Effect of Seed Priming and Foliar Application with some Plant Stimulants on Growth, Yield and Quality of Carrot.

Sally, M.S Shaban
Vegetable Res. Dept., Hort. Res. Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

This experiment comprises a Laboratory and field trials at Horticulture Research station, Mansoura and Shabrawish Village, Aga, Dakahila Governorate, Egypt during the winter seasons of 2020/21 and 2021/22 on carrot to investigate the effect of seed priming and foliar application with some stimulants on growth, yield and quality of carrot. In the experiment dry seed (control), distilled water, salicylic acid (SA) at a rate of 50 ppm, ascorbic acid (AsA)100 ppm, chitosan (Chit.) 0.5 %, Zinc sulphate ($ZnSO_4 . 7H_2O$) 2% and hydrogen peroxide (H_2O_2) 1% were tested as seed priming for 24 (hr.). In addition, the same stimulants were tested as foliar application in the same concentration in priming whereas (Chit.) was applied at 200 ppm, $ZnSO_4$ at 200 ppm and (H_2O_2) at 100 ppm spraying was done thrice at 35, 50 and 65 days after sowing date. In the Laboratory trail all priming treatments significantly increased seed germination parameters of carrot $ZnSO_4$ being the most effective treatment for (germination %, weight of 100 seedling, seedling length and seedling vigor index) while the least seed germination time was recorded in response to (chit.). Results of the field trial indicated that vegetative growth parameters, yield and its component root quality, NPK content in leaves, chlorophyll a, b and total chlorophylls were significantly increased due to seed priming in $ZnSO_4$ in both seasons. The highest NPK in roots were obtained due to foliar spraying with (H_2O_2) however, the highest value of Zn in root was recorded in response to foliar spraying $ZnSO_4$.

Keyword: Carrot; salicylic acid; ascorbic acid; chitosan; zinc sulphate

INTRODUCTION

Carrot (*Daucus carota* L.) belongs to the family Apiaceae, carrot is a cool season crops that is utilized for the edible top root. As an economically important vegetable root crop, its remarkable nutritional and rich source of carotenoids, vitamin and mineral nutrition (Rubatzky et al., 1999 and Que et al., 2019). Carrot seeds is slow to germinate depending on soil and weather conditions, delayed and erratic emergence is a major problem with fertilizer utilization, post emergence weed control and uniform harvesting of crops and impact final yield and quality especially for vegetable crops established by direct seeding such as carrot (Mereddy et al., 2000; Mozumber and Hossain 2013). Application of growth stimulators has become necessary today, for the aim of stability of agricultural crops yield. The quality of seed can be improved though priming in addition to the field management techniques for better seed germination. Priming is a physiological technique of seed hydration and drying to improve the pre-germinated metabolic processes to increase germination, seedling growth and final yield under normal as well as adverse conditions (Wagas et al., 2019). Seed priming tends to advance some metabolic processes related to germination and avoid radicle extension by controlling the hydration state of seeds (Zhao et al., 2018; Srivastava et al., 2021). Seeds priming is considered as an effective technique that can be applied for enhancement of growth and yield of crops. It was reported that variety of chemicals, antioxidants and plant hormones are used as priming agent to ensure maximum germination and crop establishment (Lee et al., 2002). Advantageous effects from priming have been reported for several vegetable seeds such as carrot (Aazami and Zahedi 2018). Salicylic acid (SA) mediates regulation of different aspects of plant life such as growth, photosynthesis and chloroplast structure (Sakhabutdinova et al., 2003). Priming the seeds in growth regulators such as salicylic acid (SA), ascorbic acid (AsA) and in water (hydro-priming) has been reported as a simple and safe technique for increasing the capacity of seeds to osmatic adjustment and enhancing seed germination (AfghaniAsI, and Taheri 2012; Ghasemi-Lemrasky and Hosseini 2012). Pre-sowing application of salicylic acid significantly affected vitamin C, TSS, TA of tomato fruit, SA ameliorated the yield contributing aspects which increased the fruit yield of tomato (Sing and Sing 2016). Foliar application of SA improved carrot growth, productivity and quality of roots (EL-Tohamy et al., 2020). Chitosan is a natural biopolymer derived chitin, a polysaccharide found in exoskeleton of crustaceans, insects as well as cell wall of fungi and some alga (Boonlertnirum et al., 2010). Chitosan seed priming improved germination, growth, and the yield of faba bean (Rabani and Cheatsazen 2021). Foliar application of chitosan alone or in combination with soil application has significant effect on growth, yield and biochemical characters of tomato (*Lycopersion esculentum* L.) fruits (Parvin et al., 2019). Zinc is one of most important essential nutrients required for plant growth, higher emergence percentage, rate of emergence, vigor index of carrot was recorded in treated seeds priming with zinc at rate of (1.5%) solution (Munawar et al. 2013). Foliar application of zinc sulfate at a rate 200 ppm significantly influenced the quality characters of tomato fruits measured in terms of total soluble solids, ascorbic acid, total sugars and moisture content in fruits (Nagar et al., 2021). Hydrogen Peroxide (H_2O_2) is the most stable form of ROS and is capable of rapid diffusion across cell membranes (Upadhyaya et al., 2007). Narimanov (2000) indicated that soaking seeds of melon, radish and carrot for short period of in 6 ١٠ ×$^{-2}$ to 6 ×10^{-5} M H_2O_2 solution increased germination, enhanced at the early appearance of sprouts and promoted the development of plants.

Therefore, the aim of this study was to investigate the effect of seed priming and foliar application of some plant stimulants on growth, yield and quality of carrot.

MATERIALS AND METHODS

This study was conducted during the winter season of 2020/21 and 2021/22 in the Laboratory of the Horticulture Research station in Mansoura and in the field at Shabrawish Village, Aga, Dakahila Governorate, Egypt to study the effect of some treatments i.e., seed priming and foliar applications by some stimulants on growth productivity and quality of carrot (Fire Wedge F1 Hybrid) the source of the hybrid F1 carrot seeds was accompany Takii & Co., Ltd. Kyoto, Japan. The experiment comprised 13 treatments follows:

The treatments were applied separately as seeds priming and foliar application.

a) Seed priming treatments:

1- Dry seed (control).
2- Seed soaking in distilled water.
3- Seed priming in 50 ppm salicylic acid (SA).
4- Seed priming in 100 ppm Ascorbic acid (AsA).
5- Seed priming in 200 ppm chitosan (Chit.).
6- Seed priming in 2 % Zinc sulphate ($ZnSO_4$).
7- Seed priming in 1% hydrogen peroxide (H_2O_2),

b) Foliar application treatments:

8- Distilled water.
9- Salicylic acid (SA) at the rate of 50 ppm.
10- Ascorbic acid (AsA) at the rate of 100 ppm.
11- Chitosan (chit.) at the rate of 200 ppm.
12- Zinc sulphate ($ZnSO_4$) at the rate of 200 ppm.
13- Hydrogen peroxide (H_2O_2) at the rate of 100 ppm.

