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GROWTH AND YIELD OF THREE RADISH (*RAPHANUS SATIVUS L.*) CULTIVARS AS AFFECTED BY TONIC AND MASS PLANT GROWTH STIMULATORS

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ABSTRACT

The study was carried out through 10th November 2019 to 27th February 2020 at Grdarasha farm - College of Agricultural Engineering Sciences - Salahaddin University- Erbil. The experiment was to evaluate the influence of Mass plant (contains IBA and NAA) and Tonic (0, 0. 3, 0.6, and 0.9%) on three radish cultivars (white, red and black) growth. The interaction treatments between Mass plant and Tonic concentrations gave significant increase of growth parameters values over control of all studied cultivars, among studied cultivars, the plants of the black cultivar showed more significant increase in plant height, number of leaves, leaves fresh weight and chlorophyll content (49.00cm 17.333, 57.600gm and 58.100spad respectively). While, the best leaf length, width and area (25.667cm, 20.667cm, and 504.133cm2 respectively) were obtained in the same treatment but with white cultivar. While, the best ones for root length (27.000cm) was registered from Mass plant application and 0.9% Tonic in white cultivar, however the same treatment on black cultivar gave the best results of root diameter, fresh weight and volume (6.333cm, 60.667g and 56.667cm3 respectively) and the highest TSS% content was obtained in two treatments of black cultivar; 0 and 0.3 Tonic both under Mass plant application.

Keywords: Radish growth, Cultivars, Nitrophenolates, IBA.

INTRODUCTION

Radish (*Raphanus sativus* L.) is classified under the Brassicaceae family, spring and summer types are annuals, while the winter cultivars are biennial type which require up to 60 days to reach the harvest stage and also they may be annual (Peirce, 1987 and Abdel, 2011). It is a popular root vegetable in both tropical and temperate regions. It can be cultivated under cover for early production but large scale production in field is widely used. It is a good source of Vitamin C (ascorbic acid) and minerals like calcium, potassium and phosphorus. Radish has got refreshing and diuretic properties. In homeopathy, it is used for neurological, headache, sleeplessness and chronic diarrhea. (Politud, 2016).

In the plants hormone interactions have several mechanisms, which act at both levels of hormone response and biosynthesis in creating a delicate response network (Weiss and Ori, 2007; Hadi *et al*., 2015). The impact of gibberellins, auxin, cytokinin, and brassinosteroids were considered as essential for plant growth and development process (Deputy and Hardtke, 2011 and De Bruyne *et al*., 2014). Mass plant contains two types of auxins; 1-naphthaleneacetic acid (NAA) and indole-3-butyric acid (IBA), auxins are a class of phytohormones involved in numerous aspects of plant growth and development at the molecular and whole-plant level. Decades of research have shown that natural auxins, such as indole-3-acetic acid (IAA), phenylacetic acid (PAA) and indole-3-butyric acid (IBA) regulate cell division, cell growth, ethylene biosynthesis, root development, leaf formation, apical dominance and differentiation of vascular tissues and fruit setting (Finet and Jaillais 2012). Synthetic auxins such as 1-naphthaleneacetic acid (NAA) induce similar physiological responses as natural auxins in bioassays (Imin *et al.,* 2005). Application of IBA gave significant results as compared with control in garlic plant of all parameters (number of leaves, length of root, fresh and dry weight of root, fresh weight of plant, height of the plant, diameter and length of the bulb, length of the clove, brix, anthocyanin, yield of allicin and total yield of the bulb (Bideshk *et al*., 2013). Bose *et al.,* (2009) studied the response of micronutrients viz; zinc, iron and copper along with growth regulator NAA 30 and 50 ml.l-1 on growth and yield of onion, they revealed that growth regulator NAA 50 ml.l-1 gave the highest plant height, number of leaves, neck diameter, fresh weight of bulb, bulb diameter and yield per hectare as compared to NAA 30 ml.l-1 and control. Abdel (2011) carried out two experiments in one research the first was the influence of Fe-EDDHA on radish growth and the

