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A study of combined antioxidant with cobalt and some plant growth regulators treatments for enhancing garlic productivity

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ABSTRACT:

Laboratory and Field trials were conducted on garlic cv. "Sids-40" during the two successive winter seasons of 2008/2009 and 2009/2010 at the Experimental Farm of Mallawy Agriculture Research Station, Agriculture Research Center, Giza, Egypt. In lab., treatments were identified and selected based on their preplanting effect. Clove seeds were soaked for 48h in aqueous solution of ascorbic acid (AA) and salicylic acid (SA) at 100 and 200ppm, gibberellic acid (GA_3), indol acetic acid (IAA), kinetin (Kin), cobalt chloride (Co) at 20ppm and their combinations. Garlic cloves were then placed in petri-dishes, moistened with distilled water when needed and, incubated under 25^0C ± 2 and 16h photoperiod. After 15 days from incubation, data were recorded for sprouting (%), plantlet height, root length and root number. In the field, the best selected promotive treatments identified in lab were used. Garlic cloves were soaked in H_2O as control treatment, another set of garlic cloves were soaked for 48h in the best selected promotive treatments identified in lab and then planted in the field. **The obtained laboratory results** revealed that the combination of AA at 100, 200ppm + Kin at 20 ppm +Co at 20 ppm; and AA at 100 ppm + GA_3 at 20 ppm +Co at 20 ppm were the best to get the highest sprouting percentage and plantlet height. AA 200 ppm, Co 20 ppm and the combination of AA 100 ppm + GA_3 20 ppm + Co 20 ppm had the best stimulatory effect on plant growth, promoting root number and root length. The lowest values were recorded with SA at 100 ppm and when combined with the other tested treatments. **Field trial,** data revealed that treating garlic cloves with AA 200 ppm and the combination of AA 100 ppm + GA_3 20 ppm + Co 20 ppm resulted in the best germination percent, plant height, cured bulb diameter, bulb dry matter percent as well as fresh and cured yield (ton/fed.). Salicylic acid at the lowest concentration (100 ppm) gave the lowest weight loss during the curing process.

Key words: *ascorbic acid, salicylic acid, growth regulators, cobalt chloride, garlic clove*

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Introduction:

Garlic (*Allium sativum* L.) is a member of the family *Alliaceae* and it is produced as an annual crop for fresh market and processed products (**Cantwell, 2000**). Because of its characteristic pungent flavour, garlic has been cultivated since antiquity as a vegetable and flavoring agent. Garlic also has many medicinal properties. Plant growth regulators (PGRs) have a particularly interesting role in modern agriculture (**Ashraf *et al.*, 2010**). There are many reports which indicate that application of growth regulators enhanced plant growth and crop yield (**Hernandez, 1997**). The PGRs are commonly used on food crops (melon, pepper, celery, garlic, onion etc) in order to improve plant productivity (**Ouzounidou *et al.*, 2011)**. **Cytokinins** enhance the cell expansion in soybean (**Makarova *et al.*, 1988**) and increase stem thickness while kinetin reduces shoot length but increases the fresh weight by increasing stem diameter in okra (**Chaudhry and Khan, 2000**). There are also some reports which indicate that kinetin in combination with GA_3 enhance germination and seedling growth in check pea (**Kaur *et al.*, 1998**). Indole-3-acetic acid (IAA) is the main auxin in plants, controlling many important physiological processes including cell enlargement and division (**Shahab *et al.*, 2009**). IAA plays a key role in the regulation of plant growth and development (**Lüthen *et al.*, 1999**).

Cobalt is an essential element for the synthesis of vitamin B12, which is required for human and animal nutrition (**Young, 1983**). **Gad, N. (2002)** showed that cobalt at 25 mg/kg soil had a positive effect of parsley plant growth, yield as well as chlorophyll content, TSS, L-Ascorbic acid. Cobalt stimulates carotenoid production in garlic leaves **(Petr *et al*, 2011)**. Cobalt (Co) is considered beneficial elements for plants and the promotive effect associated with low cobalt level had been reported by **Basu, *et al.*,** (**2006**) compared with higher ones. **Lui *et al.*, (1995)** pointed that growth of onion roots increased with increasing cobalt addition more than shoots and yield of onion bulbs decreased with increasing cobalt concentration. Application of Cobalt is required in low levels for maintaining high yield of many crops (**Gad, *et al.*, 2008**)

Ascorbic acid (AA) is one of the simplest vitamins. Today, AA has gained significant place in plant science, mainly due to its properties (antioxidant and cellular reductant etc.), and multifunctional roles in plant growth, development, and regulation of large spectrum of plant defense mechanisms against environmental stresses (**Khan *et al.*, 2011**). It is also shown to play multiple roles in plant growth, such as in cell division, cell wall expansion, and other developmental processes (**Smirnoff, 1996** and

Conklin, 2001), ameliorate the adverse effect of salt stress (**Rafique *et al*., 2011)**, has a regulatory role in promoting productivity in many plants such as pepper (**Shehata *et al*., 2002**), and potato (**Youssef, 2000**).