The treatments were applied separately as seeds priming and foliar application. That is, the seed that have been soaked will not be sprayed, but those that have not been soaked will only be sprayed. Salicylic acid, ascorbic acid, chitosan, Heptahydrate Zinc sulphate ($ZnO_4.\ 7H_2O$ 20 % Zn) and Hydrogen peroxide ($H_2O_2$10 %) were obtained from El-Gomhoria Chemicals Company Cairo, Egypt.

Laboratory experiment

Seeds were soaked in solution of distilled water and some plant stimulants for 24 hr. with seeds solution ratio of 1-5 w/v. The seeds were dried at 25℃ for 24 hr. in the Laboratory for close to original moisture content (88.2%).

Germination test was performed to determine the best seeds priming treatment that could be evaluate under field conditions one hundred seeds were planted in petri dishes (9 cm diameter) compassed of double layers of what man No.1 filter paper, which were moistened with 4 ml distilled water up to 14 days. Each treatment was replicated three times in a Completely Randomized Design (CRD), each replicate consisted of two petri dishes were placed at 25℃ those seeds were considered as germinated which showed radicle production up to 2 mm.

Data were recorded daily for assessing quality germination parameters. Germination percentage was calculated as the cumulative emerged seeds with normal radicles and plumule. After complete emergence, ten normal seedlings per replication were used to calculate seedling growth parameters. Germination quality parameters were determined as follows:

Germination percentage was calculated according to the equation of Anonymous (1990).

Germination (%) = total number germinated seeds/total number of seeds x 100

Mean germination time (MGT) was calculated according to the equation of (O'Domovan et al., 2005) as follow:

$$MGT = \frac{\sum (n_1T_1 + n_2T_2 + \ldots\ldots + n_kT_k)}{\sum (n_1 + n_2T_2 + \ldots\ldots + n_k)}$$

Where n = number of newly germinated seeds and T = time from the beginning of the experiment.

One hundred seedlings were measured from each treatment to get mean seedling root and shoot length and seedling fresh weight

Seedling vigor index (SVI) was estimated according to the equation of Paparella et al. (2015).

SVI = [seedling length] × [final germination]

Field experiment: Two field experiments were carried out during the successive winter seasons of 2020/21 and 2021/22 at Shabrawish Village, Aga, Dakahila Governorate, Egypt. Some physical and chemical properties of the experimental soil at the depth of (0-30 cm) soil are shown in Table (1).

Table (1): Physical and chemical properties of the experimental soil used.

Property / Year	Sand (%)	Silt (%)	Clay (%)	Texture	O.M.%	$CaCO_{3\%}$	pH	Available nutrients (ppm) N	P	K	Fe	Zn	Mn
2020/2021	23.05	17.43	59.52	Clayey	1.45	1.74	7.9	72.10	14.60	68.40	3.0	1.5	1.4
2021/2022	23.07	17.30	59.63	Clayey	1.79	1.76	8.1	76. 15	16.0	78.15	3.6	1.6	1.7

The experiment was laid out in a randomized complete block design with three replications. The carrot primed and unprimed seeds were sown on 2th and 9th October during 2020 and 2021 seasons respectively. The seeds were cultivated in upper bed about 1 cm depth, 4-5 cm between plants within rows with rows 20 cm apart. Each plot area was comprised three beds 5 m length, 1.2 m width plot area 18 m^2 .The unprimed seeds were foliar application three times at 35, 50 and 65 days after sowing date, in addition to the control treatment (untreated dry seeds).

For fertilization, calcium super phosphate (12.5% P_2O_5) was applied once during soil preparation at a rate of 40 kg P_2O_5/fed., ammonium nitrate (33.5% N) as a source of nitrogen at a rate of 60 kg N/fed., added as three equal portions at the 5, 7 and 9 week from seeds sowing date while, potassium sulphate (48% K_2O/fed.), at a rate of 48 Kg K_2O/fed. was divided in two equal portions was added twice, first half portion during soil preparation and the second half with third dose of nitrogen fertilizer. All other agricultural practices were followed according to Ministry of Agriculture's Recommendations.

Data recorded:

- Vegetative growth parameters

Ten plants were taken randomly from each plot at 75 days after sowing date in both seasons to determine: plant height (cm), number of leaves/plant, fresh weight (g)/ plant and dry weight (g)/plant.

- Yield and its components:

At harvest time (120) days after sowing the following date was recorded: root length (cm), root diameter (cm), root fresh weight/plant (g), total root fresh weight (t/fed.), and root dry matter/plant (g) were determined for estimation of root dry mater, roots were dried at 70 ℃ until constant weight.

- Root quality:

At harvest time, total soluble solids (TSS) in the root extract were determined by hand refractometer, Ascorbic acid content in fresh roots was estimated as mg/100 g F.W. by titration with 2, 6 dichlorophenol indophenol blue dye according to (Jacobs, 1970).

Chemical contents:

The NPK content in the leaves were determined in the 5th leaf from the plant top at 75 days from sowing date in addition NPK, as well as Zn content in root were estimated at harvesting time. Total nitrogen, phosphorus and potassium were determined according to the methods described by Bremner and Mulvaney (1982). Whereas Zn content was determined by using atomic absorption spectrometry (ASS) according to Chapman and Pratt (1971). The chlorophyll content a, b and total chlorophyll (a + b) in the fresh recently expanded leaves were determined calorimetrically as described in A.O.A.C. (1990).

Statistical and analysis Data were statistically analyzed and means were compared using Duncan's multiple range tested as described by Snedecor and Cochran (1989).

