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IMPACT OF POTATO SEEDS TREATING BY GA3 AND IAA ON GROWTH, TUBER COMPONENTS AND YIELD

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ABSTARCT

Two field experiments were carried out during the summer seasons of 2005 and 2006 on potato cv. (Spunta) in clayey loamy soil at El-Baramoon Res .Station, Mansoura, Dakahlia Governorate, Egypt to study the effect of soaking the imported potato seed tubers in growth regulators i.e GA3 and IAA and their combinations at different concentrations on vegetative growth parameters, tubers yield and its components, tubers quality and some chemical contents of potato tubers.

The results showed that soaking application of seed tubers in mixture of (GA3 + IAA) at concentrations of $(5+3\ ppm)^{-1}$ for 10 minutes before planting was very effective on the plant stand (%) at 21 and 28 DAP. The plant height (cm),number of main stems / plant , fresh weight of foliage/plant (g) and dry weight of foliage (%) at 90 DAP were increased significantly compared with control and the other treatments in both seasons. The medium tubers size percentage (35 – 65 mm) ,number of tubers/plant and total tubers yield of the 2 nd season (tons/fed) , as well as dry matter (%) , starch(%) , N, P and K contents in tubers at harvest were also significantly increased. Small tubers size percentage (>35 mm) , total tubers yield of the 1st season , specific gravity and the micronutrients concentration in tubers (Fe, Zn and Mn) at harvest were not affected significantly by different treatments during the study seasons of 2005 and 2006 .

Results revealed that soaking application of seeds tubers in mixture of (GA3 + IAA) at concentrations of $(5+3\ ppm)^{-1}$ for 10 minutes before planting led to increase of vegetative growth parameters , improvement of tubers quality and tubers yield and its components in compared with the control and the other treatments . Applying this treatment may help in solving the late sprouting problem of seed tubers in the decreased soil of relative humidity by soaking the seeds in the previous treatment and planting its immediately, in addition to produce more yield of medium tubers size which are used as seeds for the following seasons (fall, winter and summer) .

INTRODUCTION

Potato (Solamum tuberosum L.) is one of the most important and popular food crop world wide. Plant hormones and growth regulators produce major growth changes with very small concentrations. Hormones are produced naturally by plants, while growth regulators are applied to plants by humans. The growth regulating substances most often are applied as a spray to foliage or as a liquid drench to seeds to improve the crops production and quality. Gibberellins (GA) stimulate cell division and elongation , break seed dormancy and speed germination at low concentrations, whereas, Indol-3-acetic acid (IAA) plays an important role in an extent range of growth and development processes. EL- Gamal (1985) illustrated that soaking seed tubers in the lowest concentrations of GA3 (3 – 6 ppm) increased number of main stems and the dry weight of stems, he also

found significant increases in the number and weight of small and medium tubers. John (1987) indicated that using GA at concentration of (2 ppm) can cause earlier sprout of potato seeds. In the same trend, Allen *Et al.*l (1992) used - in success - GA to stimulate sprouts growth of potato seeds. Mikitizel & Fuller (1995) indicated that application of GA to seed pieces of potato at the concentration of (2 ppm) enhanced tuber weight . Ismail (1997) indicated that application of GA3 and IBA cause the highest values of number and fresh weight of leaves / plant. Xu *et al.* (1998) reported that application of IAA led to earlier tubers initiation and produced small and medium tubers. Sharma *et al.* (1999) found that GA3 enhanced both shoots and stolons growth and dry weight of plant but decreased starch content of tuber. Meliha *et al.* (2000) found that the plant growth stimulators such as IAA and GA3 increase fresh weight of plant and concentration of N & K in comparison with the control plant of tomato. Romanov *et al.* (2000) illustrated that IAA application increased predominantly the tuber size and weight. Meng *et al.* (2004) indicated that the growth rate of tuber is positively correlated with the contents of GA + IAA; they also, found that the content of starch in tuber has positive correlation with dry tuber weight. Mikitzel (2004) indicated that GA application resulted in more rapid plant emergence and increased the number of stems / plant , number of tubers/plant ,tubers yield (<50 mm) and reduced large tubers yield (>64 mm) . Suttle (2004) found that gibberellins increase sprouts growth and decrease of tuber dormancy. Arvind *et al.* (2005) found that GA3 is the best with respect to germination percentage and reducing mean germination time followed by KNO3 and IAA. Khan *et al.* (2005) show that exogenous gibberellic acid (GA_3) application increased shoots growth, photosynthesis, dry matter accumulation and increased N concentration of mustard plants. Kim *et al.* (2005) observed that GA promoted the tuber enlargement and enhanced the tubers yield. Kustiat *et al.* (2005) indicated that treating of potato seeds by GA_3 led to increase stems and tubers number, without affecting on the total yield. Sorce *et al.* (2005) found that the auxin indole acetic acid (IAA) appears to induce sprouting, as its concentration increases in tuber buds during dormancy release. Zhijun *et al.* (2005) found that the shoot length of potato plants was increased with the increasing of concentrations (0.5 – 10 mg·dm) of IAA treatment especially with the addition of GA3 (0.5 mg·dm-3) , micro tubers were formed in the treatments of (IAA + BAP) and (IAA + GA + BAP) but not observed in the treatments of IAA alone or (IAA + GA) .