Salicylic acid is a phenolic plant growth regulator having a role in regeneration of physiological processes in plants (**Sakhabutinova *et al*., 2003**). The role of salicylic acid in seed germination **(Rajou *et al.* 2006)**, photosynthetic rate (**Khan *et al*., 2003**), uptake and transport of ions (**Afzal *et al*., 2005**). and plant growth and yield **(Yıldırım and Dursun, 2009)** have been described. Moreover, salicylic acid also plays a critical role in plant defense against pathogen invasion (**Spletzer and Enyedi, 1999**). During the last 20 years this substance has drawn the attention of researchers because of its ability to induce systemic acquired resistance (SAR) in plants (**Leventtuna *et al.* 2007**). In modern agriculture a great deal of research work has been reported on the uses of plant growth regulators and antioxidant in vegetable crops, which ultimately affect the yield and quality of the crop. The response of ascorbic acid and salicylic acid and their combinations with growth regulators (GA_3, kinetin and IAA) and cobalt chloride on yield and quality improvement of garlic is evaluated in this study.

Materials and Methods

Laboratory trial:

Laboratory experiments were conducted on the first week of October, 2008 and 2009 at the Lab of Mallawy Agric. Res. Station. Horticulture Res. Inst. Healthy bulbs head of garlic cv. "Sids 40" were chosen for size homogeneity, free from all defects. Similar garlic cloves were soaked for 48h in one of 49 solutions of different treatments and concentrations (Table 1), then rinsed and seeded in Petri plates (12.0cm) on filter paper moistened (4 Petri Plates/ treatment, eight garlic seed cloves/Petri Plate) and incubated in growth chamber (25 ^{0}C ± 2 and 16h photo period). Droplets from water were added in the petri plates when needed during the incubation period. After 15 days from seeding, the sprouting (%), average plantlet length, root length (cm) and number of roots/ clove were recorded.

Table 1: Treatments and concentrations of the antioxidant (ascorbic acid and salicylic acid), cobalt chloride and growth regulators (GA_3, Kinetin and IAA) and their combinations.

Code. no.	Treatments	Conc. ppm	Code. no.	Treatments	Conc. ppm
1	Salicylic acid (SA)	100	26	SA + Kin + IAA	200+20 +20
2	Salicylic acid (SA)	200	27	SA + Kin + Co	200+20 +20
3	Ascorbic acid (AA)	100	28	SA + IAA + Co	200+20 +20
4	Ascorbic acid (AA)	200	29	AA + Co	100 + 20
5	Cobalt chloride (Co)	20	30	AA + GA_3	100 + 20
6	Gibberellic acid (GA_3)	20	31	AA + Kin	100 + 20
7	Kinetin (Kin)	20	32	AA + IAA	100 + 20
8	Indole acetic acid (IAA)	20	33	AA + Co	200+ 20
9	SA + Co	100 + 20	34	AA + GA_3	200+ 20
10	SA + GA_3	100 + 20	35	AA + Kin	200+ 20
11	SA + Kin	100 + 20	36	AA + IAA	200+ 20
12	SA + IAA	100 + 20	37	AA + GA_3 + Kin	100+20 +20
13	SA + Co	200+ 20	38	AA + GA_3 + IAA	100+20 +20
14	SA + GA_3	200+ 20	39	AA + GA_3 + Co	100+20 +20
15	SA + Kin	200+ 20	40	AA + Kin + IAA	+20 100+20
16	SA + IAA	200+ 20	41	AA + Kin + Co	+20 100+20
17	SA + GA_3 + Kin	100+20 +20	42	AA + IAA + Co	+20 100+20
18	SA + GA_3 + IAA	100+20 +20	43	AA + GA_3 + Kin	200+20 +20
19	SA + GA_3 + GA_3	100+20 +20	44	AA + GA_3 + IAA	200+20 +20
20	SA + Kin + IAA	100+20 +20	45	AA + GA_3 + Co	+20 200+20
21	SA + Kin + Co	100+20 +20	46	AA + Kin + IAA	+20 200+20
22	SA + IAA + Co	100+20 +20	47	AA + Kin + Co	+20 200+20
23	SA + GA_3 + Kin	200+20 +20	48	AA + IAA + Co	+20 200+20
24	SA + GA_3 + IAA	200+20 +20	49	**Control**	Distilled water
25	SA + GA_3 + Co	200+20 +20			

Out of 49 treatments, 11 treatments which gave the best response were selected the study under field conditions along with the control treatment. These treatments were arranged as follows.