RESULTS AND DISCUSSIONS

Laboratory experiment: (Germination parameters):

Data in Table (2) showed that priming treatment of carrot seeds significantly affected the germination parameters; resulting in greater germination percentage, mean germination time, weight of hundred seedling, seedling length, and seedling vigor index in both seasons. The highest values of germination percentage were recorded for carrot seed priming with $ZnSO_4$ at a rate of 2 %followed by chitosan 0.5 % for 24 hr. (93.67, 90.67-91.67- 88.00) compared with unprimed treatment (82.67-81.00) in the two growing seasons, respectively notably, the lowest mean germination time were recorded with chitosan at a rate of 0.5 % and $ZnSO_4$ at 2 % for 24 hr. (5.40, 5.40 and 6.30-6.47) respectively, similarly the maximum weight of hundred seedling (1.67- 1.63), seedling length (13.65-13.45) and seedling vigor index (1278.83-1272.34) were recorded with seed primed with $ZnSO_4$ at a rate of 2 % for 24 hr. followed by chitosan 0.5% which recorded of weight hundred seedling (1.57-1.35), seedling length (12.86-12.78) and seedling vigor index (1178.90-1124.33) in the two season respectively. These results agree with those of Babaevaet al., (1999) on Echinacea, (Kaya et al., 2007) on common bean Harris et al., (2008) on chickpea and Munawar et al., (2013) on carrot. Seed priming with zinc might be involved in various processes during early seed development (Cakmak 2000), seed priming enhances germination by the regulation of DNA repair pathways, degrading enzymes, catalase, and other antioxidant- scavenging enzymes, the de novo synthesis of proteins and nucleic acids, thus the accumulation of phospholipids and sterols (Rajjou et al., 2012; Kubola et al., 2015a; Paparella et al., 2015). In addition of Zn in priming solution enhancement seedling growth in early stages depending upon possible involvement of Zn in the early stages of coleoptile and radicle development (Ozturk et al., 2006). Priming induces early emergence of radicle and produced longer radical with raid cell division and cell elongation might be due to enhanced tryptophan is a precursor of auxin (Saranya et al., 2017). Also, Proper seedling may be related to induced plasma membrane fluidity, zinc plays function role in preserving structural integrity of cell membranes and protein synthesis membrane function (Mostafa et al., 2019), Seedling vigor indicates the potential for rapid germination, uniform emergence, and development of normal seedlings (McDonald 1993). Within this context (Harris et al., 2007) indicated that enriched amounts of Zn in seeds maintained by priming can produce vigorous seedling with heavier biomass.

Table (2). Effect of seed priming with some plant stimulants on germination parameters of carrot seeds during of two seasons 2020/21 and 2021/22.

Characters / Treatments	Germination (%)		Mean germination time (days)		Weight of 100 seedling (g)		Seedling length (cm)		Seedling vigor index	
	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22
Seeds priming										
Control	82.67f	81.00e	8.80a	9.20a	0.95f	0.93g	11.39f	11.19f	941.33e	906.67e
Distilled water	85.00e	83.00d	7.80b	8.17b	1.21e	1.16f	11.77e	11.62e	1000.70d	964.77d
Salicylic acid 50 ppm	89.00c	87.33b	6.80e	7.20d	1.50c	1.42c	12.13d	11.85de	1079.57c	1049.50b
Ascorbic acid 100 ppm	87.00d	85.00c	7.50c	7.50c	1.38d	1.34d	12.39c	12.22c	1078.00c	1038.40b
Chitosan 0.5%	91.67b	88.00b	5.40g	5.40f	1.57b	1.53b	12.86b	12.78b	1178.90b	1124.33a
$ZnSO_4$ 2%	93.67a	90.67a	6.30f	6.47e	1.67a	1.63a	13.65a	13.45a	1278.83a	1134.33a
H_2O_2 1%	85.00e	83.00d	7.13d	7.40cd	1.35d	1.29e	12.06d	12.08cd	1025.40d	1001.03c

Means followed by the same letter/s within each column didn't significantly differ at 5% level.

Field experiment:

Vegetative growth parameters:-

Data in Table (3) indicated that the vegetative growth parameters of carrot, i.e., plant height, number of leaves/plants, fresh and dry weight of plant were significantly increased with seed priming and foliar application the tested stimulants in the two seasons. The maximum plant height (72.29 cm) was achieved with foliar application of hydrogen peroxide (H_2O_2) at a rate of 100 ppm in the first season while maximum plant height (70.73) in the second season, maximum number of leaves/plant in both season (15.69-14.85) were recorded due to foliar spraying of $ZnSO_4$ at a rate of 200 ppm, however the maximum fresh and dry weight (61.05- 57.27 ,34.64-32.25) were recorded in response seed priming of $ZnSO_4$ at a rate of 2% in the two season respectively. These results could be due to the early seedling emergence from primed seeds allowed efficient and longer use of light and soil resource by plants during growth and development (Ghassemi et al. 2010). The favorable effect of Zn on plant development might be related to its essential role in many physiological processes and cellular functions within the plants. It is because of the fact that Zn involves in auxin metabolism that increases leaf length, additionally, Zn play a vital role in improving plant development through biosynthesis of endogenous hormones which are responsible for promoting of plant growth. The results are in close conformity with those of Elizabath et al. (2017) on carrot. Moreover, applied Zn may be increased the accumulation of nitrogen which enhancement vegetative growth. Arora and Singh (2004) on barley, similar observations were also reported by Tariq et al. (2021), on onion crops. Increases availability of Zn to plant enhances plant growth and development in respect of number of leaves plant^{-1} and plant height.

Table (3). Effect of seed priming and foliar application with some plant stimulants on vegetative growth parameters of carrot at 75 days after sowing in the two winter seasons of 2020/ 21 and 2021/22.

Characters / Treatments	Plant height (cm)		No. of leaves/plant		Fresh weight of shoot (g)		Dry weight of shoot (g)	
	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22
Seeds priming								
Control	48.83j	44.53e	9.48h	8.87h	30.20i	29.25i	12.83k	12.55i
Distilled water	52.00i	48.23d	10.53g	9.65fg	36.15g	32.25h	15.97i	14.90h
Salicylic acid 50 ppm	62.87e	54.43c	11.25f	10.64e	52.50c	48.37c	18.08h	17.48g
Ascorbic acid 100 ppm	60.23g	55.70c	11.90e	11.18e	50.53d	46.50d	27.83d	25.89d
Chitosan 0.5%	61.52f	64.83b	13.59c	12.37cd	57.64b	54.05b	29.84c	27.83c
$ZnSO_4$ 2%	59.53g	69.83a	15.56a	14.49a	61.05a	57.27a	34.64a	32.25a
H_2O_2 1%	64.77d	63.47b	14.18b	13.55b	45.41e	43.30e	21.35f	19.63f
Foliar application								
Distilled water	54.38h	50.27d	9.81h	9.03gh	32.43h	29.95i	14.75j	14.52h
Salicylic acid 50ppm	69.55b	54.73c	11.03fg	9.95f	45.60e	44.48e	17.68h	16.73g
Ascorbic acid 100ppm	70.17b	55.30c	12.68d	11.82d	42.78f	40.27f	26.10e	24.40e
Chitosan 200ppm	67.42c	68.87a	14.30b	12.97bc	52.10cd	48.38c	28.53d	26.80cd
$ZnSO_4$ 200ppm	66.31c	70.73a	15.69a	14.85a	56.62b	53.28b	32.51b	30.17b
H_2O_2 100ppm	72.29a	64.90b	14.27b	12.58c	41.07f	38.45g	19.89g	18.73f

Means followed by the same letter/s within each column didn't significantly differ at 5% level.