MATERIALS AND METHODS

This investigation was carried out during two summer seasons of 2005 and 2006 at El-Baramoon Res. Station, Mansoura, Dakahlia Governorate, Egypt to study the effect of soaking the imported potato seeds cv. Spunta in some growth regulators i.e. GA3 and IAA and their combination on vegetative growth parameters, total tuber yield and its components, tuber quality and some macro and micro nutrients contents of potato tuber.

Table (1): Physical and chemical properties of the experiment soil at El-Baramoon Res. Station, Mansoura, Dakahlia Governorate, Egypt.*

Physical properties			Chemical Properties		
Character	Depth		Character	Depth	
	0-20cm	20-40cm		0-20cm	20-40cm
Sand%	32.8	34.0	Ec dsl/m (1:5)	0.63	0.65
Silt%	24.2	23.1	Soluble anions	Meg/100 g soil	
Clay %	38.2	38.0	Co_3^-	0.0	0.0
Soil texture	Clayey	loamy	Hco_3^-	2.05	2.0
O.M%	1.8	1.8	CL^-	0.3	0.32
Ca Co_3%	2.1	2.5	So_4^-	0.8	0.93
T.S.S	0.2	0.21	Soluble cations	Meg/100 g soil	
PH	7.8	7.9	Ca++	2.70	2.18
Bulk density	1.18	1.15	Mg++	0.35	0.37
Field capacity%	44.3	42.9	Na+	0.32	0.38
Available water%	23.75	22.54	K+	0.30	0.32
Wilting point%	21.11	20.22	Available N ppm	29	25
			Available P ppm	18	14
			Available K ppm	380	322

*according to methods of Jackson (1973).

Experimental design and treatments:

Potato seed tubers were planted on 6th and 2nd of January and harvested on 25th and 20th of April; during the summer seasons of 2005 and 2006, respectively. The experimental design was a randomized complete blocks with three replications. Each plot consisted of 3 ridges; 5 m long; 75 cm wide and 25 cm apart; plot size was 11.25 m^2.

The unsprouted potato seeds (treatments from 1 to 8) were soaking before planting for 10 minutes in the growth regulators i.e. GA3 and IAA and their combinations by different concentrations as follows:

1- GA3 (2 ppm)$^{-L}$
2- GA3 (5 ppm)$^{-L}$
3- IAA (1 ppm)$^{-L}$
4- IAA (3 ppm)$^{-L}$
5- GA3 + IAA (2+1 ppm)$^{-L}$
6- GA3 + IAA (2+3 ppm)$^{-L}$
7- GA3 + IAA (5 + 1 ppm)$^{-L}$
8- GA3 + IAA (5 + 3 ppm)$^{-L}$
9- Sprouted tuber seeds without soaking in growth regulators (control).