second was studying the response of IBA at 0, 20, 30 or 40 mg. l -1 as foliar spray on carrot growth and yield, the results shows that highest carrot plot yield (kg.m2) was obtained from IBA rate of 40 mg. l-1. Márquez, *et al.,* (2016) studied the role of some external auxins on the architecture of maize root by applying IAA, IBA and NAA on the path of the root development; primary root elongation, lateral root formation, root elongation and root elongation ratio, they found that different types and concentrations of studied auxins were observed that NAA increased root elongation and all auxins increased only lateral root formation in certain zones of the primary root, Finally, it was demonstrates that primary root elongation was more sensitive to auxins than lateral root elongation. Ashraf *et al.,* (2018) investigated the effect of two plant growth regulators IBA and 2,4-D (2,4-Dichlorophenoxyacetic acid) as foliar spray, both in the same concentrations (2 and 4 ml.l-1) on radish plant, the results showed that IBA and 2,4-D led to significant increases in leaf length, plant height, number of leaves per plant, fresh and dry weight of roots, root diameter, total soluble solids, titratable acidity and vitamin C contents of radish roots over the control.

Tonic, Atonik or Asahi are commercial names of sodium nitrophenolates compounds used as a plant biostimulators. Biostimulators are a group of comparatively new products of various formulations that promote a plant's growth processes (Calvo *et al*., 2014). Biostimulants do not provide nutrients directly to Plants so they cannot be defined as fertilizers (Drobek, *et al.,* 2019). These products reduce the chemical input in agriculture and there has been an alteration toward inserted plant management and sustainable, environmentally-friendly systems ((Przybysz *et al*., 2014). Kocira *et al.,* (2015) found foliar application with Asahi SL as single spraying on (*Phaseolus vulgaris L*.) plants positively affected on yield represented by the number of pods and seeds and seeds weight compare with the control (not treated plants), however the highest thousand seeds weight was obtained in two treatments (0.1% Asahi SL spraying and control). Treating of soybean seeds with four biostimulators (Kelpak SL as a Eclonia maxima extract, Terra Sorb free amino acids Complex, Atonic as a phenolic compounds and titanium) during the growing season in a single or double foliar spraying compared to control (no bio stimulant applied) improve the yield quality without affecting the environment (Kocira *et al.,* 2017). It was demonstrated that demonstrated that total sugars, reducing sugars and sucrose content of three table potato cultivars (Bartek, Gawin and Honorata) were increased significantly with the growth regulator Asahi®SL application (Zarzecka and Gugała, 2018).

The purpose of this study was to evaluate the growth stimulators efficiency (IBA and Nitrophenolate compounds) on three radish cultivars growth and root yield in our region environment.

MATERIALS AND METHODS

Plant material and growth conditions

This experiment was carried out through 10th November 2019 to 27th February 2020 at Grdarasha farm - College of Agricultural Engineering Sciences - Salahaddin University- Kurdistan Region – Iraq (Latitude: 36. 11deg.N, Longitude:44.00 deg. E, Altitude: 434 meters above the sea level).

Seeds of three radish cultivars (Red, Black and White) from Turkish company (ŞARK ANAÇ TOHUMCULUK) were used in this experiment, the seeds were sown at 10/ 11/ 2019 in pots (250ml) filled with Potgrond peat moss (contain; green compost, wood fiber, pH = 5.2-6.2 EC≤48 mS/m). After one month the seedlings were transplanted to black plastic bags with diameter of 15 x 25cm and filled with 5Kg of moist sieved Sandy loam to sandy clay loam soil and re-irrigated after sowing, the soil analysis is clarified in the table (1) and the metrological data during the study periods are shown in the table (2).

Preparation of Mass Plant powder for plant treatments

Mass Plant is a talk compound contain two types of auxins 1- Naphthalene Acetic Acid and 3- Indole Butyric Acid was used after diluting it three times by powder, the bottom of radish seedlings roots inserted in it just before transplanting to the plastic bags however, the seedlings root of control treatment was treated only with powder without NAA and IBA.