Code no.	Treatments	Conc. ppm	Code no.	Treatments	Conc. ppm
1	SA	100	7	SA + GA_3 + Co	100 +20 +20
2	AA	200	8	AA + GA_3	200+20
3	GA_3	20.0	9	AA + Co	200+20
4	Co	20.0	10	AA + GA_3 + Co	100 +20 +20
5	SA + GA_3	100+ 20	11	Control	Tap water
6	SA + Co	100 +20			

These treatments were applied by soaking healthy garlic cloves, which chosen visually from the largest bubs, for 48h in one of the above mentioned treatments, then rinsed and planted directly on October, 20, 2008 and October 25, 2009, at the Experimental Farm of Mallawy Agric. Res. Station. Horticulture Res. Inst. in three replications in randomized complete block design (RCBD). Each experimental plot consists of 3 rows, 60 cm wide and 3 m long where the cloves were spaced on one side of each row 10 cm apart. All experimental plots received the same field treatments commonly used for garlic production. Soil samples were randomly taken before planting at the depth of 30 cm. Physical and chemical characteristics were determined in both seasons and their averages were as follows: Texture grade, Clay loam; pH, 8.16, Organic matter, 1.10 %; E.C, 1.02; total N %, 0.08; total P %, 0 .7; Exch. K mg/100g, 2.31. After 30 days from planting, germination % were recorded.

At harvest time, on 20th of April 2009 and 26th of April 2010, all plants from each plot were harvested and the plant height (cm) and fresh yield (kg/plot) were recorded and calculated as ton/fed. Then, the harvested plants were cured in the field for 30 days and then weighted. The following characteristics were measured after curing process:

1-Cured yield (ton/fed.)
2-Weight loss (%)
3-Cured bulb diameter (cm)
4-Bulb dry matter (%)

Dry matter content after curing:

For each treatment, 15 cloves were cut up and mixed together, then dried at 80 ^{o}C for 24 h and the percentage of dry matter content was determined in accordance to **Vazquez-Barrios *et al.*, 2006**)

<u>Statistical analysis</u>

Data were processed using analysis of variance (ANOVA) procedure according to **Gomez and Gomez (1984)** and mean differences were performed using **Duncan** multiple range test **(Duncan,1955).**

RESULTS AND DISCUSSION:

Laboratory trial

Sprouting (%):

Different treatments of antioxidant (ascorbic acid, AA), (salicylic acid, SA), growth regulators (GA_3, IAA and Kin),

Table 3: Sprouting and seedling length of garlic as affected by cloves soaking (48h) in different concentrations of antioxidant, cobalt chloride, growth regulators and their combinations after 2 weeks from incubation.

Treatments (ppm)	Sprouting (%)	Seedling length (cm)	**Treatments (ppm)**	Sprouting (%)	Seedling length (cm)
Salicylic acid (SA) 100	37.67 U	0.43 M-Q	SA + Kin + IAA (200+20	61.00 M	1.57 GHI
Salicylic acid (SA) 200	18.07 X	0.001 S	SA + Kin + Co (200+20 +	73.50 I	2.00 EF
Ascorbic acid (AA) 100	46.43 ST	0.83 KL	SA + IAA + Co (200+20 +	48.00 R	1.30 IJ
Ascorbic acid (AA) 200	71.3 J	1.98 EF	AA + GA_3 (100+20)	20.43 W	0.30 N-S
Gibberellic acid (GA_3) 20	82.53 D	0.001 S	AA + Kin (100+20)	80.00 E	2.39 CD
Kinetin (Kin) 20	72.00 J	2.00 EF	AA + IAA (100+20)	48.23 R	1.10 JK
Indole acetic acid (IAA) 20	53.00 O	0.36 N-R	AA + Co (100+20)	47.95 R	1.13 JK
Cobalt chloride (Co) 20	83.87 C	1.40 HIJ	AA + GA_3 + Kin (100+20	47.52 R	0.73 LM
SA + GA_3 (100+20)	46.04 T	0.43 M-Q	AA + GA_3 + IAA (100+20	18.30 X	0.23 O-S
SA + Kin (100+20)	46.50 ST	0.83 KL	AA + GA_3 + Co (100+20 +	88.50 A	2.83 B
SA + IAA (100+20)	54.60 N	1.55 GHI	AA + Kin + IAA (100+20	78.04 F	2.13 DE
SA + Co (100+20)	18.67 X	0.16 P-S	AA + Kin + Co (100+20 +	88.60 A	3.46 A
SA + GA_3 + Kin (100+20 +20)	46.40 ST	0.61 LMN	AA + IAA + Co (100+20 +	37.60 U	0.40 M-R
SA + GA_3 + IAA (100+20 +20)	18.80 X	0.05 RS	AA + GA_3 (200+20)	47.67 R	0.86 KL
SA + GA_3 + Co (100+20 +20)	46.04 T	0.56 L-O	AA + Kin (200+20)	75.47 G	2.05 DEF
SA + Kin + IAA (100+20 +20)	35.33 V	0.36 N-R	AA + IAA (200+20)	68.17 K	1.95 EF
SA + Kin + Co (100+20 +20)	60.00 M	1.73 FGH	AA + Co (200+20)	65.90 L	1.80 EFG
SA + IAA + Co (100+20 +20)	18.27 X	0.60 LMN	AA + GA_3 + Kin (200+20	84.33 C	2.38 CD
SA + GA_3 (200+20)	17.95 X	0.007 S	AA + GA_3+ IAA (200+20	46.00 T	0.46 M-P
SA + Kin (200+20)	87.00 B	2.52 C	AA + GA_3 + Co (200+20.(	50.03 Q	1.33 IJ
SA + IAA (200+20)	17.53 X	0.001 S	AA + Kin + IAA (200+20	76.00 G	2.10 DE
SA + Co (200+20)	18.83 X	0.10 QRS	AA + Kin + Co (200+20 +	88.93 A	3.66 A
SA + GA_3 + Kin (200+20 +20)	47.00 RS	0.46 M-O	AA + IAA + Co (200+20 +	47.53 R	0.90 KL
SA + GA_3 + IAA (200+20 +20)	55.17 N	1.53 GHI	Control (tape water)	51.47 P	1.33 IJ
SA + GA_3 + Co (200+20 +20)	74.67 H	2.03 EF			

