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RESPONSE OF SIX TRUE POTATO SEEDS GENOTYPES TO GA_3 IN GERMINATION AND YIELD CHARACTERS OF MINI-TUBERS PRODUCED

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Abstract

Potato multiplication with seeds reduces the costs of agriculture, environmental damage resulting from the use of pesticides to maintain seeds and helps to produce seeds resistant to viral diseases. However, low seed germination rate of some varieties can considerably limit the production of potatoes in this way. The aim of this study was to evaluate the effect of soaking seeds of six potato strain in different concentrations of gibberellin on germination rate and characters of yielded mini-tubers. Potato seeds of all strain (imported ID, MST186-1Y, MSL211, MSV093-1 and MSS927-01 and the local comparison cultivar Burren) were soaked in gibberellin at three concentration levels (0, 500 or 1000 mg/L). The seeds were then dried and planted in cork dishes inside the greenhouse. At stage of two true leafs, the seedlings were transferred to 4 kg pots containing field soil and peat moss at 3:1 ratio. Pots were distributed based on RCBD with four replicates and five pots per experimental unit. The results of the study showed that the treatment of potato seeds with gibberellin had a significant effect in increasing the rate and speed of germination and the number and weight of tubers produced. In general, the highest concentration of gibberellin (1000 mg / L) was more effective than the lowest concentration and significantly differed from the distilled water treatment. All the values of the studied traits were affected by plant cultivar. The ID cultivar recorded highest values in germination ratio, number and weight of tubers. The strain did not differ in germination speed although MSL211 gave the highest rate of germination speed among all treatments and with only significant difference from the lowest rate recorded in the comparison cultivar Borin. Interaction of gibberellin treatment and potato cultivar was always effective in increasing all the tested traits over the untreated control. Findings of this study showed successful production of potato mini-tubers from potato seeds in case of Iraqi field conditions.

Key words: Gibberellin, true potato seeds, mini-tubers, genotypes.

Introduction

Potatoes (*Solanum tuberosum* L.) is one of the most important vegetable crops in the many countries of the world due to their high yield adaptation to various environmental conditions in. This important crop is grown in most countries of the world as food source rich in carbohydrates and contains many important elements such as protein, iron, potassium, phosphorus and ascorbic acid (Mustafa, 2010). Considering the importance of this crop in the world and being a major part of the global food security system. and because of the vast areas that are grown in all countries of the world. Potato production techniques have steadily evolved to meet market needs and global consumption.

The use of modern technology in potato cultivation, production and multiplication of potatoes with true seeds (TPS) with control on diseases and pests have become important factors in increasing potato production in the world. The use of seeds in potato propagation to substitute vegetative propagation is likely to be the future technique in the seed importing areas. Researches showed that the successfulness of this technique in providing high quality potato seeds and reducing potato production costs (Hardy *et al.*, 1994). In addition, the production of potatoes using seeds is an environmentally friendly technique that eliminates the use of pesticides used for tuber treatment (Sharma, 2013).

The interest in cultivation potato from seeds in commercial production began in the late 1970 in many

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countries of the world. Propagation by true seeds has contributed to the abundance of genetic variations and consequently, the large number of cultivated varieties grown in different parts of the world (Hassan, 2012). Some countries, such as India, China, Vietnam and Bangladesh, began to cultivate real potato seed in the production for viral diseases free tubers (Vreugdenhil *et al*., 2007). In the Arab world, there are Egyptian attempts to produce potato seeds on a commercial scale using real seeds as an alternative to potato propagation by tubers. In Iraq, Jassem *et al*., (2012) have been able to produce potato tubers from the cultivation of real seeds of the Burin variety adapted to Iraq's environmental conditions. The real seeds of some potato varieties require special treatments in order to overcome seed dormancy. Sahlani's, (2008) conducted an experiment to study the treatment of real seed potatoes of the Desiree variety in several concentrations of gibberellin. It was found that the treatments affected the germination where highest germination rate was at concentration 500 mg. For the purpose of using modern technologies in commercial potato production, this research was conducted.