The mineral fertilizers were applied for all treatments as follows:

1- Single super phosphate (15.5% P_2O_5) was added once during the soil preparation at rate of 75 kg P_2O_5/fed.
2- Ammonium nitrate (33.5% N) was added in three equal portions after 4, 6 and 8 weeks from planting date at rate of 180 kg N/fed .
3- Potassium sulphate (48% K_2O) was added in twice at equal portion after 4 and 8 weeks from planting date with rate of 96 kg K_2O/fed .

Other agricultural practices were carried out according to the recommendations of the Ministry of Agriculture.

Data recorded:

a- Vegetative growth parameters:

1- Plants stand (%) at 21 and 28 days after planting (DAP) was estimated.

2- A random sample of three plants was taken from each plot at 90 DAP to evaluate: Plant height (cm); number of main stems/plant; foliage fresh weight/plant (g) and dry weight of foliage (%).

b- Yield, quality and its components:

1- At harvest, tubers size grade % (> 35, 35 –65 and < 65 mm); number of tubers/plant and total yield (tons/fed) were recorded.

2- Dry matter and starch content of tuber were determined according to the methods described by (AOAC, 1990).

3- Specific gravity of tuber was determined according to the following Equation:

$$\frac{\text{Wight in air}}{\text{Weight in air - Weight in water}}$$

c- Nutrients concentration of tuber:

1- Nitrogen, phosphorus, potassium, iron, zinc, and manganese concentrations were determined after harvest in the digested dry matter of tubers according to Rangana methods (1979).

Data were subjected to the statistical analysis and means were compared using new L.S.D method which described by Gomez and Gomez (1984).

RESULTS AND DISCUSSIONS

1- Vegetative growth parameters:

Data presented in table (2) showed that soaking of seed tubers in mixture of (GA3 + IAA) at concentrations of $(5+3\ ppm)^{-L}$ for 10 minutes before planting was very effective on the plant stand (%) at 21 and 28 DAP by stimulated and enhanced sprouts growth of potato seeds compared with the other treatments. These results agree with those obtained by John (1987), Allen *Et al.*l (1992), Mikitzel (2004), Suttle (2004), Arvind *et al.* (2005) and Sorce *et al.* (2005).

The vegetative growth parameters viz. plant height (cm) , number of stems /plant ; fresh weight of foliage/ plant (g) and dry weight of foliage (%) at 90 DAP was increased significantly by soaking tuber seeds in mixture of (GA3 + IAA) at concentrations of $(5+3\ ppm)^{-L}$ during both seasons of summer seasons of 2005 and 2006 compared with the other treatments . These increases due to an auxinic actions of (GA3 or/+ IAA) compounds on potato plants. These results are in agreement with those obtained by EL-Gamal (1985) , Ismail (1997) , Sharma *et al.* (1999) , Meliha *et al.* (2000) , Mikitzel (2004) , Khan *et al.* (2005) , Kustiati *et al.* (2005) and Zhijun *et al.* (2005) .

2- Yield and its components:

Results of soaking seed tubers in (GA3) and (IAA) and their combinations on yield and its components are presented in table (3). Data in table (3) indicate that the percentage of medium tubers size(35 –65 mm) , number of tubers/plant and total tubers yield (tons/fed) in the 2nd season were significantly increased by soaking of seed tubers in mixture solution of (GA3 + IAA) at concentrations of $(5+3\ ppm)^{-L}$ during both seasons .

Table (2): Plant stand (%) at 25 DAPS and Vegetative growth parameters at 90 DAP as affected by soaking seed tubers in GA3 and IAA and their combinations during the summer seasons of 2005 and 2006.