Mean values with similar alphabetical letter don't significantly differ from each other, using Duncan's Multiple Range test, at 0.05 probability levels

Root number:

Data root number per plantlet revealed a variation due to the application of the different treatments (Table 4 and Fig. 1). The treatments of SA100ppm and 200ppm and when combined with growth regulators and Co at 20ppm had no promotive effect on root generated per plantlet compared to the control treatment These result are in agreement with those reported by **Rajou *et al.* (2006).** The highest number of roots per plantlet was recorded for Co 20 ppm and GA_3 20 ppm (25.83 and 24.4 roots/ plantlet), respectively, with insignificant differences between them. Also, root number/plantlet was highest when combined AA at the lowest concentration (100ppm) with GA_3 20ppm + Co 20 ppm (22.0 root/plantlet) (Fig. 2). It can be concluded that cobalt and GA_3 at this concentration had a stimulating effect on the germination processes and seedling growth. **Howell and Skoog, (1975)** revealed that cobalt is a beneficial element for plant growth. In higher plants, cobalt also promoted many developmental processes including stem and coleoptile elongation opening of hypocotyl, leaf expansion and bud development. Also, **Ouzounidou *et al.* (2008)** showed that gibberellins play a major role in diverse growth processes including seed development, organ elongation, senescence and control of flowering.

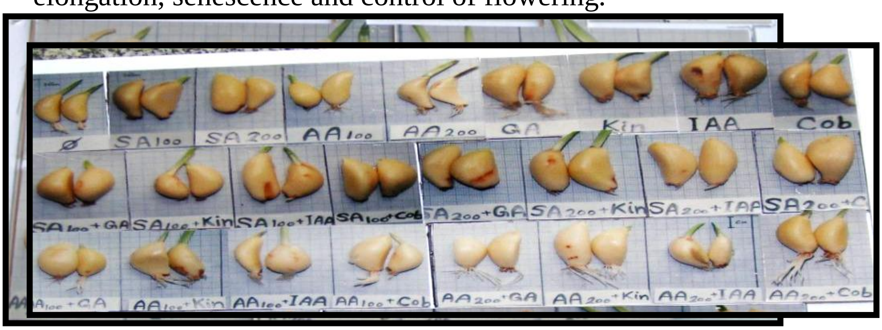

Fig. 1: Garlic sprouts and root length (cm) as affected by by cloves soaking (48h) in different concentrations of 49 treatments (AA 100ppm and 200ppm, SA 100 and 200ppm, GA_3 20.0ppm, IAA 20ppm, Kin 20 ppm, Co 20 ppm and their combinations.) after 2 weeks from the

incubation on moistened paper in petri dishes.

Fig. 2: Balance between shoot and root initiation of garlic cv. Sids-40 as affected by garlic clove seed soaking in different treatments of ascorbic acid (AA), salicylic acid (SA) growth regulators (GA_3 and Kinetin), cobalt chloride (Co) and their combinations.

Table 4: Root length and root number/garlic cloves as affected by cloves seed soaking (48h) in different concentrations of antioxidant, cobalt chloride, growth regulators and their combinations after 2 weeks of incubation