Preparation of Tonic solution sprays and treatments

Tonic solution contains; 3g. l-1 sodium para-nitrophenolate (NaC6H4NO3) 2g. l-1 sodium ortho - nitrophenolate (NaC6H4NO3) and 1g. l-1 sodium 5-nitroguaiacolate (NaC7H6NO4). The treatment solution was prepared for foliar spray at four concentrations (0, 0.3, 0.6 and 0. 9%).by diluting the stock solution with distilled water.

Experimental Parameters

The data collected from all plants at the end of the growing season. The parameters were divided into two parts: Vegetative growth parameters included; plant

height (cm), leaf number/plant, leaf length (cm), leaf width (cm), leaf area(cm^2), leaf fresh weight (g) and leaf chlorophyll content by using a portable SPAD 502 meter (Minolta, Japan), which was the average of three records for each replicate, and the Root growth parameters included; root length(cm), root diameter (cm), root fresh weight (g), root volume(cm^3) and TSS% in roots measured by using an ATC-1E hand-held Refractometer (Shahmaleki *et al.,* 2014).

Treatments and Statistical analysis

The experiment was lay out as CRD (Complete Randomized Design) with three factors; three radish cultivars (Red, Black, and White) without and with mass plant (0.52% IBA and 0.51% NAA+), and four Tonic concentrations (0, 0. 3% ,0.6% and 0.9%). with three replicates. Every experimental unit consist of three bags with two plants per each one. Treatments were sprayed on the plants when they were completely established (after one month from sowing) in three dates with 15 days' intervals. when data were collected the means were compared by Duncan's Multiple Range Test at 5% probability level (Al-Rawi and Khalaf-Alla, 1980).

RESULTS AND DISCUSSION

Response of cultivars

Data in table (3) shows that radish cultivars significantly different in their vegetative growth characters, the highest values of plant height as well as fresh weight of leaves were recorded in red cultivar. However, the highest values of leaves number and chlorophyll content in the leaves were obtained from black cultivar. While, the best results of leaf length, width and area were demonstrated with white cultivars (18.187cm,13.854cm and 257.828 cm^2). Table (4) displays that the black cultivar gave the highest significant results of all studied root parameters, except root length and there were no significant differences between red and black cultivars. These differences in vegetative and root growth parameters of studied cultivars may due to the differences in their genotypes.

Effect of Mass plant

The single application of Mass plant as a growth regulator have no significant effects on all vegetative and root character of radish in this study as shown in tables (5 and 6).

Effect of Tonic

All concentrations of Tonic bio stimulator under study had significant effects on the increase in the vegetative growth and root parameters over control treatment. The highest values (41.667cm, 15.500, 19.111cm, 13.833cm, 264.047cm^2,49.883g, 51.128 SPAD,23.611cm, 5.222cm, 38.944g, 40.278cm^3 and 4.611%) respectively of plant height, number of leaves, leaf length, leaf, leaves fresh weight, chlorophyll content root length, root diameter, root fresh weight, root volume and TSS%). respectively were recorded from 0.9% Tonic as shown in table (7 and 8).

Effect of Mass plant on three radish cultivars

Table (9) represents the response of vegetative growth parameters of radish cultivars to Mass Plant application. It was appeared that mass plant application caused increasing of these parameters of all studied cultivars. The best significant results of plant height, leaf length, leaf width and leaf area (38.250 cm, 20.042acm,15.542cm and 311.643cm^2 respectively) were recorded from the white cultivar treated with Mass plant. While, the highest number of leaves and chlorophyll content were in black cultivar with Mass plant treatment (12.889, 48.511 SPAD respectively), and the heavier fresh weight was (38.667g) recorded from The red cultivar with Mass plant. Root parameters of the three radish cultivars when their roots treated with Mass plant, all highest results were obtained from black radish plants treated with Mass plant except for root length (19.417cm) in the treatment of red radish cultivar treated with Mass plant as shown in table (10).

