the growth stimulatory effect of Se in cabbage and kohlrabi or different response of alfalfa plants to Se supplementation (Haji Boland and Amjad, 2007). In relation to fulvic-humic acids, plant growth traits were highly improved owing to their influence on chlorophyll improvements. A positive effect of humic acids on plant growth is confirmed in the study (Ferrara *et al*., 2007), as well of humic acids in the study (Xu, 1986). A favourable effect of humic and fulvic acids can be mostly observed in the stimulation of the plant root system, and consequently, a growth in its weight even by 60%. A similar growth in the root weight after the application of humic acids (Arancon *et al.,* 2006). Sarir *et al*. (2005) revealed that using humic acids to induce growth in field crops by 28%. Matysiak *et al.* (2011) stated that humic and fulvic acids increased maize shoot weight by 40% after two foliar applications. They also showed chlorophyll content improvements in plant leaves as results of using extracts from algae, humic and fulvic acids, but the process of the pigments synthesis is closely dependent on the way of application of the mentioned substances. The strongest effect on the synthesis of chlorophyll was obtained after two foliar applications both with extracts from seaweeds and humic and fulvic acids. An increase in chlorophyll content in leaves after the application of extracts from seaweeds (Blunden *et al*., 1996). A positive effect of humic acids on chlorophyll content after the application of humic acids was observed (Tejda and Gonzales, 2003; Arancon *et al.* 2006).

Table (16). Growth responses as influenced by selenium rates mg.l^{-1} and fulvic-humic acids rates ml.l^{-1} combinations (*), (**)

Se	Fu	lfwt	ldwt	lno	sfwt	sdwt	rfwt	rdwt	cfwt	cdwt	plh	Chol
0.0	0	136.8b	29.789ab	20.889c	78.411ae	17.456ab	37.867ab	16.122ac	166.63a	32.311a	58.1c	60.667ab
	1	127.34b	31.722ab	22c	82.044ad	19.189a	33.022bc	14.322bc	154.17ab	30.978a	55.589c	70.3a
	2	120.5b	27.722b	22.889bc	84.822ac	19.289a	24.522c	11.811c	123.59ab	30.278ab	59.7bc	61.011ab
0.5	0	144.98ab	33.789ab	27.111ab	88.689ab	19.189a	32.011bc	11.967c	151.71ab	28.69ab	69.456a	64.878ab
	1	163.27ab	39.478ab	26.556ab	62.644de	17.678ab	42.467ab	15.644ac	103.31b	21.667b	69.489a	66.811ab
	2	138.6b	33.567ab	24.778bc	85.311ac	15.378ac	41.2ab	12.7c	108.01b	23.189b	61.511ac	61.944ab
1	0	123.2b	34.189ab	24.444bc	58.478e	16.322ac	31.078bc	13.011c	153.42ab	33.256a	61.122ac	62.444ab
	1	133.86b	42.578a	26.778ab	91.833ab	17.044ac	47.489a	20.911a	122.01ab	25.744b	61.433ac	63.711ab
	2	129.4b	35.489ab	25.222bc	65.256ce	11.944bc	35.511bc	15.156bc	108.2b	25.8339b	60.322ac	64.144ab
1.5	0	172.76ab	38.644ab	30.222a	73.333ae	11.1c	35.778ac	14.767bc	109.78b	23.1b	69.033ab	66.011ab
	1	162.68ab	42.889a	24.222bc	93.9a	14.9ac	47.011a	18.989bc	144.69ab	29.667ab	63.333ac	60.511b
	2	197.07a	44.189a	21.444c	70.467be	14.133bc	45.856a	16.133a	135.21ab	18.633b	60.178ac	62.689ab

(*):lfwt=leaf fresh weght (g); ldwt=leaf dry weight (g); lno=leaf number per plant; sfwt stem fresh weight (g); sdfwt=stem dry weight (g); rfwt=root fresh weight (g); rdwt=root dry weight (g); cfwt=curd fresh weight (g); cdwt=curd dry weight (g); plh=plant height (cm); chol= Chlorophyll percentage out of other pigments. (**): Figures of unshared characters are significant at 0.05 level, Duncan test.

ii. Hormonal homeostasis in response to Selenium rates and Fulvic-Humic acids rates

The highest free (792 µg.g), bounded (869.3 µg.g) and total (1507.5 µg.g) IAA were observed in plants irrigated with 1 mg.l^{-1} Se sprayed by 1g.l^{-1} f-h), 1 mg.l^{-1} Se sprayed by 2g.l^{-1} f-h, 1 mg.l^{-1} Se sprayed by 1g.l^{-1} f-h, respectively. It could be deduced from these results that the combination of fulvic-humic and Se urge higher levels of auxin content to improve cell enlargement performance. Besides, it confirmed the capability of fulvic-humic to overcome selenium adversity impacts (Table, 17). Plants irrigated and sprayed with 1 mg.l^{-1} Se sprayed by 2g.l^{-1} f-h, 1.5 mg.l^{-1} Se sprayed by 0g.l^{-1} f-h, 1 mg.l^{-1} Se sprayed by 2g.l^{-1} f-h manifested the highest free (5318 µg.g^{-1}), bounded (3796.2 µg.g^{-1}) and total (7911.4 µg.g^{-1}) GA_3, respectively. This results also confirmed the potency of fulvic-humic acids in mitigating the adversity if Se. The highest free (2501µg.g^{-1}), bounded (2031µg.g^{-1}) and total (4297 µg.g^{-1}) Zeatin contents in dry leaves were recorded in 0.5 mg.l^{-1} Se sprayed by 2g.l^{-1} f-h, 1 mg.l^{-1} Se sprayed by 1g.l^{-1} f-h and 0.5 mg.l^{-1} Se sprayed by 1g.l^{-1} f-h, respectively. The highest free (15533µg.g^{-1}), bounded (70788 µg.g^{-1}) and total (77068µg.g^{-1}) ABA were observed in 1mg.l^{-1} Se sprayed by 2g.l^{-1} f-h, 0mg.l^{-1} Se sprayed by 2g.l^{-1} f-h and 0mg.l^{-1} Se sprayed by 2g.l^{-1} f-h, respectively. The coalition between Selenium and fulvic-humic acids, previous investigations confirmed that the beneficial effect of Se for plants considered in two ways. First, Selenium has a beneficial effect on consumers, i.e. animals and human; in some countries with low Se bioavailability in agricultural soils, multinutrient fertilizers for field crops supplemented with Na-selenate to ensure adequate Se intake in domestic agricultural products by humans (Ekholm *et al.* 1995). Second, due to the promotion of antioxidative system, Se supplementation could increase plant tolerance to environmental stresses and thereby improve growth and yield. One approach to improve crop the tolerance of plants to environmental stresses is to increase their antioxidant capacity (Bowler *et al.* 1992). On the other hand, fulvic-humic acids found to improve plant growth performance. Since, humic substances are the components of humus and as such are high molecular weight compounds that together form the brown to black hydrophilic, molecularly flexible, polyelectrolytes called humus. Many of the components of humus are heterogeneous, relatively large stable organic complexes. They function to give the soil structure, porosity, water holding capacity, cation and anion exchange, and are involved in the chelation of mineral elements. Elemental analysis of humic substances showed that these substances are primarily composed of carbon, oxygen, hydrogen, nitrogen, and sulfur in complex carbon chains. The aliphatic components that make up approximately 40% 50% of the total, CCCC and 4, 5, and 6 member carbon rings (aromatic components that make up 35 60% of the total) with CC, C N and C=O groupings. Humic and fulvic acids, deriving from coal or soil, exhibit the action similar to extracts from seaweeds, although a bigger importance in the development of the plant root system ascribed to them. Humic acids considered compounds increasing permeability of cellular membranes in plants (Kaya *et al*., 2005). Humic and fulvic acids significantly affect an increase in seed germination energy, the intensification of seedling growth, the growth in root weight and shoot development (Katkat *et al*., 2009).

Table (17). The influence of Se and fulvic-humic acids combination in response to hormone accumulations in broccoli and cauliflower cultivars (*)

Se/Fu/		IAA-F	IAA-B	IAA-T	GA3-F	GA3-B	GA3-T	ABA-F	ABA-B	ABA-T	Z-F	Z-B	Z-T
0	0	205b	216.5a	421.5b	3113.7ac	2307.1ac	5420.8ab	415b	732.0b	1147.1b	2151.5ab	1600.6a	3752.1ab
	1	194.4b	159.7a	354.1b	2858.1ac	1810.1ac	4697.1ab	559.2b	474.2b	1033.4b	1692.7ab	1591.5a	3284.2ab
	2	160.5b	181.7a	342.2b	4602.6a	2391ac	6993.6a	627.9b	7078.8a	7706.8a	1679.7ab	1827.8a	3507.6ab
0.5	0	217.5b	155.2a	372.7b	3695.0ab	2583.3ac	6278.3ab	601.4b	465.8b	1067.1b	2121.3ab	1683.5a	3804.8ab
	1	216.9b	194.7a	403.5b	3038.6ac	2732.1ac	5770.7ab	800.4ab	581.8b	1382.2b	2402.2a	1892.6a	4294.8a
	2	185.0b	136.5a	332.6b	663.1c	787.1c	1450.2c	383.9b	294.0b	677.9b	2501a	1719.6a	4220.6a
1	0	194.5b	215.3a	409.8b	1811.8bc	1256.4bc	3068.2bc	421.0b	343.8b	764.7b	1748.4ab	1479.8a	3228.2ab
	1	792.0a	715.4a	1507.5a	3468.9ab	1897ac	5365.9ab	837.7ab	481.7b	1319.4b	1552.5ab	2031a	3583.5ab
	2	248.3b	869.3a	1117.5ab	5301.8a	2609.5ac	7911.4a	1553.3a	315.4b	1868.7b	1175b	1396.2a	2571.2b
1.5	0	356.1ab	330.7a	686.7ab	3466.7ab	3796.2a	7263.0a	516.9b	383.3b	900.1b	1518ab	1659.5a	2571.3ab
	1	419.1ab	495.6a	914.7ab	3402.9ab	3356.5ab	6759.4a	386.6b	449.5b	836.1b	2163.152ab	1094a	3177.5ab
	2	354.8ab	398.5a	753.3ab	1883.8bc	1475.5bc	3359.3bc	340.8b	437.4b	778.2b	1872.3ab	1432.7a	3257.2ab

(*): Figures of unshared characters are significant at 0.05 level, Duncan test.

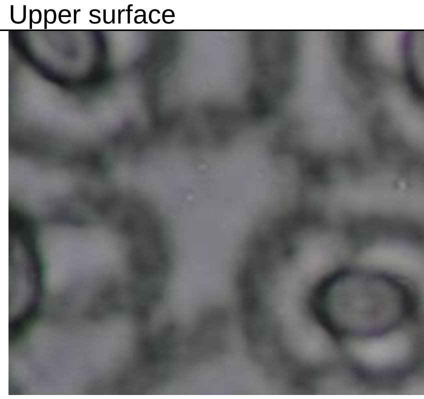
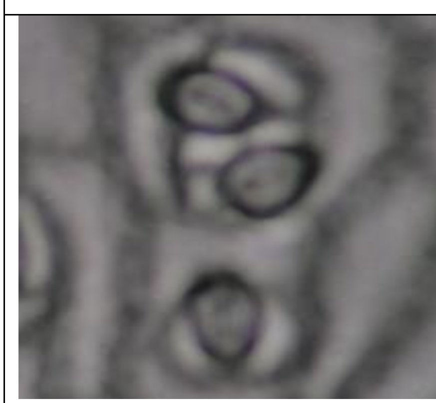
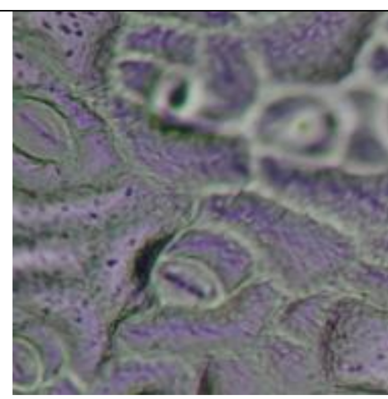
iii. Stomata behaviours in response to Selenium rates and Fulvic-Humic acids rates