Characters / Treatments	Plant stand (%) at 21 DAP		Plant stand (%) at 28 DAP		Plant height (cm)		Stems No./ plant		Fresh weight of foliage/ plant (g)		Dry weight of foliage (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1-GA3(2ppm)$^{-L}$	72.5	73.6	90.5	91.8	42.00	40.00	2.33	2.4	344.5	317.5	18.16	17.55
2-GA3(5ppm)$^{-L}$	73.8	74.4	92.6	93.9	45.33	44.33	2.5	2.6	353.0	332.3	18.65	17.80
3-IAA (1ppm)$^{-L}$	59.5	65.2	81.9	82.7	35.00	34.67	1.67	1.67	316.5	292.6	17.30	16.86
4-IAA (3ppm)$^{-L}$	58.8	64.5	82.8	83.9	37.00	38.00	2.00	1.67	318.3	299.7	17.82	17.20
5- GA3 + IAA (2+1 ppm)$^{-L}$	73.5	74.7	90.5	91.8	39.67	39.67	2.33	2.33	332.0	320.0	18.97	18.82
6-GA3 + IAA (2+3 ppm)$^{-L}$	74.5	76.8	90.6	91.7	41.67	40.67	2.33	2.5	342.0	316.4	18.94	18.85
7-GA3 + IAA (5+1 ppm)$^{-L}$	76.8	78. 5	93.7	94.6	47.67	45.33	2.5	2.67	346.3	331.0	19.10	19.03
8-GA3 + IAA (5+3 ppm)$^{-L}$	81.5	83.7	97.8	99.2	49.00	47.67	2.67	2.85	384.4	345.3	19.33	19.77
9-Sprouted seeds (control)	65.5	67.6	90.5	91.6	45.75	43.5	2.5	2.33	337.5	318.2	18.98	18.85
N-L.S.D at 0.05	1.95	2.44.	1.66	2.03	2.14	2.92	0.42	0.33	24.75	15.93	0.54	0.643

Table (3): yield and its components at harvest as affected by soaking seed tubers in GA3 and IAA and their combinations during the summer seasons of 2005 and 2006.

Characters	Tubers size grade%						No. Of tubers/plant		Total yield (tons/fed)	
	>35 mm		35 –65 mm		<65 mm					
Treatments	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1-GA3(2ppm)$^{-L}$	18.9	19.0	38.2	39.3	42.0	41.7	6.2	6.4	11.35	11.62
2-GA3(5ppm)$^{-L}$	19.0	19.1	38.5	39.0	42.5	41.9	6.5	6.8	11.52	11.96
3-IAA (1ppm)$^{-L}$	19.1	19.2	35.1	33.8	46.8	47.0	5.3	5.7	11.30	11.35
4-IAA (3ppm)$^{-L}$	19.3	19.0	33.0	33.5	47.7	47.5	5.4	5.7	11.44	11.56
5- GA3 + IAA (2+1 ppm)$^{-L}$	18.7	19.2	37.3	39.8	44.0	41.0	6.0	6.5	11.46	11.65
6-GA3 + IAA (2+3 ppm)$^{-L}$	19.0	19.1	38.0	38.3	43.0	42.6	6.2	6.8	11.50	11.74
7-GA3 + IAA (5+1 ppm)$^{-L}$	19.4	19.3	38.3	39.8	42.6	40.9	6.5	6.7	11.70	12.33
8-GA3 + IAA (5+3 ppm)$^{-L}$	19.6	18.4	38.9	40.0	41.5	41.6	6.8	7.2	11.95	12.75
9-Sprouted seeds(control)	18.5	18.4	34.2	32.6	47.3	49.0	5.8	6.1	11.88	12.35
N-L.S.D at 0.05	N.S	N.S	0.9	1.07	1.6	1.4	0.3	0.5	N.S	1.40

On the other hand ,results showed that using sprouted seeds for planting (control) recorded higher percentage of large tubers size(<65 mm) than the other treatments, whereas the percentage of small tubers size (>35 mm) and total tubers yield (tons/fed) in both seasons were not affected significantly by the different treatments. The results illustrated that soaking tuber seeds in mixture of (GA3 + IAA) at concentrations of $(5+3\ ppm)^{-L}$ stimulated and enhanced both of cells division and enlargement which caused an obvious increases in the yield and its components.

Similar trends were reported by EL-Gamal (1985), Xu *et al.* (1998), Romanov *et al.* (2000), Mikitzel (2004), Kim *et al.* (2005), Kustiati *et al.* (2005) and Zhijun *et al.* (2005).

3- Tuber quality:

Data in table (4) illustrated that the dry matter of tuber (%) and starch content in tuber (%) were increased significantly in both summer seasons of 2005 and 2006 by soaking of tuber seeds in mixture solution of (GA3 + IAA) at concentrations of $(5 + 3\ ppm)^{-L}$ for 10 minutes before planting compared with the other treatments , while , the specific gravity of tuber was not affected significantly by the different treatments in both seasons of 2005 and 2006 .