Effect of Tonic on three radish cultivars

The application of heights concentration of Tonic on three cultivars of radish roots recorded best values regarding vegetative growth and root characteristics of studied cultivars, except TSS% in the roots that recorded best result in the control treatment. Furthermore, table (11) demonstrate the highest plant, number of leaves and chlorophyll content (43.500cm, 16.667 and 55.550 SPAD) were achieved in black cultivar, and superior significant values of leaf length, width and area (24.000cm, 19.000cm and 434.467cm^2 respectively). Moreover, the highest leaf fresh weight was recorded in red cultivar. Concerning root characters, the longest root length was in white cultivar, with regard to root diameter, fresh weight and volume best values (6.250cm, 51.667g and 52.500 cm^3 respectively) were obtained from black cultivar table (12).

Interaction effect of Mass plant and Tonic

Treating the roots with Mass plant and highest

Table (1): Some physical and chemical properties of the soil used in the study*.

Properties	Experiment Media
Electrical conductivity (EC)	0.4ds-m
pH(pH-meter)	8.4
Total Nitrogen (Kjeldahl method)	0.20%
P2 O5 (spectrophotometer)	6.3ppm
K2O (Flame- Photometer)	120ppm
Organic matter	0.2%
Boron	0.65ppm
Clay %	20
Silt %	12.5
Sand %	67.5
Soil Texture	Sandy loam to sandy clay loam

*Laboratory Collage of Agriculture / Soil and Water Department.

Table (2): The metrological data during the study periods*

Year	Month	Air temperature C°		Relative humidity%	
		maximum	minimum	maximum	minimum
2019	November	29.71	4.50	88.90	6.80
	December	21.56	4.77	96.60	15.91
2020	January	17.25	-0.68	93.60	25.20
	February	-4.38	20.73	92.80	20.87

*Agriculture research center Erbil, Ministry of agriculture of Kurdistan region.

Table (3): Response of radish cultivars on vegetative growth characters

Cultivars	Plant height (cm)	Number of Leaves/plant	Leaf length (cm)	leaf width (cm)	leaf area (cm^2)	Leaves fresh Wt.(g)	Chlorophyll con. /SPAD
white	33.417 a	10.375 b	18.187a	13.854a	257.828 a	29.346 b	41.596 c
red	33.500 a	10.417 b	14.958 b	9.792b	142.698 b	35.721a	44.392 b
black	30.542 b	12.208 a	13.000 c	8.708b	112.615c	34.921a	48.387 a

Table (4): Response of cultivars on root growth characters

cultivars	root length (cm	root diameter (cm)	Root fresh Wt.(g)	Root volume (cm^3)	TSS (%)
white	14.625 b	4.417b	15.225 c	26.250 b	4.437 b
red	18.292 a	4.417b	31.458 b	28.125 b	4.146c
black	18.417 a	5.542a	34.712 a	40.833 a	4.833 a

Table (5): Effect of Mass plant on vegetative growth characters

Mass plant	Plant height (cm)	Number of Leaves/plant	Leaf length (cm)	leaf width (cm)	leaf area (cm^2)	Leaves fresh Wt.(g)	Chlorophyll con. /SPAD
Whit out	29.028a	10.000a	14.000a	9.694a	139.439a	29.544a	41.717a
with	35.944a	12.000 a	16.764a	11.875a	202.655a	37.114a	47.867a

Table (6): Effect of Mass plant on root growth characters

Mass plant	root length (cm	root diameter (cm)	Root fresh Wt.(g	Root volume (cm^3)	TSS (%)
Whit out	15.528a	4.500a	24.031a	29.722a	4.194a
with	18.694a	5.083a	30.233a	33.750a	4.750a

Table (6): Effect of Mass plant on root growth characters

Mass plant	root length (cm	root diameter (cm)	Root fresh Wt.(g	Root volume (cm^3)	TSS (%)
Whit out	15.528a	4.500a	24.031a	29.722a	4.194a
with	18.694a	5.083a	30.233a	33.750a	4.750a

Table (7): Effect of Tonic on vegetative growth characters

Tonic (%)	Plant height (cm)	Number of Leaves/plant	Leaf length (cm)	leaf width (cm)	leaf area (cm^2)	Leaves fresh Wt.(g)	Chlorophyll con. /SPAD
0	20.000d	6.722d	10222c	7.389c	73.203d	17.139d	37.072d
0.3	31.167c	9.833c	14.556b	10.444b	145.222c	28.244c	42.528c
0.6	37.111b	11.944b	17.639a	11.472b	201.716b	38.050b	48.439b
0.9	41.667a	15.500a	19.111a	13.833a	264.047a	49.883a	51.128a

Table (8): Effect of Tonic on root growth characters.