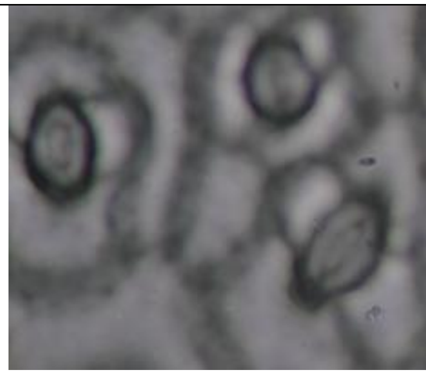
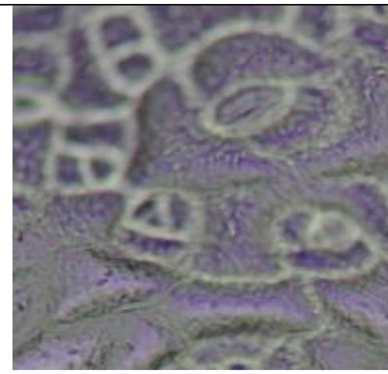
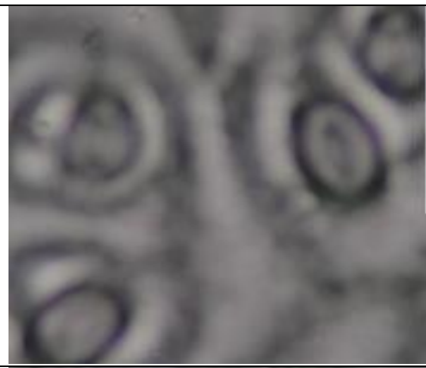
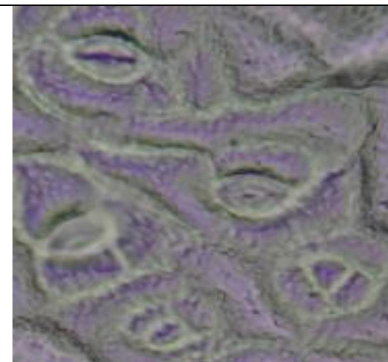
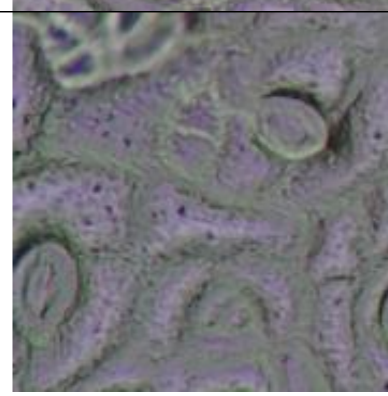
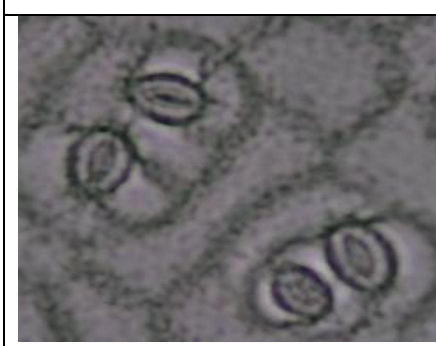
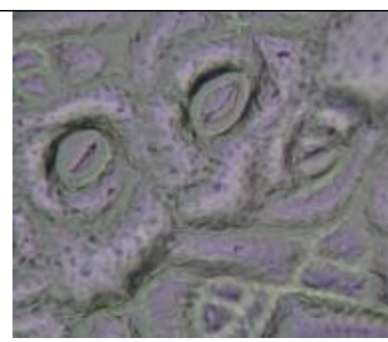
The highest stomata length at the upper leaf surface (11.24micron), stomata width (8.89 micron), the lengthiest stomata aperture (6.17 micron), the widest width (4.57 micron) concomitant to 1.5mg.l^{-1} Se sprayed by 1g.l^{-1} f-h, 0mg.l^{-1} Se sprayed by 0g.l^{-1} f-h, 0mg.l^{-1} Se sprayed by 0g.l^{-1} f-h, 1.5 mg.l^{-1} Se sprayed by 1g.l^{-1} f-h, respectively. While the lowest stomata population (1162.66 st.mm^{-2}) confined to 1.5 mg.l^{-1} Se sprayed by 1g.l^{-1} f-h. The highest stomata length at the lower leaf surface (10.86micron), stomata width (8.15 micron), the lengthiest stomata aperture (6.42 micron), the widest width (4.07 micron) concomitant to 0mg.l^{-1} Se sprayed by 0g.l^{-1} f-h, 0mg.l^{-1} Se sprayed by 0g.l^{-1} f-h, 0mg.l^{-1} Se sprayed by 0g.l^{-1} f-h, 1.5 mg.l^{-1} Se sprayed by 1g.l^{-1} f-h, respectively. The lowest stomata population (1134.02 st.mm^{-2}) observed in 1.5mg.l^{-1} Se sprayed by 2g.l^{-1} f-h, respectively (Table 18). These results suggested that lengthiest stomata aperture and aperture width accompanied to the most effective treatments. Owing to its capability to proceeds gas exchange and thereby better photosynthesis rates. In contrary, the highest stomata population revealed low rates of leaf growth. Since the number of stomata per leaf fixed at the very early leaf primordial stage. Hence, optimal growth rate would disassociate stomata from each other resulting in low stomata population per unit area. Abdel (2007) studied fababeans stomata at lower and upper leaf surface. He found very close results to that obtained in this trail, where stomata numbers at upper and lower leaflet surfaces(r=0.086 and 0.25, respectively, stomata length at upper leaf surface were (r=-0.25), aperture length of upper leaf surface stomata (r=-0.0068) and aperture width of leaf lower surface stomata (r=-0.5*). The effect of humic and fulvic acids on limiting the development of some pathogens is also known, e.g. *Fusarium* spp. (Yigit and Dikilitas, 2008). Fokin and Sinha (1969) proposed that the derived benefits of the addition of organic matter to the soils might be due to the anion replacement or competition between humate from added OM and phosphate ions on adsorbing surfaces, which in turn would have increased the P availability. Sinha (1972) indicated that fulvic acids and intermediate products of organic matter decomposition had played a significant role in mobilizing soluble phosphates. Pal and Sengupta (1985) observed that when black soil incubated with humic acid, the P availability increased. The reason attributed was phosphate ions expected to interact with humic acid more through its phenolic and hydroxyl groups, which might have changed the behaviour of P. The presence of such functional groups as assessed by infrared spectra analysis would confirm similar action in the treated soil leading to increased P availability.

Table (18). The influence of Se and fulvic-humic acids combination in response stomata behaviour in broccoli and cauliflower cultivars (*), (**)

		Stomata dimensions of upper leaf surface					Stomata dimensions of lower leaf surface				
Se/Fu/		Stl	stw	stal	stawl	St Popul.	stl	stw	stal	stawl	St Popul.
0	0	10.86ab	8.89a	6.17a	3.33ac	1191.29a	10.86a	8.15a	6.42a	3.7a	1211.34bc
	1	8.88e	6.42de	4.19c	2.59c	1234.25a	10.61a	8 a	5.550a	3.33a	1222.79bc
	2	10.493ad	8.15ac	5.55ac	3.83ac	1271.48a	10.49a	7.53a	5.06a	2.96a	1251.43ac
0.5	0	10.37ae	7.28be	4.69bc	3.33ac	1237.11a	10.74a	8.02a	5.68a	3.58a	1134.02c
	1	9.01de	6.54de	4.44c	2.72bc	1300.11a	9.58a	7.65a	4.8a	3.33a	1185.57bc
	2	9.13ce	6.2e	4.19c	3.0861bc	1225.66a	10.24a	7.77a	5.06a	3.33a	1222.79bc
1	0	9.63be	6.78ce	4.44c	2.96bc	1305.84a	10.37a	7.65a	5.93a	3.58a	1214.2bc
	1	10.25ae	7.53ae	5.43ac	3.95ab	1242.84a	9.87a	7.28a	5.18a	3.46a	1225.66bc
	2	10.62ac	7.9ad	5.92ab	4.44a	1268.61a	9.75a	6.78a	5.06a	3.7a	1311.57ab
1.5	0	9.38be	7.04be	5.06ac	3.46ac	1265.75a	9.87a	7.41a	5.18a	3.46a	1242.84ac
	1	11.24a	8.39ab	6.17a	4.57a	1162.66a	10.5a	8.15a	6.17a	4.07a	1262.89ac
	2	9.75ae	6.29e	4.56bc	3.33ac	1282.93a	10.4a	8.15a	6.17a	3.95a	1377.43a

(*). popup = stomata population at upper leaf surface; poplo = stomata population at lower leaf surface; stlup = stomata length at upper leaf surface; stalup = stomata aperture length at upper leaf surface; stwup= stomata width at upper leaf surface; stwup= stomata width at upper leaf surface; stllo= stomata length at lower leaf surface; stallo =stomata aperture length at lower leaf surface; stwlo= stomata width at lower leaf surface; stawlo= stomata width at lower leaf surface
(**): Figures of unshared characteristics are significant at 0.05 level Duncan test

Se	Ful.	cultivars	Upper surface	Lower surface
Se(1.5)	0	Calbrese		
	1			

	2			
	0	Difano		
	1			
	2			

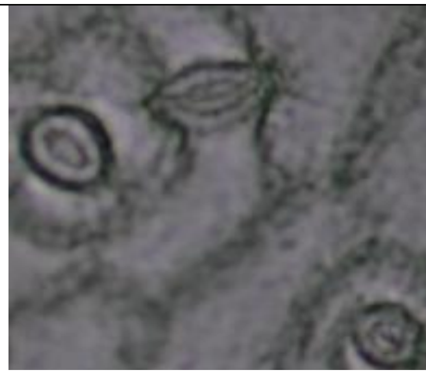
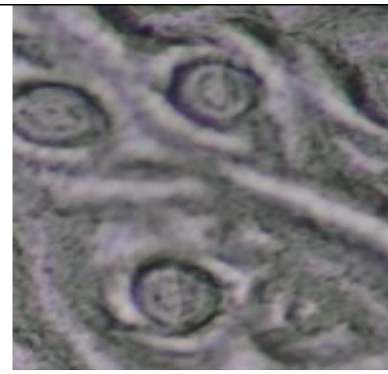
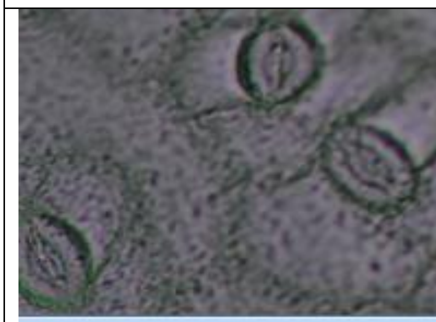
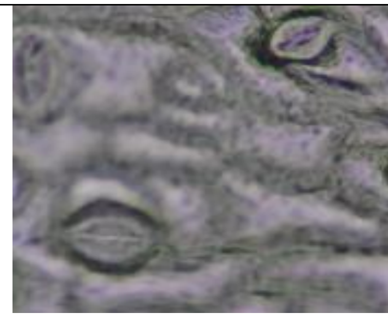
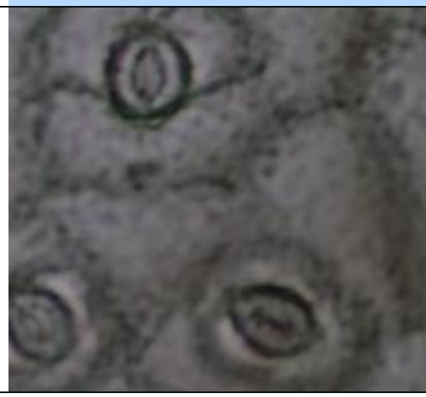
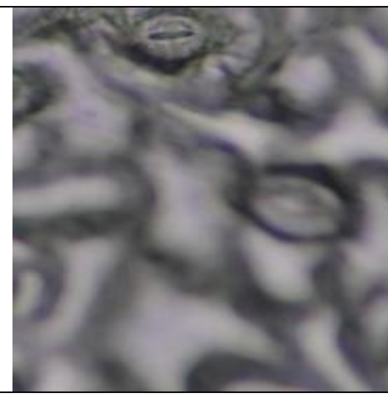
	0	Organza F1		
	1			
	2			

Figure (6): Stomata behaviour of broccoli and cauliflower cultivars

iv. Mineral accumulation in dry matter of curds, leaf, and roots in response to Selenium rates and Fulvic-Humic acids rates

The highest potassium contents in curd (43.47$\mu g.g^{-1}$), leaf (32.25 $\mu g.g^{-1}$) and root (32.88 $\mu g.g^{-1}$) dry matters were confined in 0.5$mg.l^{-1}$ Se sprayed by 0$g.l^{-1}$ f-h, 0.5$mg.l^{-1}$ Se sprayed by 0$g.l^{-1}$ f-h and 0$mg.l^{-1}$ Se sprayed by 1$g.l^{-1}$ f-h, respectively. The highest zinc contents in curd (215.37$\mu g.g^{-1}$), leaf (238.44 $\mu g.g^{-1}$) and root (202.97$\mu g.g^{-1}$) dry matters were confined in 1.5$mg.l^{-1}$ Se sprayed by 0$g.l^{-1}$ f-h, 0$mg.l^{-1}$ Se sprayed by 0$g.l^{-1}$ f-h and 1.5 $mg.l^{-1}$ Se sprayed by 2$g.l^{-1}$ f-h, respectively. The highest iron contents in curd (682.2 $\mu g.g^{-1}$), leaf (578.1 $\mu g.g^{-1}$) and root (313 $\mu g.g^{-1}$) dry matters were confined in 0$mg.l^{-1}$ Se sprayed by 0$g.l^{-1}$ f-h, 1.5$mg.l^{-1}$ Se sprayed by 2$g.l^{-1}$ f-h and 1.5$mg.l^{-1}$ Se sprayed by 1$g.l^{-1}$ f-h, respectively. The highest calcium contents in curd (5827.2$\mu g.g^{-1}$), leaf (3809.5 $\mu g.g^{-1}$) and root (3266.9 $\mu g.g^{-1}$) dry matters were confined in 0$mg.l^{-1}$ Se sprayed by 0$g.l^{-1}$ f-h, 0$mg.l^{-1}$ Se sprayed by 0$g.l^{-1}$ f-h and 1.5 $mg.l^{-1}$ Se sprayed by 2$g.l^{-1}$ f-h, respectively. Selenium partitioning among, curd, leaf and root dry matters (Table, 19), manifested that the highest Se contents of these parts were, respectively 5.35, 6.39 and 5.94 $\mu g.g^{-1}$ were observed in 0.5$mg.l^{-1}$ Se sprayed by 2$g.l^{-1}$ f-h, 0.5$mg.l^{-1}$ Se sprayed by 1$g.l^{-1}$ f-h and 0.5$mg.l^{-1}$ Se sprayed by 0$g.l^{-1}$ f-h, respectively. The highest nitrogen contents of curd (3.03%), leaf (3.95%) and root (3.99%) dry maters recorded in 0$mg.l^{-1}$ Se sprayed by 0$g.l^{-1}$ f-h. It can be deduced from these results that fulvic-humic acids was not able to alter the partitioning ratio of Selenium between curd, leaves and roots, where the highest was in leaves then roots and the curd showed the lowest Se accumulation. This phenomenon attributed to that Se was not toxic to roots, if which otherwise roots should urge acquired systematic resistance through sequestering Selenium. Subsequently, Selenium translocated safely to leaves, where inorganic Selenium converted into organic ones to replace sulfur in organic compound namely, methionine, cysteine, protein, and glutathione. A general reduction of protein concentration in response to sulfur deprivation particularly in Se treated plants could be the result of limitation of supply of proper amino acids to proteins or the result of higher destruction, i.e. as a result of Se-induced oxidative stress, which was documented also in this work. Se-methionine shown to be less effective as a substitute for peptide bond formation during translation than methionine. This could reduce the rate of protein synthesis and contribute to Se toxicity (Eustice *et. al.,* 1981).