Treatments (ppm)	oot length (cm)	Root no./clove	**Treatments (ppm)**	oot length (cm)	Root no./clove
Salicylic acid (SA) 100	0.10 P-S	0.001 R	SA + Kin + IAA (200+20.0+20)	0.43 K-P	7.34 JKL
Salicylic acid (SA) 200	0.07 QRS	0.001 R	SA + Kin + Co (200+20.0+20)	0.26 N-S	5.00 N
Ascorbic acid (AA) 100	0.48 J-O	10.67 GHI	SA + IAA + Co (200+20.0+20)	0.001 S	0.001 R
Ascorbic acid (AA) 200	0.61 H-M	18.67 C	AA + GA_3 (100+20)	0.93 FGH	11.67 FG
Gibberellic acid (GA_3) 20	1.11 EFG	24.40 AB	AA + Kin (100+20)	0.76 H-K	19.67 C
Kinetin (Kin) 20	0.33 L-S	5.67 MN	AA + IAA (100+20)	0.53 I-O	8.00 JK
Indole acetic acid (IAA) 20	0.05 RS	9.66 I	AA + Co (100+20.0)	0.83 GHI	12.33 F
Cobalt chloride (Co) 20	0.78 HIJ	25.83 A	AA + GA + Kin (100+20+20)	0.004 S	0.001 R
SA + GA_3 (100+20)	0.10 P-S	6.66 LM	AA + GA + IAA (100+20+20)	0.66 H-L	.34 FGH
SA + Kin (100+20)	0.001 S	0.001 R	AA + GA + Co (100+20+20)	2.17 AB	22.00 B
SA + IAA (100+20)	0.001 S	0.001 R	AA + Kin + IAA (100+20.0+20)	0.35 L-R	2.34 PQ
SA + Co (100+20)	0.10 P-S	3.66 O	AA + Kin + Co (100+20+20)	0.23 O-S	8.33 J
SA + GA + Kin (100+20+20)	1.10 EFG	7.00 KL	AA + IAA + Co (100+20+20)	0.53 I-O	14.34 E
SA + GA + IAA (100+20+20)	1.13 EFG	3.67 O	AA + GA_3 (200+20)	1.47 CD	10.34 HI
SA + GA + Co (100+20+20)	0.76 H-K	2.66 OP	AA + Kin (200+20)	1.92 B	11.67 FG
SA + Kin + IAA (100+20+20)	0.001 S	1.33 Q	AA + IAA (200+20)	0.001 S	0.001 R
SA + Kin + Co (100+20+20)	0.40 L-Q	2.34 PQ	AA + Co (200+20)	2.30 A	19.34 C
SA + IAA + Co (100+20+20)	0.43 K-P	2.67 OP	AA + GA + Kin (200+20+20)	1.17 DEF	0.001 R
SA + GA_3 (200+20)	0.001 S	0.001 R	AA + GA + IAA (200+20+20)	1.30 CDE	0.001 R
SA + Kin (200+20)	0.26 N-S	0.001 R	AA + GA + Co (200+20+20)	1.57 C	16.67 D
SA + IAA (200+20)	0.30 M-S	0.001 R	AA + Kin + IAA (200+20+20)	1.23 DEF	7.66 JKL
SA + Co (200+20)	0.001 S	0.001 R	AA + Kin + Co (200+20+20)	0.36 L-R	5.83 MN
SA + GA + Kin (200+20+20)	0.001 S	0.001 R	AA + IAA + Co (200+20+20)	0.001 S	0.001 R
SA + GA + IAA (200+20+20)	0.001 S	0.001 R	Control (tape water)	0.60 I-N	14.33 E
SA + GA + Co (200+20+20)	0.001 S	0.001 R			

Values with similar alphabetical letter don't significantly differ from each other, using Duncan's Multiple Range test, at 0.05 levels

Root length:

Significant variation in root length (cm) was found due to the application of AA, SA, growth regulators, cobalt chloride and their combinations (Table 4 and Fig 1 and 2). The longest root was recorded with the combination of AA 200ppm + Co 20ppm and AA 100ppm + GA_3 20ppm +Co 20ppm (2.30 cm and 2.17 cm), respectively, with insignificant differences between them. These results agree with **Shaddad *et al*. (1989)** who showed that soaking seeds in AA and pyridoxine used at 50 ppm for 4 hours before planting improved root length of *Lupinus termis* and *Vicia faba* seeds under saline conditions. **Dolatabadian and Modaressanavy (2008)** reported that AA treatment improved root length of *Brasica napus* L. and *Helianthus annus* L. Thus, it seems that ascorbic acid, GA_3 and Co and their combination are promising materials for overcome garlic dormancy and root generation. The inhibitory effects on rooting caused by SA were observed when used at 100 and 200ppm and when combined with growth regulators (GA_3, Kin and IAA) and Co at 20.0ppm. Also, SA at 200ppm when combined with GA_3 + Kin, GA_3 + IAA, GA_3 + Co, and IAA + Co gave the same inhibitions in root length. However, the lowest concentration of it (100ppm) when combined with GA_3 + Kin, GA_3 + IAA and GA_3 + Co at (20 ppm+20ppm) the significantly increased root length compared to the control treatment. These results suggest a synergistic relationship between SA and GA, an antagonistic relationship was observed during barley germination that could be explained by the addition of a higher dose of SA (**Rivas-San Vicente and Plasencia, 2011**) and also relationship between SA, Kin and IAA. Also, **Gutierrez-Coronado *et al*., (1998)** reported that the effect of exogenous SA on growth depends on the plant species, developmental stage, and the SA concentrations tested.