Tonic (%)	root length (cm	root diameter (cm)	Root fresh Wt.(g	Root volume (cm^3)	TSS (%)
0	11.056d	4.333c	15.817d	22.222c	4.417ab
0.3	15.500c	4.639b	23.083c	31.667b	4.556ab
0.6	18.278b	4.972a	30.683b	32.778b	4.306b
0.9	23.611a	5.222a	38.944a	40.278a	4.611a

Table (9): Effect of Mass plant on vegetative growth characters of three radish cultivars

Cultivars	Mass plant	Plant height (cm)	Number of Leaves/plant	Leaf length (cm)	leaf width (cm)	leaf area (cm^2)	Leaves freshWt. (g)	Chlorophyll con. /SPAD
white	**With out**	28.583 b	9.333b	16.333ab	12.167 b	204.012b	24.567b	37.775c
	with	38.250a	11.417ab	20.042a	15.542a	311.643a	34.125ab	45.417ab
red	**With out**	31.250 ab	9.500ab	13.750 b	8.833c	118.751c	32.775ab	42.108bc
	with	35.750 ab	11.333ab	16.167ab	10.750 bc	166.646 bc	38.667a	46.675ab
black	**With out**	30.200 ab	11.800ab	12.933 b	8.467c	111.657c	34.373ab	48.313ab
	with	31.111ab	12.889a	13.111b	9.111c	114.211c	35.833ab	48.511a

Table (10): Effect of Mass plant on root growth characters of three radish cultivars

Cultivars	Mass plant	root length (cm)	root diameter (cm)	Root fresh Wt.(g	Root volume (cm^3)	TSS (%)
white	**Without**	12.750b	4.125c	12.500b	25.417b	4.208c
	with	16.500ab	4.708b	17.950b	27.083b	4.667b
red	**Without**	17.167ab	4.083c	29.500a	26.250b	3.958c
	With	19.417a	4.750b	33.417a	30.000b	4.333bc
black	**Without**	18.133a	5.433a	34.533a	39.667a	4.333ab
	With	18.889a	5.722a	35.011a	42.778a	5.133a

Table (11): Effect of Tonic on vegetative growth characters of three radish cultivars

Cultivars	Tonic	Plant height (cm)	Number of Leaves/ plant	Leaf length (cm)	leaf width (cm)	leaf area (cm^2)	Leaves fresh Wt.(g)	Chlorophyll con. /SPAD
white	0	20.500f	6.833fg	10.667de	8.333d	84.867ef	11.417g	34.283g
	0.3	34.333bc	8.333fg	15.667bc	13.667bc	198.480c	24.717ef	41.950cdef
	o.6	38.667abc	10.667de	22.417a	14.417b	313.498b	35.583cd	43.583cde
	0.9	40.167ab	15.667ab	24.000a	19.000a	434.467a	45.667ab	46.567bcd
red	0	22.667ef	6.500g	10.667de	8.500d	87.242 ef	18.833fg	37.500fg
	0.3	31.833cd	9.000ef	14.833 bc	9.167d	130.468cde	29.883de	41.167def
	o.6	38.167abc	12.000cd	16.333 bc	10.000d	156.117cde	42.167bc	47.633bc
	0.9	41.333ab	14.167bc	18.000b	11.500 bcd	196.967c	52.000a	51.267ab
black	0	16.833f	6.833fg	9.333e	5.333e	47.500f	21.167f	39.433efg
	0.3	27.333de	12.167cd	13.167cd	8.500d	106.717def	30.133de	44.467cde
	0.6	34.500 bc	13.167c	14.167cd	10.000d	135.533cde	36.400cd	54.100a
	0.9	43.500a	16.667a	15.333bc	11.000cd	160.708 cd	51.983a	55.550a