Table (4): Tuber quality at harvest as affected by soaking seed tubers in GA3 and IAA and their combinations during the summer seasons of 2005 and 2006.

Characters / Treatments	Dry matter (%)		Starch (%)		Specific gravity	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
1-GA3(2ppm)$^{-L}$	19.10	19.30	13.85	13.75	1.060	1.062
2-GA3(5ppm)$^{-L}$	19.17	19.38	13.89	13.68	1.062	1.064
3-IAA (1ppm)$^{-L}$	18.57	19.33	13.73	13.63	1. 058	1.062
4-IAA (3ppm)$^{-L}$	19.17	19.40	13.86	13.81	1. 060	1.064
5- GA3 + IAA (2+1 ppm)$^{-L}$	18.83	19.30	13.73	13.63	1.058	1.062
6-GA3 + IAA (2+3 ppm)$^{-L}$	18.70	19.35	13.83	13.64	1.058	1.064
7-GA3 + IAA (5+1 ppm)$^{-L}$	18.70	19.28	13.75	13.64	1.060	1.064
8-GA3 + IAA (5+3 ppm)$^{-L}$	19.27	19.45	13.96	13.88	1.064	1.066
9- Sprouted seeds (control)	18.88	19.17	13.78	13.49	1.062	1.064
N-L.S.D at 0.05	0.51	0.32	0.22	0.13	N.S	N.S

These results indicate the positive correlation between tuber dry matter, starch content in tuber and specific gravity (Houghland, 1966) These results are in harmony with those obtained by Meng *et al.* (2004) and Khan *et al.* (2005).

4- Chemical compositions:

Data in table (5) showed that soaking seed tubers in mixture of (GA3 + IAA) at concentrations of $(5+3\ ppm)^{-L}$ led to a positive effects in the tuber contents of macronutrients viz. N (%), P (%) and K (%).These results could also be due to the role of IAA and GA in stimulating both cell division and enlargement of roots causing an increase of N, P and K absorption rates.

Table (5): N, P, K, Fe, Zn and Mn concentrations of tuber at harvest as affected by soaking tuber seeds in GA3 and IAA and their combinations during the summer seasons of 2005 and 2006.

Characters / Treatments	N		P		K		Fe		Zn		Mn	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1-GA3(2ppm)$^{-L}$	1.60	1.64	0.30	0.31	1.91	1.95	187.0	193.0	15.00	16.00	12.00	14.00
2-GA3(5ppm)$^{-L}$	1.64	1.67	0.31	0.33	1.92	2.00	192.0	194.0	16.00	18.00	13.00	14.00
3-IAA (1ppm)$^{-L}$	1.51	1.59	0.26	0.28	1.77	1.83	193.0	195.0	16.00	18.00	13.00	15.00
4-IAA (3ppm)$^{-L}$	1.51	1.55	0.29	0.30	1.81	1.90	198.0	200.0	18.00	19.00	13.00	16.00
5-GA3 + IAA (2+1 ppm)$^{-L}$	1.58	1.61	0.31	0.30	1.82	1.92	187.0	187.0	16.00	17.00	12.00	13.00
6-GA3 + IAA (2+3 ppm)$^{-L}$	1.61	1.62	0.31	0.31	1.84	1.98	194.0	188.0	16.00	18.00	12.00	14.00
7-GA3 + IAA (5+1 ppm)$^{-L}$	1.62	1.68	0.32	0.32	1.88	2.00	198.0	196.0	17.00	18.00	13.00	14.00
8-GA3 + IAA (5+3 ppm)$^{-L}$	1.81	1.84	0.33	0.35	1.95	2.06	202.0	205.0	19.00	21.00	14.00	16.00
9- Sprouted seeds (control)	1.58	1.61	0.26	0.32	1.84	1.87	195.0	198.0	16.00	19.00	12.00	14.00
N-L.S.D at 0.05	0.12	0.15	0.03	0.01	0.08	0. 12	N.S	N.S	N.S	N.S	N.S	N.S

On the other hand, the micronutrients concentrations i.e. Fe, Zn and Mn (ppm) in tubers at harvest were not affected significantly by the different treatments during the summer seasons of 2005 and 2006. Similar results were reported by Meliha *et al.* (2000) and Khan *et al.* (2005).