Field trial

Germination (%):

Data illustrated in Table (5) show that germination percent was significantly affected by treatments studied. Both AA 200ppm alone, and AA 100 ppm in combinations with GA_3 (20ppm) and Co (20ppm) significantly increased the germination percent in the two seasons (89.7%, 90.60% and 89.87%, 89.77%) respectively, with insignificant differences between them. **Ahmad *et al.* (2012**) showed that the improved seedling emergence in treated maize seeds with, AA may be due to induce physiological processes like hydrolysis, imbibitions, enzymes activation and protrusion which triggered speed of germination. Cobalt also promoted many developmental processes including stem and coleoptile elongation opening of hypocotyl, leaf expansion and bud development (**Howell and Skoog, 1975**). However, SA 100ppm or its combination with Co 20.0ppm gave an inhibitory effect on germination %. These result are in harmony with that reported by (**Mateo *et al*., (2006)** and **Canakci, (2011**) who showed that SA promotes some physiological processes and inhibiting others depending on its concentration, plant species, development stages and environmental conditions Also, **Çanakci and Munzuro lu (2007)** found that soaking *Cucumis sativus* seed before planting in salicylic acetyl acid at high concentration (0.5 x 10^{-2} M) could decrease germination but lower concentration (10^{-3},10-^{4}, and 10^{-5} M) could not**.**

Plant height (cm):

The results in Table (5) reveal that both AA 200ppm and Co 20 ppm had a significant effect on plant height (cm) in the two seasons with insignificant differences between them. Also, AA 100ppm in combination with GA_3 100ppm + Co 20ppm caused the greatest increase in plant height (cm) only in the second season. The results are in agreement with those found by **Smirnoff, 1996 and Conklin, (2001).** Also, **Palit, *et al*. (1994)** showed that low concentration of Co^{2+} in medium stimulates growth from simple algae to complex higher plants**.** Data also indicate that the addition of SA 100ppm alone or in combination with GA_3 20ppm or Co 20ppm, greatly decreased plant height. According to **Mateo *et al*. (2006)** and **Canakci, (2011**), SA promotes some physiological processes and inhibiting others depending on its concentration, plant species, development stages and environmental conditions.

Table 5: Germination percent and plant height (cm) as affected by garlic cloves seed soaking (48h) in different concentrations of antioxidant, cobalt chloride, growth regulators and their combinations in the first and second season (2008/2009 and 2009/2010).

Treatments (ppm)	First season		Second season	
	Germination (%)	Plant height (cm)	Germination (%))	Plant height (cm)
SA 100	65.43 E	60.37 E	71.17 G	69.50 F
AA 200	89.70 A	71.73 A	89.87 A	76.41 A
GA_3 20	79.49 C	61.57 DE	74.57 EF	73.80 BCD
Co 20	87.13 B	70.23 A	87.17 B	75.83 AB
SA 100+ GA_3 20	77.00 D	61.03 E	74.10 F	71.70 DE
SA 100+ Co 20	79.60 C	62.00 DE	75.77 E	71.00 EF
SA100 +GA_3 20 + Co 20	80.12 C	63.38 CD	79.67 C	73.50 CD
AA 200+ GA_3 20	76.42 D	57.90 F	77.88 D	74.00 BC
AA 200 + Co 20	80.50 C	64.1 C	78.57 CD	74.00 BC
AA 100+GA_3 20+ Co 20	90.60 A	66.60 B	89.77 A	75.07 ABC
Control (tap water)	79.00 C	64.63 C	73.93 F	73.22 CD

Values with similar alphabetical letter don't significantly differ from each other, using Duncan's Multiple Range test, at 0.05 probability levels.

Fresh and cured yield (ton/fed.):

Data presented in Table 6 show that application of AA 200ppm and cobalt 20 ppm, significantly increased not only fresh yield but also cured yield (ton/fed.) with insignificant differences between them. Concerning the combination effects of AA and SA with GA_3 and/or Co, data reveal that cured yield significantly increased only in the first season with the application of SA 100ppm +GA_3 20.0ppm + Co 20.0ppm, AA 200ppm+ GA_3 20.0ppm, AA 200ppm + Co 20.0ppm and AA 100ppm + GA_3 20.0ppm + Co 20.0ppm with insignificant differences among them. These results agree with Smirnoff (1996); Asada (1999) and Conklin (2001) who stated that ascorbic acid has been shown to play multiple roles in plant growth, such as in cell division, cell wall expansion, and other developmental processes In this context, **Palit, *et al*. (1994)** showed that Cobalt, a transition element, is an essential component

Table 6: Fresh and cured yield (ton/fed.) as affected by garlic cloves seed soaking (48h) in different concentrations of antioxidant, cobalt chloride, growth regulators and their combinations in the first and second season (2008/2009 and 2009/2010).