Table (12): Effect of Tonic on root growth characters of three radish cultivars

Cultivars	Tonic	root length (cm	root diameter (cm)	Root fresh Wt.(g	Root volume (cm^3)	TSS (%)
white	0	9.000f	4.417c	12.783f	25.000de	4.167bcd
	0.3	11.500ef	4.167c	13.117f	27.500cd	4.583abcd
	o.6	13.500e	4.333c	13.833f	25.833cde	4.167bcd
	0.9	24.500a	4.750c	21.167de	26.667cde	4.833ab
red	0	11.500ef	4.083c	17.500ef	18.333f	3.917d
	0.3	16.833d	4.333c	26.500cd	20.833ef	4.083cd
	o.6	21.333abc	4.583c	37.833b	31.667c	4.083cd
	0.9	23.500a	4.667c	44.000b	41.667b	4.500abcd
black	0	12.667e	4.500c	17.167ef	23.333def	5.167a
	0.3	18.167cd	5.417b	29.633c	46.667b	5.000a
	0.6	20.000bcd	6.000ab	40.383b	40.833b	4.667abc
	0.9	22.833ab	6.250a	51.667a	52.500a	4.500abcd

Table (13): Interaction effect of Mass plant and Tonic on vegetative growth characters

Mass plant	Tonic (%)	Plant height (cm)	Number of Leaves/plant	Leaf length (cm)	leaf width (cm)	leaf area (cm^2)	Leaves fresh Wt.(g)	Chlorophyll con. /SPAD
without	0	16.556f	5.778e	9.444d	6.111d	55.417d	14.889e	33.100 e
	0.3	27.111e	8.778d	12.889cd	9.444bc	112.207cd	24.900d	39.478d
	o.6	34.000d	10.778c	15.889bc	10.333bc	163.717bc	32.378c	45.978c
	0.9	38.444bc	14.667b	17.778ab	12.889ab	226.417a b	46.011b	48.311bc
with	0	23.444e	7.667d	11.000d	8.667cd	90.989cd	19.389e	41.044d
	0.3	35.222cd	10.889c	16.222bc	11.444abc	178.237bc	31.589c	45.578c
	0.6	40.222b	13.111b	19.389ab	12.611ab	239.716a b	43.722b	50.900ab
	0.9	44.889a	16.333a	20.444a	14.778a	301.678a	53.756a	53.944a

Table (14): Interaction effect of Mass plant and Tonic on root growth characters

Mass plant	Tonic (%)	root length (cm)	root diameter (cm)	Root fresh Wt.(g	Root volume (cm^3)	TSS (%)
without	**0**	8.889d	3.944c	14.333 d	21.667c	4.667abc
	0.3	14.667c	4.500bc	20.311cd	30.000 bc	4.833bc
	0.6	16.333c	4.556bc	27.478 bc	30.55 6bc	4.389bc
	0.9	22.222 ab	5.000ab	34.000ab	36.667ab	5.111a
with	**0**	13.222c	4.722ab	17.300cd	22.778c	4.167c
	0.3	16.333 c	4.778ab	25.856 bc	33.333b	4.278bc
	0.6	20.222 b	5.389a	33.889ab	35.000ab	4.222c
	0.9	25.000a	5.444a	43.889a	43.889a	4.111c

concentration of Tonic gave best significant results of all studied vegetative and root parameters except TSS% in the roots table (13 and 14 sequently). However, the best value of TSS% was in the treatment of 0.9(%) tonic without Mass plant application.

Interaction effect of Mass plant and Tonic on three radish cultivars

Regarding vegetative growth characters following the treatments with Mass plant and the highest concentration of Tonic, the plants of the black cultivar showed significant increase in plant height, number of leaves, leaves fresh weight and chlorophyll content (49.00cm 17.333, 57.600gm and 58.100spad respectively). While, the best leaf length, width and area (25.667cm, 20.667cm, and 504.133cm^2 respectively) were obtained in the same treatment but with white cultivar (table, 15). About root values the best ones for root length (27.000cm) was registered from Mass plant application and 0.9% Tonic in white cultivar, however the same treatment on black cultivar gave the best results of root diameter, fresh weight and volume (6.333cm, 60.667g and 56.667cm3 respectively). With that, the most TSS% content was obtained in two treatments of black cultivar; 0 and 0.3 Tonic both with Mass plant application (table 16).