Yield and its components:-

Data illustrated in Table (4) show that root length, root diameter, fresh and dry weight of root and total yield were significantly increased with seed priming of some stimulants in both seasons. The maximum root length, root diameter, fresh and dry weight and total yield (22.27-20.77, 3.71-3.34, 192.15-186.30, 26.13-24.37, 56.38-52.79) were achieved produced when seeds were primed in $ZnSO_4$ at a rate of 2 %. On the other hand, the lowest values of root length, root diameter, fresh weight, dry weight and total yield were obtained from seed unprimed in two experimental seasons. The recorded increase in root traits leading to roots yield may be due to faster emergence of plants raised from primed seeds consequently, producing more vigorous seedlings, and higher yield compared with plants raised from non-primed seeds (Harris et al. 1999). Furthermore, earlier crop establishment with vigorous growth minimizes weed competition, which facilitates increased water and nutrient absorption, reflecting in a higher number of branches and yield (Geubreegziabher and Qufa 2017). Zn plays critical role in crop growth, involving in photosynthesis, respiration and other biochemical and physiological processes and thus contribution in achieving higher yields (Zeidan et al., 2010). Zn also, plays an important role in the biosynthesis of IAA, regulating the auxin concentration in plant and other biochemical and physiological activities, initiation of primordia for reproductive parts.in these respect sharma and Parmar (2018) reported that higher yield of pea and maize Zn priming is attributed to the increased synthesis of carbohydrates and their transport to the site of grain production.

These results are in line with those reported by (Kaya et al., 2007), on common bean seed priming with zinc significantly improved yield and related trails (Tariq et al. 2021 on onion and Prajapati, 2022) on wheat,

Table (4). Effect of seed priming and foliar application with some plant stimulants on yield and its components of carrot at harvesting in the two winter seasons of 2020/21 and 20/2022.

Characters / Treatments	Root length (cm)		Root diameter /plant		Fresh weight of root (g)		Dry weight of root (g)		Total yield (ton/fed)	
	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22
Seeds priming										
Control	11.87h	10.51h	1.89h	1.82f	93.50i	90.00i	16.45i	14.63h	15.39h	14.59g
Distilled water	15.10f	12.93fg	2.17gh	2.01de	132.98g	131.07g	19.55h	18.55g	17.47g	16.48ef
Salicylic 50ppm	16.91e	15.30e	2.33fg	2.10d	172.59c	165.37c	22.05de	19.92e	20.25c	19.25c
Ascorbic acid 100ppm	18.42d	16.22d	2.71de	2.29c	168.22cd	160.08de	20.94fg	19.75ef	19.35de	18.04d
Chitosan 0.5%	20.25b	18.65b	2.95cd	2.93b	187.80ab	180.83b	23.00cd	21.37c	21.60b	20.20b
$ZnSO_4$ 2%	22.27a	20.77a	3.71a	3.34a	192.15a	186.30a	26.13a	24.37a	23.69a	22.18a
H_2O_2 1%	19.08cd	17.39c	3.14bc	2.97b	166.33de	161.68cd	23.80bc	21.50bc	19.01ef	17.78d
Foliar application										
Distilled water	14.18g	12.57g	2.00h	1.94ef	119.10h	114.81h	19.97gh	18.87fg	15.69h	15.12g
Salicylic acid 50ppm	15.23f	13.47f	2.03gh	2.01de	151.35f	146.17f	20.42gh	19.23efg	18.60f	16.98e
Ascorbic acid 100ppm	17.30e	15.21e	2.53ef	2.25c	165.70de	162.05cd	21.58ef	19.65ef	17.64g	16.05f
Chitosan 200ppm	18.86cd	17.41c	3.22bc	3.02b	168.76cd	163.97cd	21.99def	20.08de	19.62d	18.18d
$ZnSO_4$ 200ppm	19.28c	17.58c	3.41ab	3.23a	185.95b	181.98ab	24.72b	22.42b	21.22b	20.22b
H_2O_2 100ppm	18.31d	15.53de	3.17bc	3.05b	160.42e	155.96e	23.02cd	20.97cd	17.50g	16.59ef

Means followed by the same letter/s within each column didn't significantly differ at 5% level.

Biochemical constituents:-

Data presented in Table (5) demonstrate that NPK and chlorophylls in the leaves were significantly increased in response to seeds priming by plant stimulants in the two seasons, results also indicated that the plants raised from $ZnSO_4$ primed seed gave the highest value of NPK in the leaves (2.85-3.02, 0.362-0.383, 3.13-3.45) chlorophyll a, b (0.893-0.926, 0.572-0.592) and total chlorophylls a + b (1.465- 1.518) in the leaves in both seasons, while the lowest value of NPK %, Chlorophyll a, b and total chlorophylls in the leaves in both seasons were recorded in plants raised from unprimed seeds. In the present study seed priming of carrot significantly increased NPK and chlorophyll contents in leaves of carrots in Table (٥) the results agree with those obtained by Siri et al. (2013) and Sharma et al. (2014), so it might be the reason that seed priming enhanced nutrient uptake and results to enhanced chlorophyll content in carrot leaves, these results are in similar with those of earlier studies which indicated that seed priming enhanced leaf nutrients accumulation in Mung bean (Shah et al., 2021). Seed priming improved significantly nutrients uptake balancing of membrane potential and regulating of osmatic pressure cell (Cherel, 2004). It might be related to seed priming regulate nutrients uptake, chlorophyll accumulation (Anwar et al., 2020). Zinc application also, helps increasing the uptake of nitrogen and potash. Zinc is necessary for root cell membrane integrity its function and transport of P from root to leaves (Welch et al. 1982; Shivay et al., 2016 and Awad 2022) on carrot.

Table (5). Effect of seed priming and foliar application with some plant stimulants on NPK, chlorophyll a, b and total chlorophylls content in leaves of carrot at 75 days after sowing in the two winter seasons of 2020/21 and 2021/22.