Materials and Methods

Potato seeds: Seeds of five potato strain used in this study (ID, MST186-1Y, MSL211, MSV093-1, MSS927-01) were obtained from the Dept. of Agronomy University of Michigan while seeds of the local cultivar, which served as comparison, were collected at harvest from potato field at the Alusofiya district in the province of Babylon in Iraq.

Gibberellin: Commercial gibberellic acid powder was purchased from a local agricultural dealer. The gibberellin concentrations were prepared by solving gibberelic acid powder in distilled water at 500 and 1000 mg/L while the distilled water was used as control treatment.

General experimental procedure

Seeds of all the studied potato strain were soaked for 24h. in gibberellin (500 or 1000mg/L) or distilled water. Seeds were then dried and planted in cork planting dishes containing peat moss, irrigated and maintained under plastic house conditions. At stage of two true leaves (Fig. 1), all plants were transplanted into 4 Kg plastic pots two thirds (2/3) filled with 3:1 soil mixture of field soil and peat moss. Three times of hilling were applied for all pot plants during the growing season. Pots were arranged as Randomized Complete Block Design RCBD with four replicates and ten pots per unit. All the agricultural services and practices were carried out following the recommendations of potato

Fig. 1: Different potato strain grown from true seeds; A and B plants at stage of two true leaves; C, D, E & F formation of stolons, micro-tubers and early mini-tubers on potato roots.

Table 1: Effect of Gibberellin concentrations in seed germination rate (%) and germination speed (days) in six potato strain.

Potato variety	% seed germination				Speed of seed germination (day)			
	Gibberlin concentrations				Gibberlin concentrations			
	0	500mg/L	1000mg/L	Average	0	500mg/L	1000mg/L	Average
Burren	31.70d	44.00cd	48.40cd	41.40d	3.70c	3.55c	4.28bc	3.84b
ID	73.80ab	74.60ab	87.20a	78.60a	5.27bc	6.02ab	7.30ab	6.19a
MST186-1Y	60.00bc	74.10ab	87.50a	73.90ab	5.60b	6.34ab	7.44a	6.47a
MSL211	54.40c	74.40ab	73.30ab	67.40b	6.00ab	6.97ab	7.43a	6.81a
MSV093-1	45.00c	55.70c	59.20bc	53.30c	4.32bc	5.97ab	7.32ab	5.87a
MSS927-01	45.30c	55.20c	67.00bc	55.80c	5.18bc	6.13ab	7.14ab	6.15a
Average	51.70c	63.00b	70.30a		5.02c	5.83b	6.82a	

Values are means of three replicates (pots). Means that have same letter (s) within column are not significantly different according to Duncan's multiple range tests ($P \leq 0.05$).

Measurements and data analysis

Seed germination rate and germination speed (Khalil, 2004) were recorded 10 days post planting while number and weight of mini-tubers per plant were recorded at the end of the experiment 110 days post transplanting. Data were analyzed using GenStat 12th edition computing program and analysis of variance was performed for treatments across strain. Averages were compared according to Duncan's multiple range tests at $P \leq 0.05$ (Al-Rawi and Khalaf Allah, 2000).

Results and Discussion

The results showed that the treatment of soaking potato seeds with gibberellin significantly affected germination percentage which increased by increasing the concentration of gibberellin within genotype (Table 1). Gibberellin at concentration of 1000 mg.L^{-1} resulted in highest germination rate of 70.30% with significant difference from the treatment of seeds soaking in distilled water, which gave the lowest germination rate of 51.30%. The same table indicates significant differences between strain in seed germination rates. There was no significant difference between ID and other strain, although it had the highest germination rate of 78.60% compared to the local cultivar Burren which gave the lowest germination rate of 41.40%. The interaction between seed treatment with gibberellin and strain, it was showed from the results that the interaction of MST186-1Y and gibberellin at 1000 mg.L^{-1} resulted in the highest germination rate among all the treatments.