Treatments (ppm)	First season		Second season	
	Fresh yield (ton/fed.)	Cured yield (ton/fed.)	Fresh yield (ton/fed.)	Cured yield (ton/fed.)
SA 100	9.35 D	7.03 AB	8.22 BC	5.77 B
AA 200	11.97 A	7.70 A	9.47 A	6.35 A
GA_3 20	11.00 B	7.05 AB	7.22 EF	4.93 E
Co 20	11.37 AB	7.58 A	9.25 A	6.22 A
SA 100+ GA_3 20	8.69 E	6.15 B	7.85 BCD	5.14 D
SA 100+ Co 20.0	9.18 DE	6.21 B	7.38 DEF	5.204 D
SA100 +GA_3 20 + Co 20	10.10 C	7.37 A	8.07 BC	5.44 C
AA 200+ GA_3 20	10.89 B	6.99 AB	6.96 F	4.91 E
AA 200 + Co 20	10.90 B	7.29 A	7.78 CD	5.31 CD
AA 100+GA_3 20+ Co 20	11.12 B	7.37 A	8.36 B	5.81 B
Control (tap water)	9.49 CD	6.11 B	7.72CDE	5.19 D

Values with similar alphabetical letter don't significantly differ from each other, using Duncan's Multiple Range test, at 0.05 probability levels of several enzymes and co-enzymes. It has been shown to affect growth and metabolism of plants, in different degrees, depending on the concentration and status of cobalt in rhizosphere. **A** similar effect was shown with crop yield when this element was used in the form of fertilizer and pre-sowing treatment. Also, the findings by **Yildirim and Büyükbingöl (2002)** suggest that cobalt therapy may prove effective in improving the impaired antioxidant status during the early state of diabetes, and ascorbic acid supplementation potentiates the effectiveness of cobalt action. **Petr *et al*. (2011**) showed that heavy metals affects plant growth and development, cobalt stimulated carotenoid production in garlic leaves and increased grain yield of *Vicia faba* L**.** (**Hala, Kandil, 2007).**

Cured bulb diameter (cm):

The effect of treatments on the average of cured bulb diameter are shown in Table (7). Ascorbic acid at 200ppm in the two seasons caused a significant increase in bulb diameter (5.77 cm and 5.54 cm in the first and the second season, respectively) compared to the control treatment (4.61 cm and 4.63 cm) followed by Co 20.0ppm.(5.46 cm and 5.20 cm). and its combinations with AA 100ppm+ GA_3 20.0ppm (5.30 cm and 4.98 cm). These results are in agreement with those reported by **(Smirnoff, 1996; Conklin, 2001** and **Pignocchi and Foyer, 2003).**

Bulb dry matter (%): Results in Table (7) indicate that dry matter of garlic bulbs was significantly affected by the tested treatments. The highest value for garlic bulb dry matter percent was recorded with AA 200ppm alone, Co 20.0ppm alone, in combination of AA 100ppm + Co 20.0ppm and in combination of AA 100ppm + GA_3 20ppm + Co 20ppm without significant among them. No significant were found among the tested treatments in the second season.

Table 7: Cured bulb diameter and percent bulb dry matter contents as affected by garlic cloves seed soaking (48h) in different concentrations of antioxidant, cobalt chloride, growth regulators and their combinations in the first and second season (2008/2009 and 2009/2010).

Treatments (ppm)	First season		Second season	
	Cured bulb diameter (cm)	Bulb dry matter (%	Cured bulb diameter (cm)	Bulb dry matter (%)
SA 100	5.08 C	36.78 B	4.70 C	40.70 AB
AA 200	5.77 A	38.18 A	5.54 A	41.06 A
GA_3 20	4.63 D	36.80 B	4.69 C	40.72 AB
Co 20	5.46 B	37.00 AB	5.20 B	40.61 AB
SA 100+ GA_3 20	4.63 D	36.41 B	4.67 C	39.77 BC
SA 100+ Co 20	4.63 D	37.07 AB	4.57 CD	41.37 A
SA100 +GA_3 20 + Co 20	5.00 C	36.71 B	4.66 C	39.31 C
AA 200+ GA_3 20.0	4.55 D	36.80 B	4.40 D	41.41 A
AA 200 + Co 20	5.10 C	37.63 AB	4.68 C	40.81 A
AA 100+GA_3 20+ Co 20	5.30 B	38.20 A	4.98 B	40.97 A
Control (tap water)	4.61 D	36.68 B	4.63 CD	40.59 AB

Values with similar alphabetical letter don't significantly differ from each other, using Duncan's Multiple Range test, at 0.05 probability levels

Weight loss %:

Data in Table (8) showed that the effect of the tested treatments on the percent weight loss of whole plant after curing was significant. The lowest weight loss was recorded with SA 200ppm (24.78% and 29.79 %) in the first and the second seasons respectively, and also when combined with GA_3 20ppm. This treatment can be used for garlic storage. Contrary, the highest values of weight loss after curing was recorded with AA 200 and GA_3 20.0ppm in the first season and in combination of SA 100ppm+ GA_3 20ppm in the second season.

Table 8: Weight loss (%.) of garlic bulb as affected by garlic cloves seed soaking (48h) in different concentrations of antioxidant, cobalt chloride, growth regulators and their combinations in the first and second season (2008/2009 and 2009/2010).