Characters / Treatment	Leaves minerals (%)						Leaves chlorophyll content (mg. g^{-1} FW)					
	N		P		K		Chlorophyll a		Chlorophyll b		Total chlorophylls	
	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22
Seeds priming												
Control	2.18l	2.30h	0.263l	0.277g	2.34l	2.57i	0.816i	0.843g	0.490l	0.505i	1.305l	1.348k
Distilled water	2.25k	2.40g	0.274k	0.292f	2.42k	2.67h	0.829h	0.853fg	0.501k	0.516h	1.329k	1.369j
Salicylic acid 50ppm	2.74c	2.89b	0.341c	0.360b	2.97c	3.24c	0.879b	0.906b	0.556c	0.572c	1.436c	1.479c
Ascorbic acid 100ppm	2.41h	2.55e	0.300h	0.318e	2.61h	2.86g	0.847f	0.875de	0.523h	0.541f	1.370h	1.416g
Chitosan 0.5%	2.80b	2.97a	0.354b	0.376a	3.04b	3.35b	0.884b	0.909b	0.565b	0.581b	1.449b	1.491b
$ZnSO_4$ 2%	2.85a	3.02a	0.362a	0.383a	3.13a	3.45a	0.893a	0.926a	0.572a	0.592a	1.465a	1.518a
H_2O_2 1%	2.60e	2.77c	0.325e	0.346c	2.82e	3.09de	0.865d	0.899bc	0.541e	0.562d	1.406e	1.461d
Foliar application												
Distilled water	2.33ij	2.47fg	0.279jk	0.296f	2.45jk	2.68h	0.831h	0.859f	0.506j	0.523g	1.337j	1.383i
Salicylic acid 50ppm	2.30j	2.45g	0.281j	0.299f	2.47j	2.72h	0.834gh	0.863ef	0.508j	0.526g	1.342j	1.389hi
Ascorbic acid 100ppm	2.48g	2.63d	0.308g	0.326d	2.68g	2.94f	0.854e	0.885cd	0.529g	0.547ef	1.383g	1.432f
Chitosan 200 ppm	2.67d	2.86b	0.334d	0.357b	2.87d	3.13d	0.873c	0.899bc	0.548d	0.564d	1.421d	1.463d
$ZnSO_4$ 200 ppm	2.53f	2.71c	0.318f	0.341c	2.76f	3.03e	0.858e	0.888cd	0.536f	0.555e	1.394f	1.442e
H_2O_2 100 ppm	2.38hi	2.53ef	0.293i	0.312e	2.55i	2.81g	0.838g	0.863ef	0.515i	0.529g	1.353i	1.393h

Means followed by the same letter/s within each column didn't significantly differ at 5% level.

Root Quality:-

Data in Table (6) illustrate that the seeds priming and foliar spraying by stimulants significantly increased contents of NPK, Zn, total soluble solids (TSS) and vitamin C in root carrots in two seasons. The highest contents from N, P and K (1.64-1.81, 0.268-0.285, 2.63-2.79) were obtained from the plants foliar sprayed by hydrogen peroxide (H_2O_2) at a rate of 0.5% in both seasons, while the highest value of zinc in root (30.44-32.61) was recorded with foliar sprayed of zinc sulphate at a rate of 0.2% in both seasons. On the other hand, total soluble solids and vitamin C contents (10.78 -10.23, 6.92 -6.77) respect were obtained with seeds priming of zinc sulphate at a rate of 2 % in the two seasons. The increments in mineral content in the roots carrot might be attributed to the exogenous application of H_2O_2 producing a vigorous root system in the plants which increased the absorption area for important critical mineral ions inducing NPK, which further increased the N assimilation from hairs root. These results are in agreement with those obtained by (Tang et al., 2001, Hammed 2004; Li et al., 2007 and Selvaanathin and Beulah 2020), the same Table $ZnSO_4$ 2% for 24 h. significantly enhanced root quality of carrot in terms of total soluble solids and vitamin C might be due to activation of enzymes by zinc that enhances protein formation and metabolism of carbohydrates that enhances the quality of roots carrot. These results are in confirmation with Elizbath et al. (2017) on carrot Sharma and Parmar (2018) on maize and pea.Tariq et al. (2021) who reported that Zn enhances the quality of onion projapati et al. (2022) on wheat.

Table (6). Effect of seed priming and foliar application with some plant stimulants on NPK, Zn, total soluble solids and ascorbic acid contents in carrot roots at harvesting in the two winter seasons of 2020/21 and 2021/22.

Characters / Treatments	Root content								Root quality			
	N%		P%		K%		Zn ppm		TSS %		V.C mg/100g	
	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22
Seeds priming												
Control	1.23h	1.36g	0.194h	0.205k	2.15k	2.27h	23.65h	24.89h	7.65g	7.30h	5.20h	4.98g
Distilled water	1.26h	1.39g	0.197h	0.210jk	2.19jk	2.33g	23.94h	25.50gh	8.08f	7.94g	6.13f	5.96f
Salicylic acid 50 ppm	1.45ef	1.58e	0.228e	0.240g	2.38ef	2.51e	25.98e	27.38e	8.35f	8.35f	6.41de	6.40cd
Ascorbic acid 100 ppm	1.41f	1.55e	0.219f	0.232h	2.34fg	2.48ef	25.26f	26.73ef	9.37de	9.23de	6.74bc	6.62b
Chitosan 0.5%	1.35g	1.49f	0.215f	0.228h	2.30gh	2.44f	24.69fg	26.18fg	9.85bc	9.65bc	6.86ab	6.70ab
$ZnSO_4$ 2%	1.33g	1.47f	0.206g	0.218i	2.25hi	2.38g	27.22d	28.76d	10.78a	10.23a	6.92a	6.77a
H_2O_2 1%	1.49de	1.63d	0.235d	0.250f	2.42de	2.58d	26.64d	28.38d	9.47de	9.55c	6.64c	6.46c
Foliar application												
Distilled water	1.26h	1.38g	0.200gh	0.212ij	2.21ij	2.34g	24.26gh	25.68g	8.03f	7.90g	5.92g	5.86f
Salicylic acid 50 ppm	1.62a	1.79a	0.261ab	0.277b	2.59ab	2.76ab	29.19b	31.04b	8.23f	8.08fg	6.31e	6.15e
Ascorbic acid 100ppm	1.59ab	1.74b	0.256b	0.271c	2.57bc	2.72b	28.52c	30.25c	9.22f	8.95e	6.45d	6.32d
Chitosan 200 ppm	1.56bc	1.70c	0.246c	0.263d	2.53c	2.71b	27.90c	29.86c	9.65cd	9.41cd	6.48d	6.42cd
$ZnSO_4$ 200ppm	1.53cd	1.68c	0.240cd	0.257e	2.46d	2.64c	30.44a	32.61a	10.08b	9.89b	6.72c	6.61b
H_2O_2 100ppm	1.64a	1.81a	0.268a	0.285a	2.63a	2.79a	29.78b	31.66b	9.27e	9.04e	6.48d	6.38cd

Means followed by the same letter/s within each column didn't significantly differ at 5% level.