Table (19). The influence of Se and fulvic-humic acids combination in response to mineral accumulations in broccoli and cauliflower cultivars (*), (**) (*), (**)

	(0)Se			(0.5)Se			(1)Se			(1.5)Se		
Se/cv	(0)Fu-H	(1)Fu-H	(2)Fu-H	(0)Fu-H	(1)Fu-H	(2)Fu-H	(0)Fu-H	(1)Fu-H	(2)Fu-H	(0)Fu-H	(1)Fu-H	(2)Fu-H
Zn/curd	192.97ab	193.97ab	173.69bc	200.73ab	189.46ab	198.48ab	187.21ab	202.97ab	209.74ab	215.37a	146.63c	138.53c
Zn/leaf	238.44a	180.46ab	173.70b	180.44ab	202.96ab	218.76ab	184.80ab	199.69ab	196.22ab	196.21ab	191.61ab	193.96ab
Zn/root	184.97ab	187.22ab	182.70ab	86.46d	116.73cd	170.18ab	147.62bc	101.39d	123.96cd	196.21a	193.97a	202.97a
Fe/curd	682.20a	638.80a	401.90a	405.80a	455.20a	340.70a	318.90a	442.30a	297.20a	502.50a	516.80a	578.10a
Fe/leaf	682.02a	638.80a	401.90a	405.80a	455.20a	340.7a	318.90a	442.30a	297.20a	502.50a	516.80a	578.10a
Fe/root	312.7a	242a	241.7a	229.7a	246.6a	113.3a	229.6a	116.6a	291.2a	201.5a	313a	301a
Ca/curd	5827.2a	3612.8b	3782.5b	3665.6b	3417.6b	3722.6b	2838.8b	3192.4b	4000.5ab	4468.6ab	3643.9b	4379.7ab
Ca/leaf	3809.5a	3206.6ab	2884.5ab	2539.5ab	2431.2ab	2589.4ab	2361.3ab	2700.6ab	1936.6b	1955.4b	2136.7ab	2811.3ab
Ca/root	1710ce	2071.7cd	1682.5ce	2154.3cd	1372de	1381.4de	2437bc	964.4e	1677.7ce	1793.7ce	2989.6ab	3266.90a
N/curd	3.03a	2.35a	2.93a	2.76a	2.46a	2.90a	2.89a	2.97a	1.81a	2.42a	2.80a	2.21a
N/leaf	3.95a	3.37ab	2.79bc	2.64bc	2.44bc	2.70bc	2.88bc	2.58bc	2.22c	2.87bc	2.81bc	3.11ac
N/root	3.99a	2.40b	2.77b	2.53b	2.68b	2.73b	3.13ab	2.97ab	2.94ab	2.53b	2.70b	2.54b
K/curd	26.43c	40.25ab	31.31ac	43.47a	31.21ac	25.60c	28.09bc	32.77ac	28.72bc	25.50c	25.50c	25.50c
K/leaf	26.85a	27.58a	27.89a	32.25a	30.38a	31.53a	25.92a	26.12a	26.64a	27.06a	24.98a	28.51a
K/root	28.30ab	32.88a	29.45ab	32.15a	29.97ab	30.17ab	30.90ab	28.82ab	27.06ab	29.03ab	25.50b	27.27ab
Se/curd	ND	ND	ND	4.55ab	3.88ab	5.35a	4.33ab	3.57ab	3.32ab	3.84ab	2.94b	3.51ab
Se/leaf	ND	ND	ND	4.16a	6.39a	4.63a	5.67a	5.13a	4.26a	5.35a	4.74a	3.76a
Se/root	ND	ND	ND	5.94a	5.72a	5.75a	4.97a	4.33a	4.63a	4.75a	4.80a	4.39a

(*): Figures of unshared characters are significant at 0.05 level, Duncan test.(0)means not detected

E. Cultivar responses to Selenium rates

i. Growth responses of cultivars as influenced by Selenium

Calbrese broccoli cultivar irrigated with 1.5 $mg.l^{-1}$ showed the highest curd fresh weight (161.69 g), leaf fresh weight (206.7g) and leaf dry weight (44.73g). The highest leaf number (27.33), stem fresh weight (87.33g), stem dry weigh (22.57g), (root fresh weight (47.57 g) and plant height (69.89 cm) were recorded with the dual interaction treatment of Difanof1 cauliflower cultivar irrigated with 0.5 $mg.l^{-1}$ Se. The highest chlorophyll contents confined to Calbrese broccoli cultivar irrigated with 0.5$mg.l^{-1}$ Se. While, root dry weight Calbrese broccoli cultivar irrigated with 1$mg.l^{-1}$ Se. Finally, the highest curd dry weight found in Calbrese broccoli cultivar irrigated with 0$mg.l^{-1}$ Se (Table, 20). These results suggested that broccoli revealed higher efficacy to Selenium as compared to the other two cauliflower cultivars, this better response might be due to the toughness of broccoli as compared to more delicate cauliflower (Wien, 1997). It well established that varying responses occurred between species and within intra cultivars of the same species. However, such responses are highly related to the ambient environment including selenium, which in some instance high doses impart the growth of plants (Abdel, 2007). These adversities definitely overcome with the application of low dosages. For instance, Selenium can increase the tolerance of plants to UV-induced stress as well as delay senescence and promote the growth of aging seedlings. In plants grown under high light intensities, Se counteracted senescence-related oxidative stress and maintained green leaf color longer (Xue *et al.* 2001). Although glutathione peroxidase (GPX) containing Se was not identified in plants, Se supplementation consistently increased GPX activity (Hartikainen *et al*. 2000; Xue *et al.* 2001), and inhibited lipid peroxidation (Hartikainen *et al*. 2000). In contrast, the activity of superoxide dismutase (SOD) diminished in response to Se addition (Hartikainen *et al.* 2000; Xue and Hartikainen 2000).

Table (20). Growth responses of cultivars to Se (mg.l^{-1}) (*), (**)

Se/cv/HOR		Lfwt	ldwt	lno	Sfwt	sdwt	rfwt	rdwt	cfwt	cdwt	p/H	Chol
0	Barcles	138.84bd	27.43b	20.89c	77.78ab	17.76ab	36.31ac	17.89ab	153.44a	34.12a	55.62c	70.83a
	Difano	126.13cd	32.41ab	22bc	82.44ab	18.23ac	25.61c	11.81cd	149.94a	32.24ab	59.91bd	54.98d
	Organza	119.7d	29.39b	22.89ac	85.06ab	19.94ab	33.49bc	12.56bd	141a	27.20ac	57.856c	66.17ac
0.5	Barcles	121.81cd	27.86b	24.78ac	70.84ab	15.20bd	41.09ab	12.37bd	119.99a	20.37bc	62.63ac	73.39a
	Difano	181.77ab	39.89ab	27.33a	87.33a	22.57a	47.57a	17.20ac	123.52a	29.16ac	69.89a	59.81bd
	Organza	143.52bd	39.09ab	26.33ab	78.47ab	14.48bd	27.02c	10.74d	119.52a	23.93ac	67.93ab	60.43bd
1	Barcles	128.48cd	38.78ab	26.33ab	71.01ab	17.33ad	43.49ab	20.48a	138.28a	31.6ab	64.56ac	65.19ac
	Difano	122.78cd	36.40ab	24.67ac	64.88b	11.54d	34.88ac	14.26bd	120.51a	22.04bc	57.61c	58cd
	Organza	135.21bd	37.08ab	25.44ab	79.68ab	16.43bd	35.11ac	14.34bd	124.84a	31.19ab	60.71ac	67.11ac
1.5	Barcles	206.7a	44.73a	27.33a	84.49ab	13.76bd	44.74ab	17.93ab	161.69a	30.47ac	68.87ab	68.34ab
	Difano	176.27bd	40.67ab	25.11ac	80.52ab	14.02bd	43.53ab	16.10ad	118.53a	21.68bc	60.94c	55.47d
	Organza	149.54bd	40.32ab	23.44ac	72.69ab	12.36d	40.37ab	15.86ad	109.46a	19.26c	62.63ac	65.40ac

(*):lfwt=leaf fresh weght (g); ldwt=leaf dry weight (g); lno=leaf number per plant; sfwt stem fresh weight (g); sdfwt=stem dry weight (g); rfwt=root fresh weight (g); rdwt=root dry weight (g); cfwt=curd fresh weight (g); cdwt=curd dry weight (g); plh=plant height (cm); chol= Chlorophyll percentage out of other pigments. (**): Figures of unshared characters are significant at 0.05 level, Duncan test.

ii. Hormonal homeostasis of cultivars as influenced by Selenium

The highest free (778.5 µg.g-1), bounded (808.4 µg.g-1) and total (1035.5µg.g-1) IAA were recorded with organza cauliflower cultivar irrigated with 1mg.l-1 Se, Difano cultivar irrigated with 1mg.l-1 Se and Difano cultivar irrigated with 1mg.l-1 Se (Table, 21). The highest free (4465 µg.g-1), bounded (4903.4 µg.g-1) and total (8019.5 µg.g-1) GA3 were recorded with Calbrese broccoli cultivar irrigated with 0mg.l-1 Se, Calbrese broccoli cultivar irrigated with 1.5mg.l-1 Se and Calbrese broccoli cultivar irrigated with 1.5mg.l-1 Se. The highest free (278.4 µg.g-1), bounded (2030.1µg.g-1) and total (4057.4 µg.g-1) Zeatin were recorded with organza cauliflower cultivar irrigated with 0.5mg.l-1 Se, Difano f1 cultivar irrigated with 0mg.l-1 Se and organza cultivar irrigated with 0.5mg.l-1 Se. The highest free (1657.1 µg.g-1), bounded (7238.2 µg.g-1) and total (7888.8 µg.g-1) ABA were recorded with Calbrese cauliflower cultivar irrigated with 1mg.l-1 Se, Calbrese cultivar irrigated with 0mg.l-1 Se and Calbrese cultivar irrigated with 0mg.l-1 Se. Once again, Calbrese proved its potency to cope with Selenium, as compared to cauliflower cultivars. This Superiority might be came from its capability to regulate the hormonal interactions for his favor under the stress of light and heat that were prevailed during growing season. In a pot experiment, using low Se soils amended with increasing dosage of H2SeO4 it observed that at low concentrations of added Se it acted as an antioxidant, whereas at higher concentrations it was a pro-oxidant. This dual effect of Se coincided with promotion and inhibition of plant growth (Hartikainen et al., 2000). These observations indicate that Se may have particular biological functions in higher plants through alteration of antioxidant defense system. Therefore, it was found that under short wave lights for instance violet and ultraviolet, plants usually adapt defense system to avoid short wave damage through anthocyanin synthesis mechanism and thus plants showed stunting stature as in alpine plants where short waves block Gibberellins synthesis earlier in its synthesis pathways (Taiz and Zeiger, 2002). Subsequently, sucrose-induction of the anthocyanin synthesis pathway repressed by the addition of Gibberellic acid (GA) whereas jasmonate (JA) and Abscisic acid (ABA) had a synergic effect with sucrose. The gai mutant was less sensitive to GA-dependent repression of dihydroflavonol reductase. This would seem to prove that GAI signaling is involved in the crosstalk between sucrose and GA in wild-type Arabidopsis seedlings. Conversely, the inductive effect of sucrose was not strictly ABA mediated. Sucrose induction of anthocyanin genes required the COI1 gene, but not JAR1, which suggests a possible convergence of the jasmonate- and sucrose-signaling pathways. These results suggested the existence of a crosstalk between the sucrose and hormone signaling pathways in the regulation of the anthocyanin biosynthetic pathway. Ethylene appears to have a univocally positive effect on anthocyanin accumulation, whereas the results are contradictory for gibberellins (GAs), which appear to have a positive role on flowers while playing a repressive role on various other plant tissues. The published evidence on the effects of ABA, auxin (2,4-dichlorophenoxyacetic acid, 2,4 D), and Cytokinin is contradictory, although these results can be explained by taking into account the different plant species/organs studied. Most of these studies, however, do not analyze the effects of plant hormones in terms of genes, apart from the work of Devoto *et al.* (2005) who showed that JA could induce the expression of some anthocyanin related genes such as chalcone synthase, anthocyanidin synthase and leucoanthocyanidin dioxigenase in Arabidopsis.

Table (21). Hormone accumulations in responses to cultivars and se interaction (mg.l^{-1}) (*)

Se/cv/HOR		IAA-F	IAA-B	AAA-T	GA3-F	GA3-B	GA3-T	ABA-F	ABA-B	ABA-T	Z-F	Z-B	Z-T
0	Barcles	246.5ab	231.2a	477.6a	4465.0a	1875.6b	6340.6ab	650.6b	7238.2a	7888.8a	2323.5a	1163.6a	3487.1ab
	Difano	1538b	152.3a	306.2a	3600.2a	2340.6b	5940.8ab	520.0b	480.4b	1000.4b	1517.8b	2030.1a	3547.9ab
	Organza	159.6b	174.4a	334.0a	2465.6a	2292.0b	4830.1ab	431.5b	566.5b	998.0b	1682.5b	1826.2a	3508.7ab
0.5	Barcles	251.1ab	191.3a	442.4a	3120.9a	3221.7ab	6342.7ab	672.5b	656.0b	1328.5b	2029.6ab	1672.4a	3702.1ab
	Difano	157.3b	141.4a	298.8a	1982.3a	1732.0b	3714.3b	301.9b	353.8b	655.8b	2112.2ab	1871.3a	3983.6a
	Organza	222ab	148.5a	367.7a	2293.5a	1148.8b	3442.3b	811.1b	331.8b	1142.9b	2874a	1751.9a	2039.3b
1	Barcles	2293ab	765.5a	994.9a	3032.2a	1188.5b	4220.7b	1657.1a	386.2b	2043.3b	1600.2b	1274.3a	2874.5b
	Difano	2270ab	808.4a	1035.5a	3408.7a	2865.9b	6274.6ab	523.5b	305.8b	829.2b	1654.9b	1859.1a	3514.1ab
	Organza	778.5a	226.1a	1004.5a	4141.6a	1708.6b	5850.2ab	631.4b	448.8b	1080.2b	1207b	1774.3a	3981.3a
1.5	Barcles	391.7ab	393.5a	785.2a	3116.1a	4903.4a	8019.5a	344.7b	446.0b	790.7b	1548.9b	1101.3a	2650.2b
	Difano	359.7ab	4129a	772.6a	2907.8a	1512.2b	4419.9b	486.3b	421.6b	907.9b	2127.9ab	1929.5a	4057.4a
	Organza	378.6ab	418.4a	796.9a	2729.5a	2212.7b	4942.2ab	413.3b	402.5b	815.8b	1876.6ab	1155.4a	3032ab

(*): Figures of unshared characters are significant at 0.05 level, Duncan test.

iii. Stomata dimensions of cultivars as influenced by Selenium

The highest stomata length at the upper leaf surface (11.11micron), stomata width (8.52 micron), the lengthiest stomata aperture (5.8 micron), the widest width (4.32 micron) were recorded in Difano f1 irrigated 1mg.l^{-1} Se. The lowest stomata population (1159.79 st.mm^{-2}) was concomitant to Organza irrigated with 0mg.l^{-1} Se sprayed. The highest stomata length at the lower leaf surface (10.86micron), stomata width (8.39 micron), the lengthiest stomata aperture (6.05micron), the widest width (4.07 micron) and lowest stomata population (1131.16 st.mm^{-2}) were concomitant to Calbrese 0mg.l^{-1} Se, organza 0.5mg.l^{-1} Se, Calbrese 1.5mg.l^{-1} Se, Difano 1.5 mg.l^{-1} Se, Difano 0.5 mg.l^{-1} Se respectively (Table, 22). It inferred from these results that Difano was the most responded cultivar to Selenium as compared with the other two cultivars namely Organza and Calbrese. As it mentioned above that, the lowest stomata population and the lengthiest stomata aperture confined with the maximum leaf growth (Abdel, 2007). There are numerous examples of plasticity in stomata densities within species, with changes readily induced through exposure of developing leaves to changed atmospheric CO_2 concentrations (Woodward *et al*., 2002), drought stress (Abdel, 2006); drought stress hormone Abscisic acid (Franks *et al*., 2001; Al-Hamadany, 2005).