Treatments (ppm)	Weight loss (%)	
	First season	Second season
SA 100	24.78 E	29.79 D
AA 200	35.66 A	33.00 B
GA3 20	35.90 A	31.73 BC
Co 20	33.28 B	32.67 B
SA 100+ GA_3 20	29.22 C	34.53 A
SA 100+ Co 20	32.34 B	29.47 D
SA100 +GA_3 20 + Co 20	27.00 D	32.53 B
AA 200+ GA_3 20	35.80 A	29.49 D
AA 200 + Co 20	33.09 B	31.72 BC
AA 100+GA_3 20+ Co 20	33.67 B	30.50 CD
Control (tap water)	35.56 A	32.73 B

Values with similar alphabetical letter don't significantly differ from each other, using Duncan's Multiple Range test, at 0.05 probability levels

Conclusion:

It concluded from the obtained results that the best percent germination, plant height, cured bulb diameter, bulb dry matter percent as well as fresh and cured yield (ton/fed.) of garlic cv. Sids-40. were recorded with ascorbic acid (AA) at 200 ppm, and with the combinations of AA 100ppm + GA_3 20ppm + Co 20ppm

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دراسة معاملات مضادات الأكسدة مع الكوبلت وبعض منظمات النمو النباتية لتحسين إنتاجية الثوم

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أجريت تجارب معملية وحقلية على صنف الثوم سدس 40 أثناء الموسمين الشتويين 2009/2008 – 2010/2009 بالمزرعة التجريبية بمحطة البحوث الزراعية – ملوي- مركز البحوث الزراعية – الجيزة – مصر

كان الهدف من هذه الدراسة تحت الظروف المعملية هو تحديد تأثير معاملات نقع الفصوص ما قبل الزراعة لمدة 48 ساعة في محاليل بعض مضادات الأكسدة (حمض الاسكوربيك - حمض السالسليك بتركيز100و200 جزء في المليون) وبعض منظمات النمو النباتية (أندول حمض الخليك – حمض الجبريليك - الكينيتين بتركيز 20 جزء في المليون) و كلوريد الكوبلت بتركيز 20جزء في المليون وكذالك التفاعل بينهم بالإضافة إلى معاملة الكنترول (نقع في ماء مقطر) على انبات الفصوص لاختيار الافضل فى الانبات حيث بعد.النقع فى الفترة المحددة تم نقل تلك الفصوص إلى أطباق بتري على ورقة ترشيح مشبع بالماء المقطر وتم تحضين تلك الأطباق على درجة حرارة 25^{5}م±2 وفترة أضاءه 16 ساعة / 8ساعات إظلام وبعد 15 يوم من النحضين تم قياس النسبة المئوية للإنبات وطول النمو الخضري المتكون للنبات – عدد الجذور المتكونة للفصوص – طول الجذور

كان أفضل المعاملات الناتجة من التجارب المعملية هي التي تم الاعتماد عليها في استكمال الدراسة الحقلية حيث أخذت فصوص من نفس الصنف وتم نتعها في الماء كمعاملة الكنترول والباقي من الفصوص تم نقعه لمدة 48 ساعة في المعاملات التي أعطت أفضل النتائج فى الدراسات المعملية ثم الزراعة بالحقل مباشرة .

وقد أوضحت النتائج المتحصل عليها من التجارب المعملية أن اعلى نسبة انبات وارتفاع للنبت قد تحقق مع المعاملة المختلطة (حمض الاسكوربيك 100 و200جزء فى المليون +الكينتين 20جزء +كلوريد كوبلت 20جزء) و(حمض الاسكوربيك 100 جزء فى المليون + حمض الجبريلك 20 جزء في المليون + كلوريد كوبلت 20 جزء في المليون) بينما حمض الاسكوربيك بتركيز 200 جزء فى المليون وكلوريد الكوبلت بتركيز 20 جزء فى المليون وكذلك مخلوط حمض الاسكوربيك بتركيز 100 جزء فى المليون+ حمض الجبريليك بتركيز 20 جزء فى المليون + كلوريد الكوبلت بتركيز 20 جزء فى المليون أدى إلى زيادة تشجيع نموالجذور (عدد الجذور –طول الجذر/فص) واقل القيم قد سجلت مع حمض السالسليك وكذالك عند خلطه مع المركبات الأخرى

تحت ظروف الحقل – أوضحت النتائج أن اعلى نسبة الإنبات – ارتفاع النبات- قطر البصلة المعالجة- المادة الجافة للأبصال – بالإضافة إلى المحصول الأخضر والمعالج (طن/فدان) قد تحقق مع المعاملة ب حمض الاسكوربيك بتركيز 200و كلوريد الكوبلت بتركيز 20جزء وكذالك مخلوط حمض الاسكوربيك 100 جزء في المليون + حمض الجبريلك 20 جزء في المليون + كلوريد الكوبلت 20 جزء في المليون.

Naesar.et al 2012

الخلاصة:

من النتائج المتحصل عليها يمكن التوصية باستخدام معاملات نقع فصوص الثوم قبل الزراعة لمدة 48 ساعة في حمض الاسكوربيك بتركيز 200 جزء في المليون وكذلك مخلوط حمض الاسكوربيك 100 جزء في المليون+ حمض الجبريلك 20 جزء في المليون + كلوريد الكوبلت 20 جزء في المليون هام لتحسين الإنبات وكذلك جودة وإنتاجية المحصول.