Conclusions:

Seed priming is a simple low cost, and low risk treatment that useful technology for farmers, reduce crop duration and increase crop productivity especially in low quality seed, inadequate seedbed preparation, adverse soil properties (e.g., crusting) untimely sowing and poor sowing technique.

The results indicated that carrot seed priming with some stimulants have positive effect on rate of seedling emergence and seedlings growth, with seeds priming of carrot at rate of 2 % $ZnSO_4$ for 24 hours being the most beneficial treatments with respect to germination parameters, vegetative growth and yield furthermore, foliar spraying with hydrogen peroxide at a rate of 100 ppm was proved beneficial effect for enhancing roots quality of carrot through increasing their mineral nutrients content.

REFERENCES

Aazami, M.A. and S.M. Zahedi (2018). Germination of carrot (*Daucus carota* L.) Seeds in response to osmatic priming. Thai J. Agric. Sci. Val. 51 (4): 188-194.

Anonymous, (1990). International rules for seed testing. *Seed sci. and Tech*. 27- 25-30.

AfghaniAsI, M.B. and G. Taheri (2012). Survey the effect of seed priming on germination and physiological indices of cotton khor dad cultivar. *Ann. Biol. Res. 3*: 1003:1009.

Anwar, A.; Y. U. Xianchang and L.I. Yansu (2020). Seed priming as a promising technique to improve growth, chlorophyll, photosynthesis and nutrient contents in cucumber seeding. SnNotula Bootanicae Horti., Agrobatanici cluj. Napaca 48 (1): 116- 127.

AOAC (1990). "Official Methods of Analysis Association" of Official Agricultural Chemists, 12 the Ed. Washington, D.C., USA.

Arora, S. and M. Singh (2004). Interaction effect of zinc and nitrogen on growth and yield of barley on typic ustipsamments. *Asian J. Plant Sci. 3(1), 101- 103.*

Awad, A.A.M.; M. M. Rady; W.M. Semida; E. E. Belab; W.M. Omran; H.M. Yasi and E.F. Ali (2021). Foliar nourishment with different zinc-containing forms effectively sustains carrots performance in zinc- deficient soil. Agron., 11, 1853.

Bremner, J.M. and R. Mulvaney (1982). Total nitrogen, In: Page, A.L., R.H. Miller and D.R. Heeney (Eds.), Methods of soil analysis. Part 2. PP. 595-624, Amer. Soc. Agron., Madison, W.I., USA.

Boonlertnirum, S., S. Meehoul and E. Sarobol (2010). Physiological and morphological response of field corn seedling to chitosan under hypoxic conditions. Sci. Asia 36 :89- 93.

Cakmak, I. (2000). Role of zinc in protecting plant cells from reactive oxygen species. New Phytal. 149, 185- 205.

Chakma, S.P.; S.M. Chileshe, R. Thomas and P.kirshna (2021). Cotton seed priming with brassinostroied promotes germination and growth. Agron. Basel 11:566.doi:10.3390/agronomy 113056 6.

Chapman, H. and P. Pratt (1971). Method of analysis for soil, plants and water.Univ. of california, Bull.No.376, Davis,Cal.,96616.USA.

Cherel, I. (2004). Regulation of K+ channel activities in plants from physiological to molecular aspects. J. Experi., Botany 55: 337- 351.

Elizbath, A.; V.Bahadur; P. Misra;V. M. prasad and T. Thomas (2017). Effect of different concentration of iron oxide and zinc oxide nano particles on growth and yield of carrot. J. pharmacag. Phytochem., 6 (4), 1266 – 1269.

Espanany, A.;S Fallah and A. Tadayyon (2016). Seed priming improves seed germination and reduces oxidative stress in back cumin (*Nigella sativa*) in presence of cadmium. Industr. Crops prod. 79, 195- 204. doi:10.1016/j. indcrop. 11.016.

Geubreegziabher, B.G. and C.A. Qufa (2017). Plant physiological stimulation by seeds salt priming in maze (*Zea mays*): prospect for salt tolerance. *Afr. J. Biotechnol.* 16, 209- 223.

Ghassmi-Golezani, K.; A. J. Chardordordooz and S. Mohaddam (2010). Effect of hydro-priming duration on seedling vigor and grain yield of pinto bean (*Phaseolus vulgaris* L.) cultivars. Not. Bot. Hort. Agrobot. Cluj-Napaca 38, 109-113.

Ghassemi-Lemrasky, M. and S.Z. Hosseini (2012). Effect of seed priming on the germination behavior of wheat. Int. J. Agric. Crop Sci. 4: 564- 567.

Guan, Y.; J. Hu; X Wangi and C. Shao (2019). Seed priming with chitosan improves maize germination and seedling growth in relation to physiological changes under low temperature stress. J. Zhejiang Univ., Sci. B.10 (6): 427- 433.

Hammed, A. and S. Farooq (2004). Influence exogenous application of hydrogen peroxide on root and seedling growth on wheat (*Triticum aestiveem* L.) Int. J. Agri. Biol. 6, 366 -369.

Harris, D.; A. Rashid; G. Miraj; M. Arif and H. Shah (2007). On- form seed priming with zinc sulphate solution- A cast effective way to increase the maize yields of resource poor forms. *Field crops Res.*, 102 (2): 119-127.

Jackson, M.L. (1970). Soil Chemical Analysis. Prentice Hall, Englewood Ceiffs N.J.

Kaya, M.; M. Atak; K. M. Khawar; C.Y. Ciftci and S. Ozean (2007). Effect of pre-sowing seed treatment with zinc and foliar spray of humic acids on yield of common bean (*Phaseolus vulgaris* L.). inter. J. Agric. and biology. 7: 875 -878.

Kubola, S.; M.Garniczarska ;L.Wojtyla ; A. Clippe; A. Kosmala; A. Zmienko; S. Lutts and M. Quinet (2015a). Deciphering priming induced improvement of rape seed (*Brassica napus* L.) germination through an integrated transcriptomic and proteomic approach Plant Sci. 231: 94- 113.

Lee, S.Y.; J.H. Lee and T.O. Kwon (2002). Varietal differences in seed germination and seedling vigor of Korean rice varieties following dry heat treatments seed. Sci. Tech nol., 30:311- 321.

Li,S.W.; L.G. Xue; S.J.Xu; H.Y. Feng and L.Z. An (2007). Hydrogen peroxide involvement in formation and development of adventitious roots in cucumber. Plant Growth Regula. 52: 173 -180.