It was registered that growth efficiency of radish cultivars with auxin application, and its agree with the results of Ashraf *et al.,* (2018) they illustrated that IBA demonstrated important role in the development and improvement of root width. In this study the data of interaction effects of the tested factors could be due to that auxin regulates and coordinates both wall loosening and the supply of wall materials, thus the reintroduction of auxin to excised, auxin depleted segments cause wall loosening and a subsequent burst of turgor driven elongation (Vanderhoef and Dute, 1981). These results might be explicated on the role of IBA in conducting tissue effectiveness, metabolic enzymes and the role of IBA in assimilate transductions and cell wall expansion, since IBA acting as an auxin or auxin precursor (Estelle, 1998). Moreover, Márquez *et al*., (2016) referred to that seedlings can modify the root architecture in response to environmental status via changes in auxin content. Besides of auxins role, the results of this study have clearly indicated that Tonic affects all studied growth characters of radish plant development. The growth stimulation by using Tonic solutions as foliar spray, might be attributed to the fact that phenolic compounds, which are components of Tonic produces greater concentration and/or activity of auxins because the bio stimulant is acted as a higher inhibition of IAA oxidase and increasing the synthesize of natural auxins and producing more binding sites of IAA (Libbenga and Mennes, 1987; Stutte and Clark, 1990 and Djanaguiraman *et al*., 2005a, 2005b). In the other hand it was gave a higher leaf area and improving chlorophyll a and consequently intensity of photosynthesis increased ((Blatt, 2000; Schroeder *et al*., 2001; Shinozaki and Yamaguchi-Schinozaki, 2007). This caused biomass accumulation of both fresh weight and dry matter, in spite of higher rates of transpiration and lower the resistance of stomata, relative water content (RWC) was unchanged in Tonik-treated plants be the cause of the promotion of root development and consequently an increased water uptake (Przybysz *et al*., 2014).

Table (15): Interaction effect of Mass plant and Tonic on vegetative growth characters of three radish cultivars.

Culti-vars	Mas plant	Tonic (%)	Plant height (cm)	Number of Leaves/ plant	Leaf length (cm)	leaf width (cm)	leaf area (cm^2)	Leaves fresh Wt.(g)	Chlorophyllcon./ SPAD
White	without	0	13.667h	5.667i	9.667hi	6.667fgh	60.800hig	10.333 l	29.500m
		0.3	28.000e	7.333hi	13.333efghi	12.333cd	145.033defg	21.267ijk	38.967jkl
		0.6	35.000cd	9.333gh	20.000bc	12.333cd	245.417c	25.33ghij	40.167ijkl
		0.9	37.667bc	15.000abc	22.333ab	17.333ab	364.800b	41.333cde	42.467ghij
	with	0	27.333e	8.000hi	11.667fghi	10.000def	108.933efghi	12.500 l	39.067jkl
		0.3	40.667bc	9.333gh	18.000bcde	15.000bc	251.927c	28.167fghi	44.933efghij
		0.6	42.333b	12.000defg	24.833a	16.500b	381.580b	45.833bcd	47.000cdefgh
		0.9	42.667b	16.333a	25.667a	20.667a	504.133a	50.000ab	50.667bcde
red	without	0	20.333fg	5.667i	10.333ghi	6.667fgh	65.867ghij	16.667kl	34.267lm
		0.3	28.333e	8.000hi	13.333efghi	8.333defgh	105.137efghij	26.767fghi	38.567jkl
		0.6	36.667bc	11.333efg	14.667defgh	9.333defg	129.833efghi	37.333e	46.133defghi
		0.9	39.667bc	13.000cde	16.667cdef	11.000cdef	174.167cde	50.333ab	49.467cdef
	with	0	25.000ef	7.333hi	11.000ghi	10.333def	108.617efghij	21.000ijk	40.733hijkl
		0.3	35.333cd	10.000fgh	16.333cdef	10.000def	155.800def	33.000efgh	43.767fghij
		0.6	39.667bc	12.667cdef	18.000bcde	10.667def	182.400cde	47.000bc	49.133cdef
		0.9	43.000b	15.333abc	19.333bcd	12.000cde	219.767cd	53.667ab	53.067abc
black	without	0	15.667gh	6.000i	8.333i	5.000h	39.583j	17.667jkl	35.533kl
		0.3	25.000ef	11.000efg	12.000fghi	7.667efgh	86.450fghij	26.667fghi	40.900hijk
		0.6	30.333de	11.667efg	13.000efghi	9.333defg	115.900efghij	34.467ef	51.633bcd
		0.9	38.000bc	16.000ab	14.333defg	10.333def	140.283defgh	46.367bcd	53.000abc
	with	0	18.000gh	7.667hi	10.333ghi	5.667gh	55.417ij	24.667hijk	43.333fghij
		0.3	29.667de	13.333bcde	14.333defgh	9.333defg	126.983efghi	33.600efg	48.033cdefg
		0.6	38.667bc	14.667abcd	15.333cdefg	10.667def	155.167def	38.333de	56.567ab
		0.9	49.000a	17.333a	16.333cdef	11.667cde	181.133cde	57.600a	58.100a