Conclusion

This investigation indicate that soaking application of tubers seeds in mixture of (GA3 + IAA) at concentrations of $(5+3 \text{ ppm})^{-L}$ for 10 minutes before planting led to increase of vegetative growth parameters , tubers quality improvement and tubers yield and its components in compared with the control and the other treatments . This treatment may help in solving the late sprouting problem seeds in the decreased soil of relative humidity by soaking these seeds in the previous treatment and its planting immediately, in addition to produce more yield of medium tubers size which could be used as seeds for the following seasons (fall, winter and summer) .

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تأثير معاملة تقاوى البطاطس ب IAA و GA3 علي النمو ومكونات الدرنة والمحصول

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أجريت تجربتان حقليتان خلال موسمي الزراعة الصيفيين ٢٠٠٥، ٢٠٠٦ في أرض طمية طينية بمحطة بحوث البساتين بالبرامون- المنصورة- محافظة الدقهلية- مصر لدراسة تأثير نقع تقاوى البطاطس المستوردة صنف اسبونتا في منظمات النمو مثل الجبريلليك بتركيزان (٢ و ٥ جزء فى المليون)/لتر وألأندول بتركيزان (١ و٣ جزء فى المليون)/لتر بالاضافة الى تفاعلاتهم على نسبة الأنبات وقياسات النمو الخضرى والمحصول ومكوناته وجودة الدرنات وبعض المكونات الكيماوية بالدرنات .

وقد بينت النتائج ان نقع تقاوى البطاطس بخليط من(IAA+ GA) لمدة ١٠ دقائق قبل الزراعة بتركيز (٥+ ٣ جزء فى المليون من كل منهما علي التوالي) كان فعالاً جدا على نسبة الأنبات عند ٢١ و٢٨ يوم من الزراعه .كما اوضحت النتائج أن طول النبات والوزن الطازج للعرش/نبات (جم) والمادة الجافة للعرش (%)بعد ٩٠ يوم من الزراعة زادت معنويا مقارنة بالكنترول و المعاملات الأخرى في موسمي الزراعة . ا لنسبة(%) للدرنات متوسطة الحجم (٣٥ – ٦٥ ملم) ، وعدد الدرنات / نبات ، المحصول الكلى (طن/فدان) في الموسم الثاني وكذلك محتوى الدرنات من المادة الجافة(%) و النشا (%)النيتروجين(%) والفوسفور(%) والبوتاسيوم(%)عند الحصاد تأثرت معنويا بنقع تقاوى البطاطس بخليط من(IAA+ GA) لمدة ١٠ دقائق بتركيز (٥+ ٣جزء فى المليون) قبل الزراعة . ا لنسبة(%) للدرنات صغيرة الحجم (أصغر من ٣٥ملم) و المحصول الكلى (طن/فدان) في الموسم الأول والكثافة النوعيه وتركيز العناصر الصغرى (الحديد والزنك والمنجنيز) في الدرنات لم يتأثر معنويا بالمعاملات المختلفة خلال موسمى الدراسة ٢٠٠٥ و٢٠٠٦ .

وقد اوضحت النتائج ان عملية نقع تقاوي البطاطس لمدة ١٠ دقائق في خليط من (GA +IAA) بتركيز (٥ و ٣ جزء فى المليون) قبل الزراعة أدت الي زيادة في قياسات النمو الخضرى و تحسين جودة الدرنات و المحصول الكلى ومكوناته مقارنة بالكنترول والمعاملات الأخري . كما ان استخدام هذه المعاملة يمكن ان يساعد في حل مشكلة تأخر انبات تقاوى البطاطس في تربة انخفضت رطوبتها النسبية وذلك بزراعة هذه التقاوى مباشرة بعد نقعها في المعاملة السابقة ، بالاضافة الي انتاجها لمحصول كبير من الدرنات ذات الحجم المتوسط التي تستخدم كتقاوى للعروات الأخرى (خريفي – شتوي – صيفى).