On the other hand seed germination speed was slightly affected by plant strain and more affected by gibberellin concentration levels (Table 1). Speed of seed germination in all the strain was higher where seeds were treated with 1000 mg.L^{-1} gibberellin than those soaked in distilled water. From the same table, there were significant differences between the strain in germination speed as the MSL211 had the highest germination speed (6.81) compared to the lowest speed (3.84) in local cultivar Burren. The interaction between the treatment of true seed soaking in gibberellin and the strain significantly affected the germination speed and the interaction between the MST186-1Y strain and the concentration of 1000 mg.L^{-1}. It gave the lowest average germination speed of 3.55. The reason for the increased germination in seed treated with gibberellin over the distilled water treated is mostly due to the role of gibberellin in stimulating seed germination by reducing mechanical resistance in seed coat (Kucera *et al*., 2005). Gibberellin released by the growing embryo and transmitted to the cells of the Aleurone layer stimulates the genes responsible for plant degrading enzymes such as amylase, protease and nuclease responsible for germination by converting complex stored compounds such as carbohydrates, fats and proteins into available nutrients passed to the embryo to start the germination process (Shahid, 2017). The increased concentration of gibberellin may also directly increase the decomposing substances and thus increased nutrients abundance, which positively affected germination rate and speed. Or, the 24-hour soaking may have affected seed dormancy by minimizing the effect of growth inhibitors in the seeds, resulting in increased germination rate and speed. This is consistent with the findings of Cha *et al*., (2011) and Jansky *et al*., (2012) where treatment of true potato seeds with gibberellin increased seed germination rates.

Relative to mini-tubers produced, number and weight of mini-tubers (Fig. 2) were also affected by potato cultivar and seed treatment (Table 2). The treatment of seeds soaking in gibberellin at 1000 mg.L^{-1} resulted in the highest average number of tubers (8.00 tubers.plant^{-1}) while the distilled water treatment gave the lowest average (4.92 tubers.plant^{-1}). In case of potato strain, ID had the highest number of mini-tubers per plant (8.25) among all the strain with significant difference from the local Borin which recorded the lowest number of mini-tubers per