Table (22). Stomata behaviour in response to cultivars and Se interaction (mg.l^{-1}) (*), (**)

		Stomata dimensions of upper leaf surface					Stomata dimensions of upper leaf surface				
Se/cv/		Stl	stw	stal	stawl	St Popul.	stl	stw	stal	stawl	St Popul.
0	Barcles	10.12ac	7.9ab	5.55ab	3.21ab	1225.66a	10.86a	8.0239a	5.8019a	3.9502a	1205.61b
	Difano	9.88ac	7.78ab	5.31ab	3.33ab	1311.57a	10.49a	7.9004a	5.6784a	2.9627a	1211.34b
	Organza	10.25ab	7.78ab	5.1ab	3.21ab	1159.79a	10.62a	7.7770a	5.5550a	3.0861a	1268.61ab
0.5	Barcles	9.63ac	7.16ac	4.81ab	3.33ab	1245.70a	9.83a	7.1598a	4.6909a	2.7158a	1205.61b
	Difano	10.25ab	6.79bc	4.32b	3.21ab	1179.84a	10.25a	7.9004a	5.8019a	4.0737a	1131.16b
	Organza	8.64c	6.05c	4.19b	2.59b	1337.34a	10.49a	8.3942a	5.0612a	3.4564a	1205.61b
1	Barcles	9.51bc	6.91bc	4.94ab	3.33ab	1328.75a	9.99a	7.2832a	5.5550a	4.0737a	1219.93b
	Difano	11.11a	8.52a	5.8a	4.32a	1191.29a	9.99a	7.5301a	5.8019a	3.5799a	1251.43ab
	Organza	9.88ac	6.79bc	5.06ab	3.7ab	1297.25a	9.99a	6.9129a	4.8143a	3.0861a	1280.07ab
1.5	Barcles	9.9990ac	7.16ac	5.06ab	3.33ab	1225.66a	10.62a	8.1473a	6.0488a	4.0737a	1285.80ab
	Difano	10.49ab	7.53ac	5.43ab	4.19a	1228.52a	10.3693a	8.0239a	6.0488a	4.0737a	1219.93b
	Organza	9.88ac	7.04ac	5.31ab	3.83ab	1257.16a	9.7521a	7.5301a	5.4316a	3.3330a	1377.43a

(*) popup = stomata population at upper leaf surface; poplo = stomata population at lower leaf surface; stlup = stomata length at upper leaf surface; stalup = stomata aperture length at upper leaf surface; stwup= stomata width at upper leaf surface; stwup= stomata width at upper leaf surface; stllo= stomata length at lower leaf surface; stallo =stomata aperture length at lower leaf surface; stwlo= stomata width at lower leaf surface; stawlo= stomata width at lower leaf surface

(**): Figures of unshared characteristics are significant at 0.05 level Duncan test

iv. Mineral accumulations in cultivar leaves as influenced by Selenium

The highest nitrogen contents of curd (3.31%), leaf (4.91%) and root (3.08%) dry maters were recorded in Calbrese irrigated by 0mg.l^{-1} Se, Difano irrigated by 0mg.l^{-1} Se and Calbrese irrigated by 0mg.l^{-1} Se, respectively. The highest potassium contents in curd (37.97 µg.g^{-1}), leaf (33.4 µg.g^{-1}) and root (32.15µg.g^{-1}) dry matters were confined in Difano 0.5mg.l^{-1} Se, Difano 1mg.l^{-1} Se and Difano 0mg.l^{-1} Se, sprayed, respectively. The highest zinc contents in curd (218.74µg.g^{-1}), leaf (236.2 µg.g^{-1}) and root (202.98µg.g^{-1}) dry matters confined in Organza 1mg.l^{-1} Se, Calbrese 1.5mg.l^{-1} Se and Organza 1.5 mg.l^{-1} Se, respectively. The highest iron contents in curd (696 µg.g^{-1}), leaf (380.1 µg.g^{-1}) and root (399.5 µg.g^{-1}) dry matters were confined to Calbrese 0mg.l^{-1} Se, Difano 0.5mg.l^{-1} Se, Organza irrigated by 1.5mg.l^{-1} Se, respectively. The highest calcium contents in curd (4800.9µg.g^{-1}), leaf (4121.7 µg.g^{-1}) and root (2905.4 µg.g^{-1}) dry matters confined in Calbrese 0mg.l^{-1} Se, Difano 0mg.l^{-1} Se and Calbrese 1.5 mg.l^{-1} Se, respectively. The highest Selenium contents of curd, leaf and root dry matters (Table, 22) were 5.18, 6.20 and 6.69 µg.g^{-1}, they were detected in Difano irrigated with 0.5 mg.l^{-1} Se, Organza irrigated by 0.5mg.l^{-1} Se, Difano irrigated by 0.5mg.l^{-1}, respectively. Low levels of Selenium applications cauliflower cultivars; this manifested the capability of low Selenium dosages to provoke plant tolerance to abiotic stresses. In number of previous works, an amelioration of stresses such as UV radiation (Hartikainen and Xue 1999; Xue and Hartikainen 2000), cold injury (Seppanenn *et al.,* 2003) and aging (Xue *et al.,* 2001), by Se was attributed to the activation of antioxidant defense system of plants.

Table (23). Mineral accumulations in response to cultivars and Se interaction (mg.l^{-1}) (*),

	(0)Se			(0.5)Se			(1)Se			(1.5)Se		
Se/cv	Brocc	Difano	Organza	Brocc	Difano	Organza	Brocc	Difano	Organza	Brocc	Difano	Organza
Zn/curd	175.96bc	180.44ac	204.22ab	189.47ac	202.98ab	196.22ab	193.98ac	187.20ac	218.74a	154.51c	169.18bc	176.84bc
Zn/leaf	180.44a	175.96a	236.2a	218.76a	180.44a	202.96a	202.82	189.47a	188.42a	205.11a	184.98	191.69a
Zn/root	184.98a	187.20a	182.71a	132.86b	116.81b	123.70b	125.88b	130.39b	116.70b	191.70a	198.47a	202.98a
Fe/curd	696a	510.4a	516.4a	512.5a	457.2a	232.1a	432.4a	319a	307.1a	679.3a	545.9a	372.2a
Fe/leaf	286.1a	289.3a	367.1a	238a	380.1a	113.6a	159a	176.8a	293.3a	289.3a	238a	192.6a
Fe/root	295ab	259.7ab	241.7ab	155.1b	204.4ab	230.1ab	170.9ab	196.5ab	270.1ab	241.2ab	174.8ab	399.5a
Ca/curd	4800.9a	4301.3ab	4120.3ab	3298.1ab	3661.3ab	3846.4ab	3527.5ab	2328.5b	4175.7ab	4492.5a	3712.6ab	4287ab
Ca/leaf	2781.8ab	4121.7a	2997.1ab	2499.6ab	2663.5ab	2397ab	2401/2ab	2974.3ab	1623b	2184.7b	3015.5ab	1703.1b
Ca/root	1695.6cd	1966.3bd	1802.3bd	1694.4cd	1436d	1777.3bd	1184.4d	2073.5ad	1821.1bd	2905.4a	2503.8ac	2641ab

N/curd	3.31a	2.50a	2.51a	2.28a	2.49a	3.37a	2.68a	2.56a	2.43a	2.46a	2.14a	2.83a
N/leaf	2.89b	4.19a	3.03b	2.71b	2.64b	2.43b	2.49b	2.55b	2.65b	2.90b	2.41b	3.48ab
N/root	3.08a	3.01a	3.07a	2.71a	2.56a	2.66a	2.80a	3.17a	3.08a	2.53a	2.50a	2.73a
K/curd	37.97a	23.63cd	36.41ac	35.16ac	35.68ac	29.44ad	24.25bd	28.41ad	36.93ab	21.86d	29.14ad	25.50ad
K/leaf	30.90ab	26.74ab	24.67b	31.01ab	33.40a	29.76ab	28.82ab	24.77b	25.08b	26.12ab	29.24ab	25.19b
K/root	30.17ab	30.49ab	29.97ab	28.20ab	32.15a	31.94ab	29.55ab	27.47ab	29.76ab	28.41ab	27.58ab	25.81b
Se/curd	0.00e	0.00e	0.00c	4.42ab	4.91a	4.45ab	4.01ac	5.18a	2.03cd	2.29bd	4.12ac	3.88ac
Se/leaf	0.00c	0.00c	0.00c	5.36ab	4.48ab	5.35ab	5.48ab	3,32b	6.20a	3.46ab	4.78ab	5.61ab
Se/root	0.00c	0.00c	0.00c	6.69a	5.13ab	5.59ab	4.74ab	4.57ab	4.62ab	3.66b	6.47a	3.82b

(*): Figures of unshared characters are significant at 0.05 level, Duncan test.

F. Cultivar responses to Fulvic-Humic acids

i. Cultivar growth responses to Fulvic-Humic acids

Calbrese broccoli cultivar sprayed with 0mg.l^{-1}f-h (Table, 24) exhibited the highest curd fresh weight (160.59g), curd dry weight (32.98g), and plant height (68.01 cm). Difano sprayed with 2mg.l^{-1}f-h showed the highest leaf fresh weight (157.22g). The highest leaf dry weight (41.2g), leaf number (26.08), stem fresh weight (84.79g), stem dry weight (18.73), root fresh weight (46.33 g), root dry weight (19.67g) and chlorophyll percentage (71.96%) were found in organza 1mg.l^{-1}f-h, Difano 0mg.l^{-1}f-h, Difano 1mg.l^{-1}f-h, Difano 1mg.l^{-1}f-h, Calbrese 1mg.l^{-1}f-h, Calbrese 1mg.l^{-1}f-h and Calbrese 1mg.l^{-1}f-h, respectively. Fulvic-humic acids left remarkable signs on growth traits, which might be due to its high nutritional contents. The humic substance is assumed to be formed by microbial activities and chemical processes which can involve both degradation and polymerization (Hedges, 1988; Stevenson 1994; McKnight and Aiken, 1998). The biopolymer-degradation model proposes that organic macromolecules such as carbohydrates and proteins partially degraded and biopolymers such as lignin transformed into humic substances. The biotic-condensation model proposes that spontaneous abiotically heteropoly condensation reactions among small reactive intermediates for example amino acids, phenols and sugars released during enzymatic breakdown of bio macromolecules can produce extremely complex assemblages of molecules that exhibit a brown colour (Calace *et al*., 2005). These macromolecules are interesting because of their structural features, which includes binding sites with different complexing strength, able to form inert and labile complexes with metals (Yamamoto and Ishiwatary, 1992).

Table (24). Growth responses to fulvic-humic acid and cultivar interaction (*), (**)

Fu-H/cv/TRAITS		lfwt	Ldwt	lno	sfwt	sdwt	rfwt	rdwt	Cfwt	cdwt	Plh	Chol
0 Fu-H	Calbres	144.99a	33.84a	25.50a	79.63a	17.28a	36.78ab	16.04ac	160.59a	32.98a	68.01a	70.22a
	Difano	152.18a	32.98a	26.08a	72.72a	16.20a	33.58b	13.83bc	126.49ab	25.31ab	63.26ab	56 c
	Organ	136.21a	35.48a	25.42a	71.83a	14.58a	32.18b	12.03c	147.08ab	29.66ab	62ab	64.28ab
1 Fu-H	Calbres	149.72a	36.46a	25.08a	81.34a	16.45a	46.33a	19.67a	153.48ab	30.19ab	63.71ab	71.96a
	Difano	145.86a	39.84a	25.17a	84.79a	18.73a	42.21ab	17.23ab	127.36ab	28.33ab	60.98ab	55.13c
	Organza	144.78a	41.20a	24.42a	81.68a	16.43a	38.96ab	15.50ac	112.30b	22.52b	62.69ab	68.91a
2 Fu-H	Calbres	152.18a	33.80a	23.92a	67.12a	14.31a	41.12ab	15.79ac	115.98ab	24.24ab	57.05b	66.14ab
	DIfano	157.22a	39.20a	23.08a	78.88a	14.84a	37.90ab	13.47bc	130.53ab	25.20ab	62.01ab	60.06bc
	Organza	129.99a	32.73a	23.75a	83.40a	16.41a	31.30b	12.59bc	109.74b	24.01ab	62.23ab	61.14bc

(*):lfwt=leaf fresh weght (g); ldwt=leaf dry weight (g); lno=leaf number per plant; sfwt stem fresh weight (g); sdfwt=stem dry weight (g); rfwt=root fresh weight (g); rdwt=root dry weight (g); cfwt=curd fresh weight (g); cdwt=curd dry weight (g); plh=plant height (cm); chol= Chlorophyll percentage out of other pigments

. (**): Figures of unshared characters are significant at 0.05 level, Duncan test.

ii. Hormonal homeostasis in responses to Fulvic-Humic acids

The highest free (2545 µg.g^{-1}), IAA bounded (6507 µg.g^{-1}) and total (9052 µg.g^{-1}) IAA were recorded with Calbrese cultivar sprayed with 2 mg.g^{-1}f-h, Difano cultivar sprayed with 2mg.g^{-1} and Difano cultivar sprayed with 2mg.g^{-1} f-h, respectively (Table, 25). The highest free (4343.9µg.g^{-1}), bounded (3643.1µg.g^{-1}), and total (7987µg.g^{-1}) GA_3 recorded with Calbrese cauliflower cultivar sprayed with 1mg.g^{-1}f-h, respectively. The highest free (2047.9 µg.g^{-1}), bounded (1998.9µg.g^{-1}) and total (3937..9 µg.g^{-1}) Zeatin were recorded with organza cauliflower cultivar sprayed with 1mg.g^{-1}f-h, Difano cultivar sprayed with 1mg.g^{-1} and Difano cultivar sprayed with 2mg.g^{-1} f-h, respectively. The highest free (1369.5µg.g^{-1}), bounded (5309.4µg.g^{-1}), and total (6678.9µg.g^{-1}) ABA recorded with Calbrese cultivar sprayed with 2mg.g^{-1}f-h. The beneficial of hormonal homeostasis brought up to optima growth, especially when plants provided with required nutrients and moisture. The preferential sorption of aromatic humic moieties to aluminum (Al) and iron (Fe) oxides were detected (McKnight *et al*., 1992; Gu *et al*., 1995).

Ligand exchange-surface complexation proposed as the dominant interaction mechanism for sorption of humic substances on Fe oxide (Gu *et al*., 1994). Yoon *et al.* (2005) found that weak outer-sphere type complexes would play an important role during the interaction of humic substances with boehmite (γ-AlO(OH)). Other factors, such as the stereo chemical arrangement of the functional groups on humic substances may also lead to preferential sorption of certain humic fractions (Gu *et al.*, 1994). Strong interaction between Elliot soil humic acid (ESHA) and hydrous Al oxide (HAO) led to ESHA-promoted dissolution of HAO and surface charge reversal. The ESHA-HAO sorption–desorption isotherms were successfully described using a modified Langmuir model that accounted for the heterogeneity of HAO surface and ESHA. Ligand exchange proposed as the major interaction mechanism and the edge Al atoms on HAO surface considered as the sorption sites for ESHA macromolecules. ESHA coated onto HAO to achieve two different organic content (*f*oc) levels of 0.81 and 1.52% (Gu *et al.,* 2007). Sorption results compared for the binary ESHA-tetracycline and HAO-tetracycline systems, and the ternary ESHA-HAO tetracycline system. The coating of ESHA on HAO significantly suppressed tetracycline sorption levels, which was attributable to altered HAO surface charge characteristics and/or direct competition between ESHA and tetracycline for potential sorption sites. Higher Organic content (*f*oc) level, besides increasing the extent of sorption suppression, also resulted in greater ionic strength dependence and increased nonlinearity of sorption behavior.