McDonald, M.B. (1993). The history of seed vigor testing. J. Seed Technol. 17, 93- 101.

Mehsin, A.U.; A.U.H. Ahamed; M.Farooq and S. Uallh (2014). Influence of zinc application through seed treatment and foliar spray on growth, productivity and grain quality of hybrid maize. J. Animal and Plant Sci. 24: 1494-1503.

Mereddy, R.; L. Wu; S.W. Hallgren, Y. Wu and K. E. Conway (2000). Solid matrix priming improves seedling vigor of okra seeds. Proc. Okla. Acad. Sci. 80: 33-37.

Mozumder, S.N. and M.M. Hossain (2013). Effect of seed treatment and soaking duration on germination of *Eryngium foetidum* L. Seeds Int. J. Hort. 3: 1046 – 1051.

Munawar, M.; M. Ikram; M. Iqbal; M.Muzaffar Razan ; S. Habib; G. Hammad ; M. Najeebullah; M. Salleen and R. Ashraf (2013). Effect of seed priming with zinc, boron and manganese on seedling health in carrot (*Daucus carota* L.) Int. J. Agri. and sci. 5-22-2697-2702.

Nagar, V.; S. Kumar; U. K. Bagri; R.R. Bunker and H. Rans (2021). Assessment effect of foliar spray zinc sulphate on fruit quality of tomato under polyhouse. Inter. J. Curr. microbial App. Sci. Vol. 10 (02): 2376- 2383.

Narimanov, A.A., (2000). Resowing treatment of seeds with hydrogen peroxide promotes germination and development of plants. Biologia (*Bratislova*) 55 (4): 425 -428.

Mostafa, S.E.; A.A. Leilah and E. A. Fayed (2019). Effect of seed soaking and foliar application with zinc sulphate on rice seedling strength, yield and its components. J. prod., Mansoura Univ., val.10 (12): 1169-1182.

O'Danovan, J.T.; R.E. Blackshaw; K.N. Harker;; G.W. Clayton and R. Mckenzie (2005). Variable crops plant establishment contribute to differences in competitiveness with wild oat among cereal varieties can J. plant Sci. 85, 771-776.

Olson, S.R. and L.E. Somners (1982). Phosphorus In: Page, A.L., R.H. Miller, Soc. Agron., Madison, W.I., USA., pp. 403-430.

Ozturk,L.;M.A. Yazici; C. Cekic; A. Bagci and I. Cakmak (2006). Concentration and localization of zinc during seed development and germination in wheat. *Physiological Plantarum*, 128 (1):144-152.

Paparella, S., S. Arauja; G. Rossi; M. Wijayasinghe; D. carbonera and A. Balestrazzi (2015). Seed priming state of the art and new perspectives plant cell Rep. 34 (8): 1281-1293.

Parvin, M.A.; H.M. Zakir; N. Sultana; A. Kali and H.P. (2019). Effect of different methods of chitosan on growth, yield and quality of tomato (*Lycopersicon esculentum mill*.). Archives Agriculture and environmental Science, 4 (3):261-267, https://dx. Doi org./ 1026832/ 24566632.2019.40301.

Prajapati, A.R.; K.I. Patel; Z. Y. Chauhan; C.K. Patel and P.P. Chaudhari (2022). Effect of zinc fertilization on growth, yield and quality of wheat (*Triticum aestivum* L.). The pharma Innovation J. 11(44): 1399 – 1402.

Que, F.; X.L. Hou; G.L. Wang; Z.S, XU and G.F. Tan; Lit (2019). Advances in research on the carrot, an important root vegetable in *Apiaceae* Family. Hort. Res., 6-69.

Rabani, V.; H. Cheatsazan (2021). Chitosan seed priming improves the yield and the root system of faba (*Vicia faba* L.). Short Title: Chitosan impact on yield of faba bean. J. Agri. Sci., and Technology B11 53- 60.

Rajjou, L.; M. Duval; K.Gallardo and J. Catusse (2012). Seed germination and vigor J. Bally; C. Job; D. Job. Annu Rev. Plant Biol 63: 507- 533.

Rubatzky, V. E; C. F. Quiros and P.W. Simon (1999). Carrots and related vegetable Umbelliferae (CABI, Publishing, CAB international Wallingford Oxonox108 DE, UK.

Sadeghi, H.; F. Khazei; L. Yari and S. Sheidaei (2011). Effect of seed Osmo priming on seed germination behavior and vigor of soybean (*glycine max* L.) J. Agric. Biol. sci. 6:39:73.

Sakhabutdinova, A.R.; D.R. Fatakutdinnova; N.V. Bezrukova and E.M.Shakirova (2003). Salicylic acid prevents the damaging action of stress factors on wheat plants. Bulg. J. Plants Physiol. 21:314-319.

Saranya, N.; J. Renugadevi; K. Raja; V. Rajashree and G. Hemalatha (2017). Seed priming studies for vigor enhancement in onion Co. J. Pharma Cogen Phyto. hem 6 (3): 77- 82.

Selvaananathin, A. and J.S. Beulah (2020). Study on the effect of fertilizers and hydrogen peroxide on soil property, growth yield and nutrient content of (*Abelmoschus Fsculentus* L.). Moench. Int. J. Agric. Syst. 8 (2): 77- 84.

Shah, H.; T. Jalwat; M. Arif and G. Miraj (2021). Seed priming improves early seedling growth and nutrient uptake in mungbean. J. plant nutrient 35: 805 -816.

Sharma, A. D. and S.V.S 2014. Comparison various seed priming methods for seed germination, seedling vigor and fruit yield in okara (*Abelmoschus eculentusl* L. *Moench*). Scientia Hort.165:75-81.

Sharma, M.and D.K. Parmar (2018). Effect of seed priming with zinc sulfate on yield and quality parameters of rainfed maize- pea sequence under mid hill conditions. himachal Pradesh. J. pharmacognosy and phytochemistry 7 (1):1401-1407.

Sheikh, S.K. and F.M. Al-Malki (2011). Growth and chlorophyll responses of bean plants to the chitosan application. Eur. J. Sci. Res., 50: 124-134.

Shivay, Y., S.; U. Singh; R. Prasad and R. Kau (2016). Agronomic interventions for micronutrient bio fortification of pulses, Indian J. Agron. 61(4th IAC special Issue):161-172.

Singh, S.K. and P.K. Singh (2016). Effect of seed priming of tomato with salicylic acid on growth, flowering, yield and fruit quality under high temperature stress conditions. Int. J. A. dv. Res. 4: 723-727.

