Encouragement Germination of Potato Seed Cultivars (*Solanum tuberosum* L.)

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Abstract: A greenhouse experiment were conducted to study encouragement germination capacity of some potato tuber cultivars. The mean aim of this experiment was to assess the effect of some plant growth regulators treatments *i.e.* IAA and GA3, soaking time *i.e.* at (10 minutes, 20 minutes and 30 minutes on some germination and vegetative parameters of some potato cultivars *i.e.* Cara, Draga and Spunta. The results showed that Cara cultivar recorded highest germination index followed by Cv. Spunta without significant differences between them. Draga cultivar recorded tallest plant, highest fresh weight and dry weight in gm/plant followed by Cv. Cara for plant height only and followed by Cv. Spunta for fresh and dry weight without significant differences between them. Highest germination index percentage, tallest plants and highest fresh and plant dry weight were obtained from soaking tubers in GA3 at 10 ppm plus IAA at 6 ppm. While, soaking tubers in GA3 at concentration of 10 ppm produced highest mean of germination time. Results clearly indicated that soaking tubers for 30 minutes produced highest fresh weight followed by soaking for 20 minutes without significant differences between them. The interaction among cultivars and growth regulator treatments recorded significant differences on mean germination time, fresh weight and dry weight. Within this context, it is important to recognize the role of some growth regulators, soaking times and their interactions on encouragement germination capacity of some potato tuber cultivars.

Keywords: Potato cultivars, IAA, GA_3, germination index and vegetative parameters.

INTRODUCTION

In Egypt, potato, (*Solanum tuberosum* L.) is a major food crop and considered to be one of the most important vegetable crop for local consumption, and exportation. Plant growth regulators are chemicals that modify plant growth, flowering, and dormancy by mimicking plant hormones. Potato seed propagation is the most common method for production of many ligneous plants. Bud dormancy is a characteristic prevalent in many plant species. It can be initiated by various factors, including moisture stress, high or low temperatures, day length and heredity [1]. Fresh potato tubers are in a state of endogenous dormancy which must be terminated before sprout growth will commence. When gibberellins are applied to dormant tubers, dormancy can be broken according to [2-5]. Potato tubers remain dormant for up to 10 weeks depending on the variety and seasonal weather conditions during the growth period [6]. Seed treatment by potassium humate for 6-12 h and seed direct planting in greenhouse percent without seed germination under *in vitro*, caused to increase seed germination percent [7].

Gibberellins (GA) stimulate cell division and elongation, break seed dormancy and speed germination at low concentration. Whereas, andol-3-acetic acid (IAA) plays an important role in an extent range of growth and development processes. GA stimulate sprouts growth of potato seeds [8]. GA3 enhanced both shoots and stolons growth and dry weight of plant but decreased starch content of tuber [9-12]. Gibberellins play a very important role in the regulation of growth and development in higher plants [13]. Soaking application of seed tubers in mixture of GA3+IAA at concentration of 5+3 ppm for 10 minutes before planting was very effective on the plant start at 21 and 28 day after planting, increase vegetative growth parameters, improved tubers quality, tubers yield and its components as compared to the control and other treatment [14, 15]. Hemberg reported that Gibberellins are plant hormones, enhancing seed germination [16], gibberellins were able to numerically increase barley germination up to 18%. Pardhan and Bodla concluded that e*x situ* produced seeds attained physiological dormancy [17], which was broken by pre-sowing treatments using gibberellic acid at concentration of 50 to 350 µM most effectively stimulated seed germination [18] suggested that lower levels of GA_3 of up to 20 mg kg^{-1} should be adopted for promotion of sprouting of potato seed tubers. Similar conclusion was reported by [19] who studied enhancement seed germination of *Chlorophytum borivilianum* highest germination percentage occurred with 10^{-6} M concentrations of testosterone (36.45%) followed by cholesterol (35.17%) with respect to control (8.5%). The maximum shoot length of seedlings was observed when seeds were treated with 10^{-6} M

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concentration of testosterone (4.43 cm), cholesterol (4.27 cm) and 24-epiBL (4.25 cm) with respect to control (2.80 cm).