Table (25). Hormonal homeostasis responses to fulvic-humic acid and cultivar interaction (*),

Fu-H/cv/HOR		IAA-F	IAA-B	IAA-T	GA3-F	GA3-B	GA3-T	ABA-F	ABA-B	ABA-T	Z-F	Z-B	Z-T
0 Fu-H	Calbrese	2459a	2505a	4964a	26682a	2496.4ab	51647ab	3395b	5466a	886.1b	1962.7a	1344.9a	3307.6a
	Difano	2262a	2373a	4635a	31565a	2264.1ab	54207ab	4958b	3592a	855b	1715.5a	1807.8a	3523.2a
	Organza F1	2578a	2004a	4582a	32406a	2696.7ab	59373ab	6304ab	5378a	1168.2b	1975.4a	1664.8a	3640.2a
1 Fu-H	Calbrese	3380a	705.8a	1043.9a	4343.9a	3643.1a	7987a	7847ab	6888a	1473.6b	1942.4a	1255.1a	3197.4a
	Difano	1927a	2483a	4411a	22725a	1942.2ab	42147b	3980b	4187a	8167b	1867.6a	1998.5a	3866.1a
	Organza F1	686a	2221a	8999a	29692a	1761.5b	47431b	7552ab	3828a	1138b	2047.9a	1704.6a	3752.5a
2 Fu-H	Calbrese	2551a	2297a	4848a	32886a	2252.4ab	55410ab	13695a	5309.4a	6678.9a	1721.6a	1308.632a	3030.2a
	Difano	2545a	6507a	9052a	34952a	2131.6ab	56268ab	4800b	3933a	873.3b	1976.6a	1961.3a	3937.9a
	Organza F1	2101a	3091a	5193a	25548a	1063.4b	36181b	3299b	3916a	721.5b	1723.2a	1512.4a	3235.6a

(*): Figures of unshared characters are significant at 0.05 level, Duncan test.

iii. Stomata behaviour of cultivars in responses to Fulvic-Humic acids

The highest stomata length at the upper leaf surface (10.74 micron), stomata width (8.05 micron), the lengthiest stomata aperture (5.56 micron), the widest width (4.07micron), lowest stomata population (1176.9 mm^{-2}) were recorded in Difano f1 2ml.l^{-1}f-h, Calbrese 0ml.l^{-1}f-h, Difano 2mg.g-1f-h, and Organza 2ml.l^{-1}f-h, respectively (Table, 26). The highest stomata length at the lower leaf surface (10.92 micron), stomata width (8.05 micron), the lengthiest stomata aperture (6.11 micron), the widest width (3.8micron), lowest stomata population (1181.27mm^{-2}) were recorded in Calbrese 0ml.l^{-1}f-h, Calbrese 0ml.l-1f-h, Difano 2ml.l^{-1}f-h, Difano 2ml.l^{-1}f-h and Difano 0mg.g-1f-h, respectively. Stomata behaviour reflected the leaf growth at cellular levels. The best responses cultivars to fulvic-humic acids confined to Difano and Calbrese, which attributed to the positive effects of K organic matter on leaf growth performances. The enhanced microbial activity due to humic acid application would also have paved way for the increased availability of K through reducing its fixation in the soil and dissolution of fixed K. Further, the K that contained (6.25%) in the potassium humate, which was applied as a source of humic acid in the present study, would also have contributed for the increase of soil K under submerged condition. With the increasing period of incubation, the K availability increased significantly. The probable exchange between hydronium ions and exchangeable K might be a reason for the increase in K availability (Bama *et al*., 2003). Tan (1978) reported that, at pH 7.0, humic and fulvic acids were capable of dissolving small amounts of K from the minerals by chelation, complex reactions, or both. The amount released reported to increase with time and reach a maximum at 800 to 8000 hours. A steady increase in the available K from 15th to 90th day might be due to solubilizing effect caused by humic acid coupled with the release from exchangeable sites by other cations (Khan *et al*. 1997).

Table (26). Stomata behaviours responses to fulvic-humic acid and cultivar interaction (*), (**).

		Stomata dimensions of upper leaf surface					Stomata dimensions of lower leaf surface				
Fu-H/cv/stomata		stl	stw	stal	stawl	St Popul.	stl	stw	stal	stawl	St Popul.
0 Fu-H	Calbres	10.28ab	8.05a	5.56a	3.52ab	1234.97a	10.92a	8.05a	6.10a	3.61a	1187.71b
	Difano	10.55ab	7.59a	5.09a	3.52ab	1258.59a	10.09a	7.50a	5.74a	3.43a	1181.27b
	Organza	9.35b	6.85a	4.63a	2.78b	1256.44a	10.37a	7.87a	5.56a	3.70a	1232.82b
1 Fu-H	Calbres	9.63ab	6.94a	4.99a	3.06ab	1254.30a	9.96a	7.50a	5.28a	3.70a	1234.97b
	Difano	9.99ab	7.59a	4.99a	3.70ab	1247.85a	9.99a	7.96a	5.65a	3.80a	1207.04b
	Organza	9.91ab	7.13a	5.18a	3.61ab	1202a	10.46a	7.87a	5.37a	3.15a	1230.67b
2 Fu-H	Calbres	9.54ab	6.85a	4.72a	3.33ab	1280.1a	10.09a	7.41a	5.18a	3.80a	1265.03b
	Difano	10.74a	7.78a	5.56a	4.07a	1176.9a	10.74a	8.05a	6.11a	3.80a	1222.08b
	Organza	9.72ab	6.76a	4.91a	3.61ab	1329.5a	9.81a	7.22a	4.72a	2.87a	1385.31a

(*) popup = stomata population at upper leaf surface; poplo = stomata population at lower leaf surface; stlup = stomata length at upper leaf surface; stalup = stomata aperture length at upper leaf surface; stwup= stomata width at upper leaf surface; stwup= stomata width at upper leaf surface; stllo= stomata length at lower leaf surface; stallo =stomata aperture length at lower leaf surface; stwlo= stomata width at lower leaf surface; stawlo= stomata width at lower leaf surface
(**): Figures of unshared characteristics are significant at 0.05 level Duncan test.

iv. Mineral accumulations in cultivar leaves in responses to Fulvic-Humic acids

The highest Selenium contents of curd, leaf and root dry matters (Table, 27) were 4.52, 5.28و and 4.38µg.g^{-1}, they were detected in Difano 0ml.l^{-1} f-h, Organza 1ml.l^{-1}, Difano irrigated by 1ml.l^{-1}, respectively. The highest N contents of curd, leaf and root dry matters were 3.21, 3.38ز and 3.23%, they detected in Calbrese 0ml.l^{-1} f-h, Organza 0ml.l^{-1}, Difano 0ml.l^{-1}, respectively. The highest Potassium contents of curd, leaf and root dry matters were 32.77, 30.3, and 32.23 µg.g^{-1}, they detected in Difano 1ml.l^{-1} f-h, Difano 2ml.l^{-1}, Difano 0ml.l^{-1}, respectively. The highest Zinc contents of curd, leaf and root dry matters were 204.78, 222.24و and 181.33 µg.g^{-1}, they were detected in Organza 2ml.l^{-1} f-h, Organza 0ml.l^{-1}, Organza 2ml.l^{-1}, respectively. The highest Iron contents of curd, leaf and root dry matters were 605.1, 326.3, and 329.13 µg.g^{-1}, they detected in Difano 1ml.l^{-1} f-h, Organza 1ml.l^{-1}, Organza 1ml.l^{-1}, respectively. The highest Ca contents of curd, leaf and root dry matters were 4425.6, 3327.7, and 2118 µg.g^{-1}, they were detected in Organza 2ml.l^{-1} f-h, Difano 2ml.l^{-1}, Organza 0ml.l^{-1}, respectively. Application of nitrogenous fertilizers has been widely hailed as one of the most important advances in agricultural technology. The increases in both yield and protein content of feed and food crops have been reassuring to those concerned with the prospect of feeding a continually increasing human and animal population, from a more-or-less static land base. There have been problems too, however, since the increased biomass produced by nitrogenous fertilization tends to dilute, and lower the plant levels of other essential nutrients, particularly the levels of essential minerals. In the case of selenium, this situation remedied through the addition of carefully controlled levels of selenium salts to the fertilizers. New York state workers added sodium selenite to fertilizers at levels of 2.24 and 4.48 kg/ha and found that these resulted in crop selenium contents of over 0.1ppm over a four year study, which was sufficient to protect animals fed the crops from selenium deficiency. The highest levels produced in the first year of the trial were less than those considered toxic (Cary and Allaway, 1973). This practice of selenium fertilization has reached the point of commercial usage in two countries, Finland (Koivistoinen and Huttunen, 1986) and New Zealand (Watkinson, 1983), where it has proven to be both effective and safe.

Table (27). Mineral accumulations responses to fulvic-humic acid and cultivar interaction (*),

	(0) Fu-H			(1) Fu-H			(2) Fu-H		
Se/cv	Calbrese	Difano	Organza	Calbrese	Difano	Organza	Calbrese	Difano	Organza
Zn/curd	193.13ac	202.42ab	201.66ac	173.68ac	185.50ac	190.58ac	168.62bc	166.93c	204.78a
Zn/leaf	198.92a	178.77a	222.24a	188.82a	185.53a	206.69a	217.62a	183.84a	185.52a
Zn/root	154.14ab	169.73ab	137.57b	146.29ab	152.52ab	150.68ab	176.13ab	152.40ab	181.33a
Fe/curd	572.1a	452.2a	407.8a	599.4a	605.1a	335.3a	568.6a	317.1a	327.8a
Fe/leaf	261.8a	270.1a	196.6a	237.5a	246.4a	326.3a	230.1a	296.7a	202a
Fe/root	291.73a	194.58a	243.81a	150.15a	209.38a	329.13a	204.71a	222.62a	283.11a
Ca/curd	4344.3a	4311.3a	3944.6a	3485.1a	2963.2a	3951.8a	4260a	3228.3a	4425.6a
Ca/leaf	2463.9a	2993.2a	2542.2a	2809.7a	3260.4a	1786.2a	2126.9a	3327.7a	2211.7a
Ca/root	1974.7a	1978.5a	2118a	1676.9a	1965.7a	1905.7a	1958.3a	2040a	2007.7a
N/curd	3.21a	2.21a	2.91a	2.42a	2.65a	2.87a	2.40a	2.41a	2.58a
N/leaf	2.72a	3.16a	3.38a	2.97a	3.02a	2.42a	2.56a	2.67a	2.90a
N/root	2.74a	3.23a	3.15a	2.80a	2.58a	2.68a	2.79a	2.63a	2.82a
K/curd	27.63a	32.38a	32.62a	31.84a	32.77a	32.69a	29.97a	22.49a	30.90a
K/leaf	29.19a	29.27a	25.60a	28.56a	25.99a	27.24a	29.89a	30.36a	25.68a
K/root	29.27ab	32.23a	28.80ab	27.55ab	30.04ab	30.28ab	30.43ab	25.99b	29.01ab
Se/curd	2.04bc	4.52a	2.99ac	3.36ac	2.90ac	1.54c	2.64ac	3.25ac	3.67ab
Se/leaf	4.40ac	3.93ac	3.06ac	3.58ac	3.33ac	5.28a	2.74bc	2.17c	4.84ab
Se/root	4.04a	4.12a	3.60a	3.41a	4.38a	3.36a	3.87a	3.64a	3.93a

(*): Figures of unshared characters are significant at 0.05 level, Duncan test.

G. Cultivar responses to Selenium and Fulvic-Humic acids

i. Cultivar growth in response to Selenium and Fulvic-Humic acids

Calbrese broccoli cultivar irrigated 1.5 mg.l^{-1} Se and sprayed ml.l^{-1} Fulvic-Humic acids manifested the highest curd fresh weight (224.83 g). The highest fresh weight of leaves (251.1g), leaf dry weigh (52.27g), leaf number (32.33), stem fresh weight (104.27 g), stem dry weight (27.3 g), root fresh weight (52.57 g), root dry weight (22.23 g), plant height (77.9 cm) and chlorophyll percentage (83.77) were detected in Difano irrigated with 1.5 mg.l^{-1} Se and sprayed with 2ml.l^{-1}f-h, Organza irrigated with 1mg.l^{-1} Se and sprayed with 1ml.l^{-1}f-h, Calbrese irrigated with 1.5 mg.l^{-1} Se and sprayed with 0ml.l^{-1}f-h, Calbrese irrigated with 1.5 mg.l^{-1} Se and sprayed with 1ml.l^{-1}f-h, Difano irrigated with 0.5 mg.l^{-1} Se and sprayed with 1ml.l^{-1}f-h, Organza irrigated with 1 mg.l^{-1} Se and sprayed with 1 ml.l^{-1}f-h, Calbrese irrigated with 0 mg.l^{-1} Se and sprayed with 1ml.l^{-1}f-h, Calbrese irrigated with 1.5 mg.l^{-1} Se and sprayed with 1ml.l^{-1}f-h, Calbrese irrigated with 1 mg.l^{-1} Se and sprayed with 0 ml.l^{-1}f-h, Difano irrigated with 0.5 mg.l^{-1} Se and sprayed with 1ml.l^{-1}f-h and Calbrese irrigated with 0 mg.l^{-1} Se and sprayed with 1ml.l^{-1}f-h, respectively, (Table, 28). Se added at appropriate levels (0.1 mg kg-1) can also delay senescence and promote the growth of ageing seedlings in lettuce (*Lactuca sativa*) (Xue *et al*. 2001). Large additions are toxic and may induce pro-oxidative reactions. In areas where soils are low in bioavailable Se, its deficiency can occur. It is toxic at high concentrations due to incorporation of Se in place of sulphur in amino acids, with subsequent alteration of protein three-dimensional structure and impairment of enzymatic function (Amweg *et al*. 2003). Both humic substances and soil minerals are important soil components from the standpoint of interaction with organic and inorganic contaminants. Sorption of tetracyclines to humic substances and soil minerals involves diverse mechanisms that respond differently to solution chemistry. For example, cation exchange (Gu *et al*., 2007), cation bridging (MacKay and Canterbury, 2005), and hydrogen bonding (Sithole and Guy, 1987b) have been proposed for the association of tetracycline with humic substances. Consequently, the interaction of several antibiotics, including tetracycline, with humic substances significantly underestimated by considering only the hydrophobic partitioning mechanism (Tolls, 2001). Similarly, the role of cation exchange and surface complexation during the sorption of tetracyclines to clay (Porubcan *et al*., 1978; Sithole and Guy, 1987a; Figueroa *et al*., 2004) and oxide minerals (Figueroa and MacKay, 2005; Gu and Karthikeyan, 2005a) has been highlighted as well. Since the soil minerals have a strong affinity for humic substances, humic-mineral complexes are likely to form and exert a strong influence on the reactivity of antibiotics. Cegarra *et al.* (1987) who established a direct relation with humification and consequent increase in the functional groups and CEC. These findings lent support to the increase of CEC by HA application in the present study. The incubation experiment highlighted that, the response of humic acid observed up to 40 kg ha^{-1} for increasing nutrient availability in Alfisol. To confirm this result in the presence of crop a pot experiment conducted with rice crop.