Siri, B; K. Vichirphan; P.Kacwnaree; S. Vichitphan and P. Klanrit (2013). Improvement of quality, membrane integrity and antioxidant systems in sweet pepper (*Capsicum annuum Linn.*) Seed affected by Osmo priming. Austr. crop Sci., 7 (3):2068.

Snedecor, G.W. and W.G. Cochran (1989). Statistical Methods ^th Ed, The Iowa State Univ., Press, Amer., Iowa, USA.

Srivastava, A. K. ; J. S.Kumar and K. Sduprasanna (2021). Seed primeamics: plants memorize their germination under stress. Biol. Rev. 96, 1723-1743. Doi: 10 1111/ brv.12722.

Tang, L. C.; P. Hinsinger; J. J. Drevon and J.A. Illar (2001). Phosphorus deficiency impairs early nodule functioning and enhances proton release in roots of medicagavtruncatula L. Ann. Botany, 88: 131- 138.

Tariq, M.; M.Tariq; R. Ali; M.O. Khan; A.Z. Murad; M. Ali; M.K. Khalil and S. Muhammed (2021). Impact of soil and foliar application of various zinc sources on the yield and uptake by onion under agroclimatic condition of swat. Int. J. agric. Stat. Sci. vol. 17, supplement 1, pp. 2363- 2376.

Upadhyaya, H.; M.H. Khan and S. K. Panda 2007. Hydrogen peroxide induces oxidative stress in detached leaves of (*Oryza Sativa* L.). General and Applied plant physiology, 33: 83-95.

Waqas, M., N.E.Korres ; M.D. Khan; A.S. Nizami; F. Deeba; I. Ali and H. Hussain (2019). Advances in the concept and methods of seeds priming. *In Priming and Pretreatment of Seeds Seedlings.* Springer: Singapore, pp.11-41.

Welch, R. M.; M. J. Webb and J.F. Lonegaran (1982). Zinc in membrane fuction and its role in phosphorus to xicity. I: *Proceedings of the ninth Internation Plant Nutrition Calloquium.* Common weath Agricultural bureau, A. Scarify (Editor). Farnham Rayal, England. PP. 710 -715.

Zeidan, M.S.; F.Manal and H. A. Hamouda (2010). Effect of foliar fertilization of Fe, Mn and Zn on wheat yield and quality in low sand soils fertility. J. Agric. Sci. 6 (6): 696- 699.

Zhao,Y.;M. Hu;Z. Gao ; X.Chen and D. Huang (2018). Biological mechanisms of a novel hydro- electro- hybrid priming recovers potential vigor of onion seeds.Environ. Exper. Bat. 150, 260 - 271.doi:10: 1016/j. envexpbot 04.002.

تاثير النقع والرش ببعض المحفزات علي النمو والمحصول والجودة في الجزر

سالي محمد صفوت ابو كامل شعبان

قسم بحوث الخضر- معهد بحوث البساتين -مركز البحوث الزراعية -الجيزة – مصر.

أجريت تجربتان إحدهما معملية بمعمل محطه بحوث البساتين بالمنصورة والأخري حقلية بمزرعه خاصه بقرية شبراويش- مركز أجا- محافظة الدقهلية في الموسم الشتوي ٢٠٢٠/٢١ و٢٠٢١/٢٢ علي هجين الجزر فيرودج F1 لدراسة تأثير النقع والرش ببعض المحفزات علي النمو والمحصول والجودة في الجزر و قد تم إستخدام طريقتين منفصلتين للإضافة وهما نقع البذرة والرش الورقي، وكانت المعاملات كالأتي البذرة الجافة (كنترول)- النقع في الماء المقطر – النقع في حمض السالسيلك عند تركيز ٥٠ جزء في المليون وحمض الأسكوبيك عند تركيز ١٠٠ جزء في المليون والنقع في الشيوزان عند تركيز ٠.٥ % وسلفات الزنك عند تركيز٢ % والنقع في فوق أكسيد الهيدروجين عند تركيز ١ % لمدة ٢٤ ساعة، أما طريقة الرش الورقي كانت كالاتي: الرش بالماء والرش بحمض السالسيلك عند تركيز ٥٠ جزء في المليون والرش بحمض الأسكوبيك عند تركيز ١٠٠ جزء في المليون والرش بالشيتوزان عند تركيز ٢٠٠ جزء في المليون وسلفات زنك عند تركيز ٢٠٠ جزء في المليون و فوق أكسيد الهيدرجين ١٠٠ جزء في المليون عند عمر ٣٥ و٥٠ و٦٥ يوم من ميعاد الزراعة.

وكانت نتائج التجربة المعملية كالتالي: حيث أدت معاملات نقع البذرة إلي زيادة معنوية علي صفات الأنبات مثل نسبة الإنبات ، وزن ١٠٠ بادرة ، طول البادرة ودليل قوة البادرة وكانت معاملة نقع البذرة بالزنك عند تركيز ٢ % لمدة ٢٤ ساعة هي الافضل من حيث (نسبة الإنبات - ووزن ١٠٠ بادرة – طول البادرة – قوة البادرة) بينما أقل وقت للإنبات كان مع معاملة البذرة بالشيتوزان عند تركيز ٠.٥ % لمدة ٢٤ ساعة مقارنة بالبذرة الغير معاملة في كلا موسمي الزراعة.

وكانت نتائج النجربة الحقلية كالاتي حيث أدي نقع البذرة لمدة ٢٤ ساعة إلي زيادة معنوية في الصفات الخضرية مثل (طول النبات وعدد الأوراق والوزن الطازج والجاف للنبات) كما أدت إلي زيادة معنوية في المحصول ومكوناتة مثل (طول الجزر- قطر الجزر – الوزن الطازج و الجاف للجذر و المحصول الكلي للفدان) وصفات الجودة للجذور عند الحصاد مثل المواد الصلبة الذائبة الكلية، وفيتامين C وNPK.

الصفات الكيماوية مثل الكلورفيل b, a والكلوروفيل الكلي في الأوراق عند عمر ٧٥ يوم من الزراعة و قد أعطت معاملة نقع البذور بسلفات الزنك عند تركيز ٢ % لمدة ٢٤ ساعة أحسن النتائج علي جميع الصفات في كل من موسمي الزراعة، وأعطي الرش الورقي بفوق أكسيد الهيدروجين عند تركيز ١٠٠ جزء في المليون أعلي محتوي من NPK في الجذور وكانت أعلي قيم من الزنك في الجذورمع الرش الورقي بسلفات الزنك بتركيز ٢٠٠ جزء في المليون.