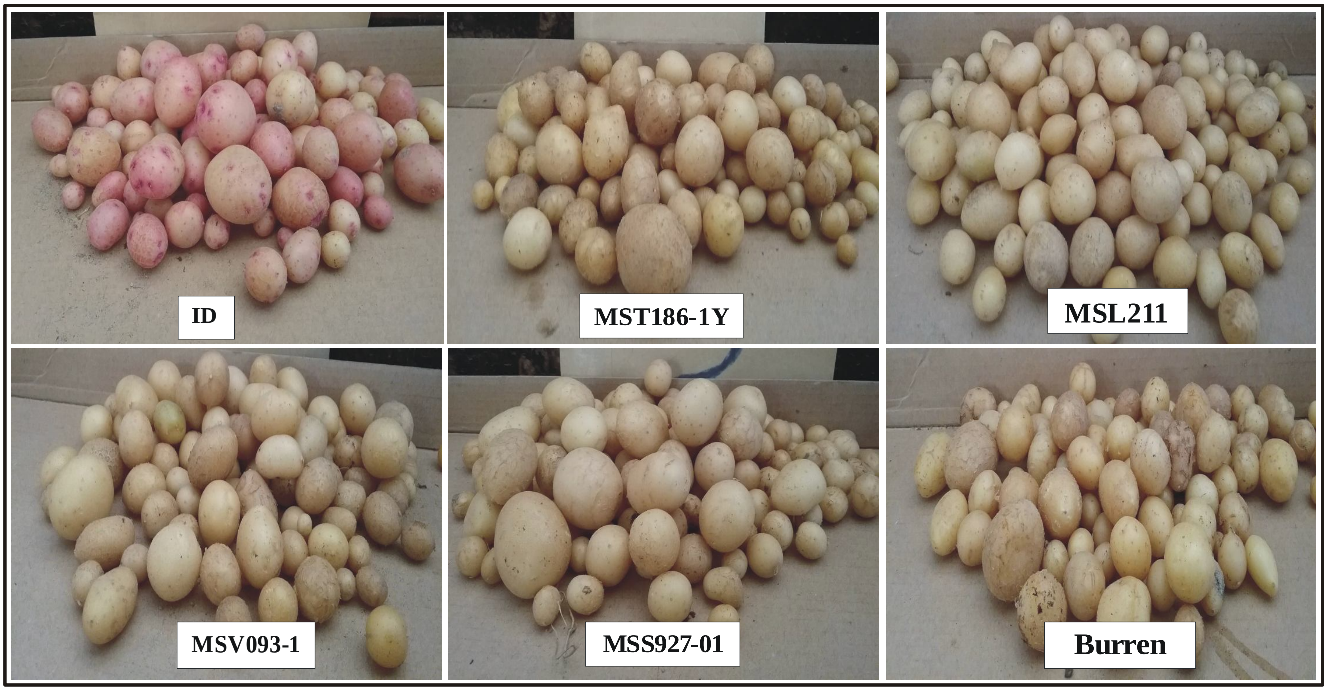

Fig. 2: Potato mini-tubers at different live stages and sizes produced from true seeds of six potato strain.

plant (4.56). Likewise, the interaction treatment of ID and gibberellin at 1000 mg.L^{-1} recorded the highest average (10.25 mini-tuber.plant^{-1}) compared to interaction treatment the local Borin and seed soaking with distilled water which recorded only 3.44 mini-tuber.plant^{-1}.

Similarly, the weight of mini-tubers was affected by different treatments and plant cultivar (Table 2). Generally, the highest mean weight of mini-tubers (65.96g.plant^{-1}) was recorded in 1000 mg.L^{-1} gibberellin compared to the lowest (49.74g.plant^{-1}) in the distilled water treatment. Among potato strain, the highest weight (73.50 g.plant^{-1}) was recorded in cultivar ID with a significant difference from the lowest value (43.16 g.plant^{-1}) in the local cultivar Burren the highest rate of mini-tubers weight was recorded in the interaction treatment of ID and gibberellin at 1000mg.L^{-1} reaching 79.12g.plant^{-1} compared to lowest average of 35.40g.plant^{-1} from interaction of Burren and soaking with distilled water.

The results show the superiority of cultivar ID in the number and weight of tubers over the local Burren. This is probably due to the fact that the high quality ID seeds contributed to production of strong seedlings with vigorous vegetative growth and free of disease, which consequently resulted in higher values in the number of weight of produced mini-tubers (Pallais, 1991). Or it may be due to the genetics that affect performance of this cultivar to have good qualities in terms of nature of growth and number of ground stems (Stolons) formed on plant roots. Genetics may also made this cultivar to be more adaptive to environmental conditions, which positively affected vegetative growth and thus increase the number of ground stems and number and weight of mini-tubers. This is consistent with the finding Prakash and Gautam, (2014) that true seeds can be used for potato production.

Table 2: Effect of Gibberellin concentrations in number of mini-tubers plant^{-1} and tuber weight (g.plant^{-1}) in six potato strain.

Potato variety	**No. of Mini-tubrs plant^{-1}**				**Mini-tuber weight (g.plant^{-1})**			
	Gibberlin concentrations				**Gibberlin concentrations**			
	0	**500mg/L**	**1000mg/L**	**Average**	**0**	**500mg/L**	**1000mg/L**	**Average**
Burren	3.44d	4.50cd	5.75c	4.56d	35.40f	42.53e	51.54d	43.16d
ID	6.50bc	8.00b	10.25a	8.25a	65.17bc	76.20a	79.12a	73.5a
MST186 -1Y	5.50c	6.50bc	7.75b	6.58b	41.61e	54.72d	62.93c	53.09c
MSL211	4.00cd	5.25cd	7.00bc	5.42c	43.65e	52.34d	64.02bc	53.34c
MSV093 -1	4.75cd	5.75c	7.75b	6.08bc	53.53d	66.42bc	68.93bc	62.96b
MSS927-01	5.25cd	6.75bc	9.50ab	7.17b	59.09c	64.75bc	69.19b	64.34b
Average	4.92c	6.13b	8.00a		49.74 c	59.51 b	65.96 a	

Values are means of three replicates (pots). Means that have same letter (s) within column are not significantly different according to Duncan's multiple range tests ($P \leq 0.05$).

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