Table (28). Growth responses of cultivars to Se and F-H triple interactions

Se/Fu-H/ Cvs			Lfwt	ldwt	Lno	sfwt	sdwt	rfwt	rdwt	Cfwt	cdwt	plh	Chol
Se 0 ($mg.l^{-1}$)	Fu-H (0)	Calbrese	133.57ce	27.83ad	18g	74.53ad	16.37af	31.9ah	15.83ag	185.33ad	36.67ad	58.50bg	69.3ag
		Difano	141be	24.7bd	20fg	74.73ad	16.6af	30.9ah	15.13ag	145.67af	31.77ad	55.47cg	46.93h
		Organza	135.93ce	36.83ad	24.67ag	85.97ad	19.4ae	50.8a	17.4ag	168.90ae	28.3ad	60.33bg	65.77bg
	Fu-H 1	Calbrese	162.7ae	37.13ad	23bg	95.33ac	21.17ae	46.53ad	22.23a	152.73af	38.37ac	61.83ag	83.77a
		Difano	117.63ce	35.9ad	23bg	74.8ad	18.17af	26.73bh	9.77eg	186.37ad	34.57ad	57.47bg	52.07gh
		Organza	101.7de	22.13cd	20fg	76ad	18.23af	25.8ch	10.97cg	123.4bf	20cd	47.47cg	75.07ac
	Fu-H 2	Calbrese	120.27ce	17.33d	21.67cg	63.47be	15.73bf	30.5ah	15.6ag	122.27bf	27.33ad	46.53g	59.43ch
		Difano	119.77.ce	36.63ad	23bg	97.8ac	19.93ae	19.2h	10.53dg	117.8cf	30.4ad	66.8ae	65.93bg
		Organza	121.47ce	29.2ad	24bg	93.2ac	22.2ac	23.87dh	9.3fg	130.7af	33.1ad	65.77ae	57.67dh
Se 0.5 ($mg.l^{-1}$)	Fu-H 0	Calbrese	118.83ce	30.1ad	25ag	88.87ad	19.17ae	30ah	9.37fg	180.7cf	20.67cd	70.73ac	78.1ab
		Difano	167.97ae	35.27ad	28.33ae	97.67ac	24.33ab	45.23ae	15.57ag	140.17af	28.77ad	69.07ad	61.633bh
		Organza	148.13be	36ad	28af	79.53ad	14.07bf	20.8gh	10.97cg	206.27ac	36.37ad	68.57ad	55.5eh
	Fu-H 1	Calbrese	95.4de	26.63ad	24bg	52.57de	11.7cf	46.13ad	15ag	131.57af	18.9cd	59.63bg	67.43ag
		Difano	237.83ab	47.83ac	29.33ac	70.8ae	27.3a	47.87ac	20.7ad	110.57cf	29.87ad	77.9a	61.27bh
		Organza	156.67ae	43.96ad	26.33af	64.57ae	14.03bf	33.4ah	11.23bg	67.8f	16.23d	70.93ac	71.73ae
	Fu-H 2	Calbrese	151.2be	26.83ad	25.33ag	71.1ae	14.73bf	47.13ac	12.73ag	119.7cf	21.53cd	57.53bg	74.63ad
		Difano	139.5be	36.57ad	24.33ag	93.63ac	16.07af	49.69b	15.33ag	119.83cf	28.83ad	62.7ag	57.13eh
		Organza	125.87ce	37.3ad	24.67ag	91.3ad	15.33bf	26.87bh	10.03eg	84.5ef	19.2cd	64.3af	54.07fh
Se 1 ($mg.l^{-1}$)	Fu-H 0	Calbrese	133.57ce	37.17ad	26.67af	78.37ad	21.43ad	48.67ac	21.6ab	219.67ab	45.73g	69.97ad	62.53bh
		Difano	149.77be	37.1ad	26.33bf	33.07e	9.8df	22.03fh	9.6fg	115.37cf	20.27cd	62.67ag	60.37ch
		Organza	86.3e	28.3ad	20.33eg	64ae	17.73af	22.53eh	7.83g	125.23bf	33.77ad	50.73eg	64.43bg
	Fu-H 1	Calbrese	122.77ce	38.53ad	25.33ag	73.22ad	17.70af	42.37ag	21.27ac	104.77df	20.97cd	58.77bg	68.4ag

		Difano	100.07de	36.93ad	24.67ag	103.77a	14.7bf	47.53ac	19.27af	111.27cf	22.93cd	55.17cg	54.77eh
		Organza	178.73ae	52.27a	30.33ab	98.53ab	18.73ae	52.57a	22.2a	150af	33.33ad	70.37ad	67.97ag
	Fu-H 2	Calbrese	129.10ce	40.63ad	27af	61.47b	12.87bf	39.43ah	18.57af	90.4df	28.1ad	64.93ae	64.63bg
		Difano	118.50ce	35.17ad	23bg	57.8ce	10.13cf	35.07ah	13.9ag	134.90af	22.93cd	55cg	58.87ch
		Organza	140.06be	30.67ad	25.67ag	76.50ad	12.83cf	32.03ah	13ag	99.30df	26.47ad	61.03ag	68.93ag
Se 1.5 (mg.l^{-1})	Fu-H 0	Calbrese	194ad	40.27ad	32.33a	76.77ad	12.13cf	36.57ah	17.37ag	128.67af	28.87ad	72.83ab	70.93af
		Difano	149.8be	43.87ad	29.67ac	85.4ad	14.07bf	36.17ah	15ag	104.7df	20.43cd	69.50ae	55.67eh
		Organza	174.47ae	40.8ad	28.67ad	57.83ce	7.1f	34.6ah	11.93ag	95.90df	20cd	68.37ad	71.43af
	Fu-H 1	Calbrese	218ac	43.53ad	28af	104.27a	15.23bf	50.27a	20.7ae	224.83a	42.53ab	74.60ab	68.23ag
		Difano	127.9ce	38.7ad	23.67bg	89.8ad	14.77bf	46.7ad	19.2af	101.23df	25.97ad	53.40dg	52.43gh
		Organza	142.13be	46.43ac	21dg	87.63ad	14.7bf	44.07af	17.6ag	180cf	20.50cd	62ag	60.87bh
	Fu-H 2	Calbrese	208.13ad	50.4ab	21.67cg	72.43ad	13.9bf	47.4ac	16.27ag	131.57af	20cd	59.2bg	65.87bg
		Difano	251.10a	48.43ac	22cg	63.37ad	13.23bf	47.73ac	14.1ag	149.6af	18.63cd	63.53ag	58.30ch
		Organza	132.02ce	33.73ad	20.67dg	72.60ad	15.27bf	42.43ag	18.03ag	124.47bf	17.27cd	57.8bg	63.90bh

(*):lfwt=leaf fresh weght (g); ldwt=leaf dry weight (g); lno=leaf number per plant; sfwt stem fresh weight (g); sdfwt=stem dry weight (g); rfwt=root fresh weight (g); rdwt=root dry weight (g); cfwt=curd fresh weight (g); cdwt=curd dry weight (g); plh=plant height (cm); chol= Chlorophyll percentage out of other pigments. (**): Figures of unshared characters are significant at 0.05 level, Duncan test.

ii. Hormonal homeostasis in response to Selenium and Fulvic-humic acids

The highest free (6768.7 µg.g^{-1}), bounded (6766.7 µg.g^{-1}) and total (11144.5 µg.g^{-1}) GA_3 were recorded with Difano cauliflower cultivar irrigated with 0mg.l^{-1}Se sprayed with 2mg.g^{-1}f-h, Calbrese irrigated with 1.5mg.l^{-1} Se sprayed with 1 mg.g^{-1}f-h, and Difano irrigated with 1mg.l^{-1} Se sprayed with 2mg.g^{-1}f-h, respectively. The highest free (3177.7 µg.g^{-1}), bounded (2759.1 µg.g^{-1}) and total (5015.2µg.g^{-1}) Zeatin were recorded with Organza cauliflower cultivar irrigated with 0.5 mg.l^{-1}Se sprayed with 2mg.g^{-1}f-h, Difano irrigated with 0 mg.l^{-1} Se sprayed with 2 mg.g^{-1}f-h and Organza irrigated with 0.5mg.l^{-1} Se sprayed with 1 mg.g^{-1}f-h, respectively. The highest free (3851.7 µg.g^{-1}), bounded (2019.3 µg.g^{-1}) and total (2478.7 µg.g^{-1}) ABA were recorded with Calbrese cultivar irrigated with 1 mg.l^{-1}Se sprayed with 2mg.g^{-1}f-h, Calbrese irrigated with 0 mg.l^{-1} Se sprayed with 2 mg.g^{-1}f-h and Calbrese irrigated with 0 mg.l^{-1} Se sprayed with 2 mg.g^{-1}f-h, respectively. The highest free (1923.1 µg.g^{-1}), IAA bounded (1892.7 µg.g^{-1}) and total (2208.5 µg.g^{-1}) IAA were recorded with organza cauliflower cultivar irrigated with 1mg.l^{-1}Se sprayed with 1mg.g^{-1}f-h, Difano irrigated with 1mg.l^{-1} Se sprayed with 2mg.g^{-1}f-h, and Difano irrigated with 1mg.l^{-1} Se sprayed with 2mg.g^{-1}f-h, respectively, (Table, 29). However, the positive effect of Se observed in non-stressed plants and in the early growth period. The lack of functional significance of antioxidative capacity of plants in growth response suggests that the cause of growth stimulatory effect of Se supplementation most likely lies in the other mechanisms, for example in the availability of reduced cell metabolites or changes of lignification and of auxin catabolism. Such mechanisms suggested to be involved in the tolerance to metal toxicity (Chaoui and El Ferjani 2005). Fulvic-humic acids also recruits the positive effects on Difano cauliflower cultivars through boosting growth of plants , and hence dual positive actions are combined. Humic acid, the main fraction of soil organic matter is a vital factor for maintenance of soil fertility.

The nitrogen availability was increased with increasing doses of HA (80 kg ha^{-1}) and till 60 days after incubation (DAI). The significant increase was observed at 20kg HA ha^{-1} and beyond that level, any further increase in HA exhibited a decrease in the increasing period. The decrease in the increment of available N at HA levels higher than 20kg.ha^{-1} might be due to reduced microbial activity in the presence of some high content of phenolic produced by HA in the soil (Bama *et al*., 2003). The increase in available N attributed to the N contributed from the native N by the enhanced microbial activities induced by the humic acid (Deepa, 2001). Similar increase in N availability were confirmed by the application of HA at 50 kg ha^{-1} (Govindasamy *et al.,* 1989).The released HA from the added tree leaves was very effective (Prasad *et al.,* 1991). A linear trend in P availability was observed for graded doses of HA till the end of incubation period. However, the increase was marked for 40 kg ha^{-1} and up to 60 DAI. Beyond that level, the magnitude of increase reduced. The increase in the availability of P attributed to the chemical and biochemical processes involved. The humic acids might have helped in solubilizing P from insoluble to soluble form resulting in its increase (Bama *et al*., 2003). Similar increase reported for the application of metal humate up to 50 ppm (Khan *et al*., 1997).

Table (29). Hormonal homeostasis responses of cultivars to Se and F-H triple interactions

Se//Fu-H/ Cvs			IAA-F	IAA-B	AAA-T	GA3-F	GA3-B	GA3-T	ABA-F	ABA-B	ABA-T	Z-F	Z-B	Z-T
Se/Fu-H/ Cvs			IAA-F	IAA-B	AAA-T	GA3-F	GA3-B	GA3-T	ABA-F	ABA-B	ABA-T	Z-F	Z-B	Z-T
Se 0 (mg.l^{-1})	Fu-H (0)	Calbrese	265.9b	308.7b	574.6ac	5241.3ac	2197.2bd	7438.5ad	474.6b	1031.7b	1506.3b	2469ac	1226.3ab	3695.3ac
		Difano	172.8b	173.6b	346.4bc	2505.4ad	2375bd	4880.4bf	440.6b	565.6b	1006.3b	1760.7ac	1573.9ab	3334.6ac
		Organza	176.5b	167.1b	343.6bc	1594.3bd	2349.2bd	3943.5cf	329.9b	598.7b	928.6b	2224.3ac	1998.9ab	4223.2ac
	Fu-H 1	Calbrese	315.6b	179.6b	495.2ac	4065.5ad	1492.8bd	5558.3af	1017.8b	489.8b	1507.6b	2340.2ac	968.7ab	3308.9ac
		Difano	118.9b	125.4b	244.3c	1526.5cd	1632bd	3158.5df	160.5b	426.1b	586.6b	1258.5ac	1760.7ab	3019.2ac
		Organza	148.6b	174.1b	322.7bc	3044.5ad	2305.4bd	5374.4af	499.1b	506.9b	1006b	1477.4ac	2044ab	3521.4ac
	Fu-H 2	Calbrese	157.9b	205.2b	363.2bc	4088.2ad	1936.9bd	6025.1af	459.4b	2019.3a	2478.7a	2159.9ac	1290.7ab	3450.6ac
		Difano	169.8b	157.9b	327.7bc	6768.7a	3014.8bd	9783.5ac	958.8b	449.4b	1408.2b	1535.3ac	2759.1a	4294.4ac
		Organza	153.6b	182.1b	335.7bc	2950.9ad	2221.4bd	5172.3af	465.5b	593.9b	1059.4b	1342.1ac	1432.3ab	2774.4ac
Se 0.5 (mg.l^{-1})	Fu-H 0	Calbrese	214b	146.2b	360.2bc	2798.6ad	2930.8bd	5729.4af	396.4b	570.8b	967.2b	2140.6ac	1264.9ab	3405.5ac
		Difano	139.6b	147.4b	287.0bc	3236.6ad	2692.3bd	5928.9af	315.7b	344.5b	660.2b	1767.2ac	2121.3ab	3888.5ac
		Organza	298.9b	172.1b	471.0ac	5049.6ad	2126.9bd	7176.5ae	1092b	482.1b	1574b	2456.1ac	1651.3ab	4107.4ac
	Fu-H 1	Calbrese	318.4b	297.9b	616.3ac	4963.4ad	4792.8ab	9756.2av	795.2b	1023.8b	1819b	2308ac	1883ab	4191ac
		Difano	131.3b	136.8b	268.0c	2517.7ad	2278.3bd	4796bf	449.6b	455.5b	905.1b	1889.5ac	1780ab	3669.5ac
		Organza	200.9b	126.6b	326.1bc	1634.8bd	1125.2bd	2760f	1156.3b	266.2b	1422.5b	3003.4ab	2011.8ab	5015.2a
	Fu-H 2	Calbrese	220.8b	129.8b	350.6bc	1600.8bd	1941.7bd	3542.5df	825.9b	373.5b	1199.4b	1638.4ac	1863.7ab	3502.1ac
		Difano	201.1b	140.2b	341.3bc	192.6d	225.3d	417.9f	140.5b	261.5b	402.1b	2681.4ac	1702.8ab	4384.2ac
		Organza	166.3b	139.6b	306.0bc	195.9d	194.3d	390.3f	185.2b	247.1b	432.2b	3177a	1586.9ab	4763.9ac
Se 1 (mg.l^{-1})	Fu-H 0	Calbrese	205.7b	158.3b	364.0bc	198.1d	189.4d	387.5f	182.9b	224.7b	407.6b	2327.3ac	1619ab	3946.3ac
		Difano	179.1b	332.0b	511.1ac	2218.6ad	1763.9bd	3982.6cf	472b	272b	744b	1316.4ac	1561.1ab	2877.5ac
		Organza	198.7b	155.7b	354.4bc	3018.7ad	1815.8bd	4834.5bf	608b	534.6b	1142.6b	1599.7ac	1258.5ab	2858.2ac
	Fu-H 1	Calbrese	266.9b	1819.5a	2086.3ab	4568.3ad	1520.1bd	6088.3af	936.7b	739.9b	1676.6b	1593.3ac	1470.9ab	3064.2ac
		Difano	186.1b	200.7b	386.8bc	1518.2cd	2178.5bd	3696.8cf	580.2b	388.5b	968.6b	1902.4ac	2539.8ab	4442.2ac
		Organza	1923.1a	126.2b	2049.3ac	4320.2ad	1992.5bd	6312.7af	996.3b	316.7b	1312.9b	1155.4ac	2089.1ab	3244.5ac
	Fu-H 2	Calbrese	215.4b	318.8b	534.2ac	4330.1ad	1856.1bd	6186.2af	3851.7a	194.1b	4045.8b	548.8c	736.9b	1285.7c
		Difano	315.8b	1892.7a	2208.5a	6489.4ab	4655.1ab	11144.5a	518.4b	256.8b	775.1b	1747.8ac	1477.4ab	3225.2ac