Table (16): Interaction effect of Mass plant and Tonic on root growth characters of three radish cultivars

Cultivars	Mass plant	Tonic (%)	root length (cm)	root diameter (cm)	Root fresh Wt.(g	Root volume (cm^3)	TSS (%)
White	without	0	6.667i	4.000ghi	10.333k	25.000efgh	4.000de
		0.3	12.000h	4.333efghi	10.667jk	26.667efgh	4.500cde
		0.6	10.333h	3.667i	11.667jk	25.000efgh	4.000de
		0.9	22.000bcd	4.500defgh	17.333hijk	25.000efgh	4.333cde
	with	0	11.333h	4.833def	15.233jk	25.000efgh	4.333cde
		0.3	11.000h	4.000ghi	15.567ijk	28.333efg	4.667bcd
		0.6	16.667f	5.000cde	16.000ijk	26.667efgh	4.333cde
		0.9	27.000a	5.000cde	25.000efgh	28.333efg	5.333ab
red	without	0	10.000h	3.833hi	17.333hijk	18.333h	3.833e
		0.3	15.667fg	4.000ghi	23.667fghi	20.000gh	4.000de
		0.6	20.000cde	4.167fghi	35.000cd	30.000def	4.000de
		0.9	23.000bc	4.333efghi	42.000bc	36.667cd	4.000de
	with	0	13.000gh	4.333efghi	17.667hijk	18.333h	4.000de
		0.3	18.000ef	4.667defg	29.333def	21.667fgh	4.167de
		0.6	22.667bc	5.000cde	40.667bc	33.333de	4.167de
		0.9	24.000ab	5.000cde	46.000b	46.667b	5.000abc
black	without	0	10.000h	4.000ghi	15.333jk	21.667fgh	4.667bcd
		0.3	16.333f	5.167bcd	26.600efg	43.333bc	4.333cde
		0.6	18.667def	5.833ab	35.767cd	36.667cd	4.667bcd
		0.9	21.667bcd	6.167a	42.667bc	48.333b	4.000de
	with	0	15.333fg	5.000cde	19.000ghij	25.000efgh	5.667a
		0.3	20.000cde	5.667abc	32.667de	50.000ab	5.667a
		0.6	21.333bcd	6.167a	45.000b	45.000b	4.667bcd
		0.9	24.000ab	6.333a	60.667a	56.667a	5.000abc

CONCLUSION

From the present study it could be concluded that:

1- The black then white cultivars were respond more significantly to Mass plant and Tonic treatments.

2- Mass plant alone did not affect significantly on the growth of radish cultivars. However, Various Tonic concentrations especially 0.9% enhanced growth properties of same cultivars.

3- Significant interactions were noticed between Mass plant and Tonic concentrations over control treatments on studied parameters of radish cultivars. Interaction of Mass plant with higher Tonic concentration gave the highest results.

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