The successful soaking process in the growth regulators was depend on the time was taken, So the researcher must be take this steps by all of careful to ensure to get the accurate results. Indole acetic acid (1AA), Abscisic acid (ABA) and Kinetin each at 10^{-6}M were used as seed soaking treatment on *Glycine max* (L.) and stated that maximum values were recorded in IAA and kinetin treated plants and the minimum value was recorded in ABA treated plants. Plants grown in commercial soil and sprayed with GA3 100 ppm had shortened the dormancy period by 30-80% in 'Atlantic' and 28-53% in 'Nor Valley' under room temperature and 5-12.5% in 'Atlantic' and 0-7.5% in 'Nor Valley' under 4˚C condition compared to the untreated control. The length of the longest sprout was indeed different among cultivars. Frieslander did not react on GA3 in contrast to cultivar Marfona, which showed a strong response to both doses of GA3 by producing longer sprouts [20].

Regarding to the interaction between cultivars and time of soaking, vegetative growth and tuber yield were increased by treatment GA3 at 5 ppm + IAA at 3 ppm [14]. Seed tubers soaked in GA3 for 10 minutes resulted highest number of sprouts and uncut control produced lowest number of sprouts. Frieslander cultivar produced higher number of sprouts and also more weight of sprouts than other cultivars [20]. Seed soaking in GA at 50 ppm caused an obvious increase in stem length [21]. Tubers were dipped in 5 or 7 mg/liter for 5 minutes before sowing and compared with tuber dipped in water. GA3 7 mg/liter resulted in a significant increase in average plant height in the first season [15]. The objectives of the present study were aimed to enhancement of potato tuber seed cultivars germination using soaking times of different plant growth regulators doses.

MATERIALS AND METHODS

A greenhouse experiment was carried out at experimental station of faculty of agriculture, Mansura University during May 2011 to study the effect growth regulators treatments and its time soaking on germination capacity of some potato cultivars. Three cultivars of the commercial cultivated potatoes *i.e.* Cara, Draga, Spunta were used. Studied cultivars were get it from ministry of agriculture, potato producer society. Plastic bags with four pores filled with 3kg sand loamy soil each were separately planted with one peace tuber of one sprout from each tested cultivars. One hundred and thirty five plastic bags were used in this experiment, forty five for each potato cultivar. Plastic bags then received water as needed. All plastic bags were arranged in split plot design system with for replicates. Germination and vegetative parameters were measured. Five treatments of plant growth regulators *i.e.* control, IAA at concentration of 6 ppm, GA3 at concentration of 10 ppm, IAA at 3 ppm + GA3 at 5 ppm and IAA at 6 ppm + GA3 at 10 ppm. Effect of two growth regulators *i.e.* IAA and GA3 singly or mixed or in combination at half doses to study this affect of such growth regulators i.e. IAA or GA3 or their mixture or half of their mixture at three times of soaking. Each treatment was replicated three times. Three time of soaking were applied *i.e.* (10, 20 and 30 minutes).

In this experiment, forty five black plastic bags with four small pores (two at each side) containing 3 kg, sandy loam soil were planted with one piece tuber with one sprout of potato seed cultivars /bag after soaking in such growth regulators under study, *i.e*. IAA at 6ppm or GA3 at 10 ppm or their combination at the half dose for 10, 20 and 30 minutes before planting on February 2011. Treatments were as follows, where each was replicated three times. All plastic bags then received water as needed and other agricultural practices as NPK etc. were carried out according to the recommendations of the Ministry of Egyptian Agriculture. All plastic bags were arranged in split plot design system. Seventy five days after seed germination, vegetative growth parameters were determined and recorded as this was the peak of its growth.