		Organza	213.6b	396.3b	609.8ac	5086.0ad	1317.4bd	6403.4af	289.9b	495.3b	785.1b	910.8bc	1979.6ab	3225.2ac
Se 1.5 (mg.l^{-1})	Fu-H 0	Calbrese	297.9b	388.9b	686.7ac	2434.9ad	4668.3ab	7103.2ae	304b	359.3b	663.4b	910.8bc	1258.5ab	2890.4bc
		Difano	413.3b	296.3b	709.6ac	4665.4ad	2225.4bd	6890.8ae	754.9b	254.5b	1009.4b	2024.7ac	1966.8ab	2169ac
		Organza	357.0b	306.8b	663.8ac	3299.8ad	4495ac	7794.8ad	491.7b	535.9b	1027.6b	1619.1ac	1747.8ab	3991.5ac
	Fu-H 1	Calbrese	451.2b	526.4b	977.6ac	3778.4ad	6766.7a	10545.1ab	389.2b	502b	891.2b	1522.5ac	704.7b	3366.9ac
		Difano	334.7b	530.5b	865.2ac	3527.8ad	1679.9bd	5207.7af	401.7b	405b	806.7b	2417.5ac	1908.8ab	2227.2ac
		Organza	471.5b	429.7b	901.3ac	2902.6ad	1622.8bd	4525.3bf	369b	441.4b	810.4b	2546.3ac	672b	4326.3ac
	Fu-H 2	Calbrese	426.1b	265.1b	691.2ac	3135.1ad	3275.1ad	6410.1af	340.8b	476.8b	817.6b	2205ac	1342.2ab	3218.3ac
		Difano	331.2b	412.0b	743.1ac	530.1cd	631.2cd	1161.3ef	302.3b	605.4b	907.7b	1941ac	1908.8ab	3547.2ac
		Organza	307.1b	518.6b	825.7ac	1986.2ad	520.3d	2506.4df	379.2b	230.2b	609.4b	1464.5ac	1045.9ab	3849.8ac

(*): Figures of unshared characteristics are significant at 0.05 level Duncan test.

iii. Stomata behaviour of cultivars in response to Selenium and Fulvic-Humic acids

The highest stomata length at the upper leaf surface (11.85 micron), stomata width (9.63 micron), the lengthiest stomata aperture (7.4 micron), the widest width (5.18 micron). The lowest stomata population (1091.1 mm^{-2}) recorded in Organza irrigated with 0mg.l^{-1} Se and sprayed with 2ml.l^{-1}f-h, Calbrese irrigated with 0mg.l^{-1} Se and sprayed with 0 ml.l^{-1}f-h, Calbrese irrigated with 0mg.l^{-1} Se and sprayed with 0 ml.l^{-1}f-h, Organza irrigated with 1.5 mg.l^{-1} Se and sprayed with 1 ml.l^{-1}f-h, Organza irrigated with 1.5 mg.l^{-1} Se and sprayed with 0 ml.l^{-1}f-h, respectively, (Table, 30). The highest stomata length at the lower leaf surface (12.22 micron), stomata width (9.26 micron), the lengthiest stomata aperture (7.78 micron), the widest width (4.81 micron). Whereas, the lowest stomata population (1065.3 mm^{-2}) were recorded in Calbrese irrigated with 0mg.l^{-1} Se and sprayed with 0 ml.l^{-1}f-h, Calbrese irrigated with 0 mg.l^{-1} Se and sprayed with 0 ml.l^{-1}f-h, Calbrese irrigated with 0mg.l^{-1} Se and sprayed with 0 ml.l^{-1}f-h, Calbrese irrigated with 0 mg.l^{-1} Se and sprayed with 0 ml.l^{-1}f-h, Organza irrigated with Organza irrigated with 0 mg.l^{-1} Se and sprayed with 1 ml.l^{-1}f-h, respectively. Cultivation of plants enriched with Se could be an effective way of producing Se-rich foodstuffs, with benefits to health (Ip and Lisk 1994; Lyons *et al*. 2005a). Environmental toxicity of Se in animals and humans is rare. In horses and cattle ingestion of plants containing over 5 but usually less than 50 mg kg-1 caused chronic poisoning. In humans there have been a number of cases reported Se poisoning as a result of accidental ingestion of selenic acid (30g l^{-1}) (Tinggi, 2003).

The beneficial effects of Se are dependent on the chemical form, selenomethionine (SeMet, H_3N^+CH (COO^-) CH2CH2SeCH3) being the most readily assimilated form (Patrick 2004). Duffield-Lillico *et al*. (2003) reported that supplementation of the human diet with selenium yeast, containing SeMet as the main chemical form, significantly reduced the occurrence of prostate cancer. However, Peters *et al*. (2007) reported that greater prediagnostic serum Se concentrations were not associated with prostate cancer risk, although greater concentrations were associated with reduced prostate cancer risk in men who reported a high intake of vitamin E, in multivitamin users, and in smokers. David *et al.* (1994) found that, humus would form protective coating over sesqui oxides and thereby reducing the fixation of any phosphate, which made them available in the soil. The increase in available P might also be due to the mineralization of soil organic P (Dusberg *et al.* 1989) as well as humic acid (Vaughan and Ord, 1985). Thangavelu and Manickam (1989) reported that, the P availability increased with application of manure due to less fixation and release of P by humic substances released during mineralization of organic matter. These results lent support to the finding of increased P availability due to HA noticed in the present study.

Table (30). Stomata behaviour responses of cultivars to Se and F-H triple interactions (*); (**)

Se/Fu-H/ Cvs			Stomata dimensions of upper leaf surface					Stomata dimensions of upper leaf surface				
			stl	stw	stal	stawl	St Popul.	stl	stw	stal	stawl	St Popul.
Se 0 (mg.l^{-1})	Fu-H (0)	Calbrese	11.48ab	9.63a	7.41a	3.70ac	1091.1b	12.22a	9.26a	7.78a	4.81a	1151.2bd
		Difano	11.48ab	9.26ab	6.30ab	3.70ac	1348.8b	9.99ab	7.41ab	5.93ac	3.33a	1168.4bd
		Organza	9.63ad	7.78ae	4.82b	2.59bc	1134b	10.37ab	7.78ab	5.56ac	2.96a	1314.4ad

	Fu-H 1	Calbrese	9.26ad	6.30ce	4.44b	2.59bc	1237.1b	9.99ab	7.41ab	4.81ac	3.70a	1254.3ad
		Difano	8.15d	6.30ce	3.70b	2.59bc	1374.6b	10.74ab	8.52ab	5.19ac	2.59a	1177bd
		Organza	9.26ad	6.67be	4.44b	2.59bc	1091.1b	11.11ab	8.15ab	6.67ac	3.70a	1237.1bd
	Fu-H 2	Calbrese	9.63ad	7.78ae	4.81b	3.33ac	1348.8b	10.37ab	7.41ab	4.81ac	3.33a	1211.3bd
		Difano	9.99ad	7.78ae	5.93ab	3.70ac	1211.3b	10.74ab	7.78ab	5.93ac	2.96a	1288.7
		Organza	11.85a	8.89ac	5.93ab	4.44ac	1254.3b	10.37ab	7.41ab	4.44bc	2.59a	1254.3ad
Se 0.5 (mg.l^{-1})	Fu-H 0	Calbrese	10.74ad	8.52ad	5.56ab	4.07ac	1254.3b	10.74ab	7.78ab	5.19ac	2.59a	1116.8cd
		Difano	11.48ab	7.41ae	4.81b	3.70ac	1108.2b	10.37ab	7.41ab	5.93ac	3.70a	1219.9bd
		Organza	8.89bd	5.93de	3.70b	2.22c	1348.8b	11.11ab	8.89ab	5.93ac	4.44a	1065.3d
	Fu-H 1	Calbrese	9.26ad	6.67be	4.81b	2.96ac	1288.7b	9.48b	7.04ab	4.81ac	2.96a	1288.7ad
		Difano	8.89bd	6.30ce	3.70b	2.59bc	1297.3b	9.26b	8.15ab	5.56ac	4.07a	1065.3d
		Organza	8.89bd	6.67be	4.81b	2.59bc	1314.4b	9.99ab	7.78ab	4.07c	2.96a	1202.7bd
	Fu-H 2	Calbrese	8.89bd	6.30ce	4.07b	2.96ac	1194.2b	9.26b	6.67ab	4.07c	2.59a	1211.3bd
		Difano	10.37ad	6.67be	4.44b	3.33ac	1134b	11.11ab	8.15ab	5.93ac	4.44a	1108.2cd
		Organza	8.15d	5.56e	4.07b	2.96ac	1348.8b	10.37ab	8.52ab	5.19ac	2.96a	1348.8ad
Se 1 (mg.l^{-1})	Fu-H 0	Calbrese	8.89bd	6.30ce	4.44b	2.96ac	1417.5	10.74ab	8.15ab	6.67ac	4.44a	1177bd
		Difano	10.74ad	7.78ae	4.81b	3.33ac	1254.3b	10.37ab	8.15ab	6.30ac	3.33a	1177bd
		Organza	9.26ad	6.30ce	4.07b	2.59bc	1245.7b	9.99ab	6.67ab	4.81ac	2.96a	1288.7ad
	Fu-H 1	Calbrese	8.89bd	6.67be	4.44b	2.96ac	1357.4b	9.63b	6.67ab	4.44bc	3.33a	1219.9bd
		Difano	11.11ac	8.89ac	6.30ab	4.81ab	1108.2b	9.63b	7.41ab	5.93ac	4.07a	1314.4ad
		Organza	10.74ad	7.04ae	5.56ab	4.07ac	1262.9b	10.37ab	7.78ab	5.19ac	2.96a	1142.6bd
	Fu-H 2	Calbrese	10.74ad	7.78ae	5.93ab	4.07ac	1211.3b	9.63b	7.04ab	5.56ac	4.44a	1262.9ad
		Difano	11.48ab	8.89ac	6.30ab	4.81ab	1211.3b	9.99ab	7.04ab	5.19ac	3.33a	1262.9ad
		Organza	9.63ad	7.04ae	5.56ab	4.44ac	1383.2b	9.63b	6.30b	4.44bc	3.33a	1408.9ab
Se 1.5 (mg.l^{-1})	Fu-H 0	Calbrese	9.99ad	7.78ae	4.81b	3.33ac	1177b	9.99ab	7.04ab	4.81ac	2.59a	1305.8ad
		Difano	8.52cd	5.93de	4.44b	3.33ac	1323b	9.63b	7.04ab	4.81ac	3.33a	1159.8bd
		Organza	9.63ad	7.41ae	5.93ab	3.70ac	4837.3a	9.99ab	8.15ab	5.93ac	4.44a	1262.9ad
	Fu-H 1	Calbrese	11.11ac	8.15ae	6.30ab	3.70ac	1134b	10.74ab	8.89ab	7.04ac	4.81a	1177bd
		Difano	11.85a	8.89ac	6.30ab	4.81ab	1211.3b	10.37ab	7.78ab	5.93ac	4.44a	1271.5ad
		Organza	10.74ad	8.15ae	5.93ab	5.18a	1142.6b	10.37ab	7.78ab	5.56ac	2.96a	1340.2ad
	Fu-H 2	Calbrese	8.89bd	5.56e	4.07b	2.96ac	1366b	11.11ab	8.52ab	6.30ac	4.81a	1374.6ac
		Difano	11.11ac	7.78ae	5.56ab	4.44ac	1151.2b	11.11ab	9.26a	7.41ab	4.44a	1228.5bd
		Organza	9.26ad	5.56e	4.07b	2.59bc	1331.6b	8.89b	6.67ab	4.81ac	2.59a	1529.2a

(**) popup = stomata population at upper leaf surface; poplo = stomata population at lower leaf surface; stlup = stomata length at upper leaf surface; stalup = stomata aperture length at upper leaf surface; stwup= stomata width at upper leaf surface; stwup= stomata width at upper leaf surface; stllo= stomata length at lower leaf surface; stallo =stomata aperture length at lower leaf surface; stwlo= stomata width at lower leaf surface; stawlo= stomata width at lower leaf surface
(**): Figures of unshared characteristics are significant at 0.05 level Duncan test

iv. Mineral accumulations in cultivar leaves in responses to Selenium and Fulvic-Humic acids

The highest Nitrogen contents of curd, leaf and root dry matters were 4.17, 4.85 and 4.31%, they were detected in Calbrese irrigated by 0 mg.l^{-1} Se sprayed with 0 ml.l^{-1} f-h, Difano irrigated by 0 mg.l^{-1} Se sprayed with 1 ml.l^{-1} f-h, Organza irrigated by 0 mg.l^{-1} Se sprayed with 0 ml.l^{-1} f-h, respectively. The highest Potassium contents of curd, leaf and root dry matters were 57.39, 36.82 and 36.82 µg.g^{-1}, they were detected in Difano irrigated by 0.5 mg.l^{-1} Se sprayed with 0 ml.l^{-1} f-h, Calbrese irrigated by 0.5 mg.l^{-1} Se sprayed with 0 ml.l^{-1} f-h, Calbrese irrigated by 1.5 mg.l^{-1} Se sprayed with 0 ml.l^{-1} f-h, respectively. The highest Zinc contents of curd, leaf and root dry matters were 248.03, 340.9 and 216.4 µg.g^{-1}, they were detected in Organza irrigated by 1 mg.l^{-1} Se sprayed with 0 ml.l^{-1} f-h, Calbrese irrigated by 0.5 mg.l^{-1} Se sprayed with 2 ml.l^{-1} f-h, Calbrese irrigated by 0.5 mg.l^{-1} Se sprayed with 2 ml.l^{-1} f-h, respectively. The highest Iron contents of curd, leaf and root dry matters were 1210, 567.6 and 662.5 µg.g^{-1}, they were detected in Calbrese irrigated by 1.5 mg.l^{-1} Se sprayed with 2 ml.l^{-1} f-h, Organza irrigated by 0 mg.l^{-1} Se sprayed with 1 ml.l^{-1} f-h, Organza irrigated by 1.5 mg.l^{-1} Se sprayed with 1 ml.l^{-1} f-h, respectively. The highest Calcium contents of curd, leaf and root dry matters were 7576, 4444 and 3909.3 µg.g^{-1}, they were detected in Calbrese irrigated by 0 mg.l^{-1} Se sprayed with 0 ml.l^{-1} f-h, Difano irrigated by 0 mg.l^{-1} Se sprayed with 0 ml.l^{-1} f-h, Calbrese irrigated by 1.5 mg.l^{-1} Se sprayed with 2 ml.l^{-1} f-h, respectively. The highest Selenium contents of curd, leaf and root dry matters (Table, 31; 32) were 6.69, 8.69 and 7.68 µg.g^{-1}, they were detected in Difano irrigated by 1 mg.l^{-1} Se sprayed with 0 ml.l^{-1} f-h, Calbrese irrigated by 1 mg.l^{-1} Se sprayed with 0ml.l^{-1} f-h, Calbrese irrigated by 0.5 mg.l^{-1} Se sprayed with 2 ml.l^{-1} f-h, respectively. The toxicity of lead (Pb) to animals reduced by the presence of other minerals, especially calcium (Ca) in the diet (Washington DC, 1980). Schrauzer *et al.,* (1981) showed that lead (5 and 25 ppm) as the acetate antagonizes selenium (1 ppm) in the organic forms in which it occurs normally in foods; low levels of lead (5 ppm) in this case produced high mortality among female mice thus exposed. The following study initiated to determine whether a high, but not lethal, level of dietary selenite was protective against Pb toxicosis in domestic sheep. These results provided evidence that this level of selenite-Se increased rather than decreased Pb toxicosis in sheep under the experimental conditions employed. Nevertheless, humic substances can capture a certain amount of available metals in sediment. In particular, metals captured by humic acids, which are not soluble in water, definitively subtracted from the environment (Hedges, 1992). Bound humic substances may influence mineral reactivity by altering the type and charge on surface functional groups as well as the available sorption sites. Meanwhile, mineral-bound humic substances can also undergo physiochemical and conformational changes (Kretzschmar *et al.,* 1997; Chorover *et al*., 1999; Li *et al*., 2003; Wang and Xing, 2005; Yoon *et al*., 2005) leading to altered surface properties. Thus, the sorption characteristics of both the minerals and humic substances modified due to the formation of humic-mineral complexes. The amount of metals strongly bound to humic acids showed the following order: Cu >> Zn >> Co> As> Z≥ Mn. The fraction of Cu, Zn and As bound to humic acid (µg g^{-1} of HA) increases in the first 10–12 cm of cores, then a decrease is observed. This observation could be related both to the presence of a mobile fraction of metals in sediments successively bound to humic acids and to different structural features showed by humic acids along the cores, due to transformation processes (Calace *et al.,* 2005).

Table (31). Mineral accumulations responses of cultivars to Se and F-H triple interactions (*)

Se/Fu-H/ Cvs			Zn C	Zn L	Zn R	Fe C	Fe L	Fe R	Ca/ C	Ca L	Ca R
Se 0 (mg.l^{-1})	Fu-H (0)	Calbrese	166.93be	200.73bc	180.47ae	1112.6ab	362.6a	342.6ab	7576a	3182ab	1715.7bi
		Difano	200.73ad	173.70bc	193.97ac	478.9ab	449.3a	354.5ab	5983ab	4444a	1480.5ci
		Organza	211.23ac	340.90a	180.47ae	455.2ab	256a	241.1ab	3922ac	3802ab	1933.7bi
	Fu-H 1	Calbrese	180.47ae	173.67bc	187.23ad	650.6ab	395.9a	188.6b	2742bc	2682ab	1587.2bi
		Difano	193.97ad	180.47bc	193.97ac	757.2ab	105.7a	277.5ab	4174ac	3884ab	2895.6ae
		Organza	207.47ad	187.23bc	180.47ae	508.5ab	567.6a	259.7ab	3922ac	3054ab	1732.1bi
	Fu-H 2	Calbrese	180.47ae	166.93bc	187.23ad	324.9ab	99.8a	353.6ab	4085ac	2481ab	1783.9bi
		Difano	146.63be	173.70bc	173.67af	295.2ab	313a	147.2b	2746bc	4038ab	1522.9ci
		Organza	193.97ad	180.47bc	187.20ad	585.5ab	277.6a	244.2b	4517ac	2135ab	1740.9bi
Se 0.5 (mg.l^{-1})	Fu-H 0	Calbrese	200.73ad	200.73bc	82g	363.7ab	283.4a	147.2b	3738ac	2703ab	2405.9ah
		Difano	221ab	153.40c	103.80ef	544.1ab	372.3a	230.1b	4221ac	2370ab	1830.7bi
		Organza	180.47ae	187.20bc	73.57g	336.7ab	93.9a	311.7ab	3037bc	2545ab	2226.3bi
	Fu-H 1	Calbrese	173.70ae	180.43bc	100.17ef	721.7ab	165a	159b	3525bc	2930ab	1664.1bi
		Difano	200.70ad	207.47bc	125.57af	413.7ab	502.4a	271.5ab	3058bc	2430ab	1292.1ei
		Organza	193.97ad	220.97bc	124.47af	230.1ab	147.2a	309.2ab	3669bc	1934ab	1159.7fi
	Fu-H 2	Calbrese	193.97ad	275.10ab	216.40a	479ab	265.6a	159b	2631bc	1865ab	1013.1gi
		Difano	187.23ad	180.47bc	121.07cf	413.7ab	265.6a	111.6b	3704bc	3191ab	1185.2fi
		Organza	214.23ac	200.70bc	173.07af	129.4ab	99.8a	69.4b	4833ac	2712ab	1946bi
Se 1 (mg.l^{-1})	Fu-H 0	Calbrese	187.23ad	186.73bc	173.67af	490.7ab	129.4a	212.3b	2216bc	1728ab	1660.1bi
		Difano	166.93be	193.97bc	187.20ad	348.5ab	93.9a	129.4b	2058c	2832ab	3080.2ac
		Organza	207.47ad	173.70bc	82g	117.6b	265.6a	347.2ab	4243ac	2524ab	2570.7ag

	Fu-H 1	Calbrese	207.47ad	214.27bc	103.80ef	546.9ab	206.4a	165b	2802bc	2926ab	766.3hi
		Difano	200.70ad	180.47bc	96.57fg	478.9ab	135.3a	99.8b	2058c	4003ab	599.6i
		Organza	200.73ad	204.33bc	103.80eg	301.2ab	407.8a	85.1b	4717ac	1173ab	1527.2ci
	Fu-H 2	Calbrese	187.23ad	207.47bc	100.17eg	259.7ab	141.3a	135.3b	5564ac	2550ab	1126.8fi
		Difano	193.97ad	193.97bc	107.40eg	129.4ab	301.2a	360.2ab	2870bc	2088ab	2540.7ag
		Organza	248.03a	187.23bc	164.30af	502.5ab	206.4a	378ab	3567bc	1173ab	1365.5di
Se 1.5 (mg.l-1)	Fu-H 0	Calbrese	217.63ab	207.47bc	180.43ae	348.5ab	271.6a	464.8ab	3847ac	2242ab	2117.2bi
		Difano	221ab	194bc	193.97ac	437.4ab	164.9a	64.3b	4983ac	2327ab	1522.8ci
		Organza	207.47ad	187.17bc	214.23a	721.7ab	170.9a	75.3b	4576ac	1297ab	1741.1bi
	Fu-H 1	Calbrese	133.10de	186.90bc	193.97ac	478.5ab	182.7a	88b	4871ac	2701ab	2689.8af
		Difano	146.63be	173.70bc	193.97ac	770.6ab	241.9a	188.7b	2562bc	2725ab	3075.5ac
		Organza	160.17be	214.23bc	193.97ac	301.2ab	182.7a	662.5a	3499bc	984b	3203.6ab
	Fu-H 2	Calbrese	112.80e	220.97bc	200.70ac	1210.8a	413.7a	170.9b	4760ac	1612ab	3909.3a
		Difano	139.9ce	187.23bc	207.47ab	429.8ab	307.1a	271.4b	3593bc	3995ab	2913ae
		Organza	162.9be	173.67bc	200.73ab	93.7b	224.2a	460.8ab	4786ac	2827ab	2978.4ad

(*): Figures of unshared characteristics are significant at 0.05 level Duncan test.

Table (32). Mineral accumulations responses of cultivars to Se and F-H triple interactions (*)

Se/Fu-H/ Cvs			Se/curd	Se/leaf	Se/root	N/curd	N/leaf	N/root	K/curd	k/leaf	K/root
Se 0 (mg.l-1)	Fu-H (0)	Calbrese	0.00	0.00	0.00	4.17a	2.74bf	3.57a	29.03bd	27.47a	24.36cd
		Difano	0.00	0.00	0.00	2.06ab	4.44ac	4.08a	24.67bd	26.22a	36.51a
		Organza	0.00	0.00	0.00	2.86ab	4.67ab	4.31a	25.60bd	26.85a	24.05cd
	Fu-H 1	Calbrese	0.00	0.00	0.00	2.60ab	3.63af	2.54a	45.24ab	33.71a	33.08ac
		Difano	0.00	0.00	0.00	2.41ab	4.85a	2.49a	30.90bd	25.60a	32.15ac
		Organza	0.00	0.00	0.00	2.04ab	1.62f	2.18a	44.62ab	23.42a	33.40ac
	Fu-H 2	Calbrese	0.00	0.00	0.00	3.15ab	2.30df	3.13a	39.63ac	31.53a	33.08ac
		Difano	0.00	0.00	0.00	3.01ab	3.29af	2.46a	15.32d	28.41a	22.80cd
		Organza	1.66ce	1.05de	1.46de	2.62ab	2.80bf	2.71a	39.01ad	23.73a	32.46ac
Se 0.5 (mg.l-1)	Fu-H 0	Calbrese	2.88ae	4.15ae	6.35ac	1.67b	3.11af	2.33a	40.88ac	36.82a	28.72ad
		Difano	5.53ac	5.47ad	4.79ad	2.81ab	2.48cf	2.47a	57.39a	34.95a	35.89ab
		Organza	5.24ac	2.87be	6.68ac	3.81ab	2.31df	2.79a	32.15bd	24.98a	31.84ad
	Fu-H 1	Calbrese	5.38ac	6.47ac	6.03ac	2.64ab	1.98ef	2.61a	40.56ac	25.92a	24.67bd
		Difano	3.62ae	5.91ad	6.30ac	2.10ab	2.73bf	2.67a	26.23bd	31.84a	29.03ad
		Organza	2.64ae	6.80ac	4.85ad	2.65ab	2.61cf	2.75a	26.85bd	33.40a	36.20a
	Fu-H 2	Calbrese	4.99ac	5.45ad	7.68a	2.52ab	3.03af	3.19a	24.05bd	30.28a	31.21ad
		Difano	5.59ac	2.06ce	4.32ae	2.55ab	2.71bf	2.55a	23.42bd	33.40a	31.53ad
		Organza	5.47ac	6.38ac	5.24ad	3.64ab	2.37df	2.45a	29.34bd	30.90a	27.79ad
Se 1 (mg.l-1)	Fu-H 0	Calbrese	3.52ae	8.69a	5.88ad	4.13a	2.87bf	2.46a	23.73bd	26.85a	27.16ad
		Difano	6.70a	4.09ae	4.14ae	1.97ab	2.90af	3.80a	19.99cd	25.92a	29.66ad
		Organza	2.79ae	4.22ae	4.88ad	2.57ab	2.88bf	3.13a	40.56ac	24.98a	35.89ab
	Fu-H 1	Calbrese	5.66ac	5.41ad	4.49ad	2.03ab	2.47cf	3.45a	22.18bd	29.97a	28.41ad
		Difano	4.52ad	2.73be	3.83ae	3.88ab	2.33df	2.63a	39.32ad	23.42a	32.15ac
		Organza	0.53de	7.27ac	4.67ad	3.01ab	2.94af	2.83a	36.82ad	24.98a	25.92ad
	Fu-H 2	Calbrese	2.86ae	2.34be	3.84ae	1.88b	2.11ef	2.47a	26.85bd	29.66a	33.08ac
		Difano	4.33ad	3.14be	5.73ad	1.84b	2.43cf	3.07a	25.92bd	24.98a	20.62d
		Organza	2.78ae	7.30ab	4.31ae	1.72b	2.14ef	3.29a	33.40bd	25.29a	27.47ad
Se 1.5 (mg.l-1)	Fu-H 0	Calbrese	1.76ce	4.76ae	3.90ae	2.88ab	2.14ef	2.61a	16.88cd	25.60a	36.82a
		Difano	5.84ab	6.15ad	7.53ab	1.98ab	2.83bf	2.58a	27.47bd	29.97a	26.85ad
		Organza	3.92ae	5.15ae	2.82ce	2.39ab	3.64af	2.39a	32.15bd	25.60a	23.42cd
	Fu-H 1	Calbrese	2.41be	2.45be	3.11be	2.43ab	3.79ae	2.61a	19.37cd	24.67a	24.05cd
		Difano	3.46ae	4.70ae	7.38ab	2.20ab	2.17ef	2.51a	34.64ad	23.11a	26.85ad
		Organza	2.97ae	7.06ac	3.93ae	3.77ab	2.50cf	2.97a	22.49bd	27.16a	25.60ad
	Fu-H 2	Calbrese	2.71ae	3.17be	3.96ae	2.07ab	2.79bf	2.36a	29.34bd	28.10a	24.36cd
		Difano	3.06ae	3.49be	4.49ad	2.23ab	2.25ef	2.43a	25.29bd	34.64a	29.03ad
		Organza	4.76ac	4.61ae	4.70ad	2.33ab	4.30ad	2.84a	21.86bd	22.80a	28.41ad

(*): Figures of unshared characteristics are significant at 0.05 level Duncan test.

Conclusions

The experiment results expressed in the following conclusion items:

The most effective rate of Selenium was 1mg.l^{-1}. However, the optimum Selenium rate for agricultural food enrichments depends upon many factors; mainly Se enriched cultivar and/or species, Selenium status of soil and sulfur levels in soils.

The applied Selenium rates substantially promoted plant growth, stomata dimensions, optimal hormonal homeostasis, and nutrient partitioning within curds, leaves, and roots.

Fulvic-humic acids was very effective in recruiting the positive effects of Selenium, particularly $1ml.l^{-1}$treatment. This treatment manifested optimal growth, stomata dimensions, optimal hormonal homeostasis, and nutrient partitioning within curds, leaves, and roots.
The highest responses to Selenium and fulvic-humic acids confined to Calbrese broccoli cultivar followed by Difano cauliflower cultivar. However, Organza f1 exhibited the lowest responses.
Curd content of selenium ranged between 0.512 to 6.96 $\mu g.g^{-1}$ this range categorized with in the safe food enriched with Selenium, which in some references went up to 22.76 $\mu g.g^{-1}$.
Drip-hydroponic system is very potent in Se enrichment program where reducing nutrient loss and soil mineral interaction avoidance are apparent.
Studies should be conducted on Dohuk calcareous soils.
Using different water qualities should be included with Selenium studies
Varying Selenium rates less than 0.5 $g.l^{-1}$ might be of significance.
Further studies on other cultivars and species are required.

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