Studied Characters

A. Germination Parameters

1- Germination index (GI): It was calculated as described by International Seed Testing Association, 1996 [25] as the following formulae:

GI = No. of germinated seeds÷ Days of first count +…..+ No. of germinated seeds/ Days of final count

2- Coefficient of velocity (CV): a unit less parameter determined by a mathematical manipulation that incorporates the number of seeds germinated and the velocity of germination was calculated using the following formula:

$$C V = 100 [\sum Ni \div \sum Ni\ Ti]$$

Where N is the number of seeds germinated on day I and T is the number of days from sowing [26]. In general, a higher CV value reflects increased germination and shorter germination time.

3- Mean germination time (MGT): It was determined according to the equation of [24]:

MGT= ∑dn ÷∑ n

Where (n) is the number of seeds which were germinated on day (d), and (d) is the number of days counted from the beginning of germination

B. Vegetative growth parameters:

1- Plant height: Plant height representative in main stem was measured as the average height in centimeters of plants. The measurement started from the surface of ground to plant stem apex.

2- Plant fresh weight: Fresh weight of plant representative in main stem was determined as the average weight per plant in grams from each replication.

3- Plant dry weight: Fresh plants were dried out in an oven till constant weight at 70 ºC.

Statistical Analysis

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split – plot design as published by using means of "MSTAT-C" computer software package [25]. Least Significant Difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described [26].

RESULTS AND DISCUSSION

1. Performance of Cultivars

The results in Table 1 showed that Cara cultivar recorded highest value of germination index (13.52%) followed by Spunta cultivar (12.02%) without significant effect between them. Similar conclusions were recorded by [12, 20, 27-29]. The results showed that Draga cultivar recorded highest value of plant height, fresh weight and dry weight (22.93 cm), (91.24 g/plant) and (20.55 g/plant), respectively followed by Cara cultivar for plant height only (22.84 cm) and followed by Spunta cultivar for fresh weight and dry weight (79.77 g/plant) and (19.77 g/plant) without significant differences between them. These results are in agreement with those obtained by [9, 10, 13, 14, 21, 28, 30-32].

2. Growth Regulators Effects

The results in Table **1** indicated that a significant difference between growth regulators treatments on germination index, highest germination index was obtained by soaking in GA3 at concentration of 10 ppm plus IAA at concentration of 6 ppm (16.76%) followed by soaking in GA_3 at concentration of 10 ppm (16.66%). Similar conclusions were recorded by [6, 9, 27, 33]. Meanwhile significant differences between growth regulator treatments for mean germination time, soaking in GA_3 at concentration of 10 ppm produced highest value of mean germination time (16.54 days) followed by soaking in GA3 at concentration of 10 ppm plus IAA at concentration of 6 ppm (16.85 days). Similar conclusions were reported by [14, 34, 35]. The results in Table 1 indicated that a significant differences between growth regulators for all vegetative parameters, tallest plants, highest fresh weight and dry weight were obtained from soaking in GA3 at 10 ppm plus IAA at 6 ppm followed by GA3 at concentration of 10 ppm (23.55 and 23.40 cm for plant height), (111.85 and 83.70 g/plant for fresh weight) and (22.77 and 20.37 g/plant for dry weight). Gibberellins are plant hormones, enhancing seed germination [16], gibberellins were able to numerically increase barley germination up to 18%. Pardhan and Bodala concluded that *ex situ* produced seeds attained physiological dormancy [26], which was broken by pre-sowing treatments using gibberellic acid at concentration of 50 to 350 µM most effectively stimulated seed germination. These results are in agreement with those obtained by [9, 10, 14, 21, 28, 31, 32, 36].

3. Time of Soaking Effects

Regarding to the effect of time of growth regulators soaking, the results in Table 1 clearly indicated that there is significant differences between times of soaking on fresh weight per plant. Growth regulators soaking for 30 minutes produced highest fresh weight (79.33 g/plant) followed by soaking for 20 minutes (75.00 g/plant) without significant differences between them. Similar trends were reported by [9, 10, 14, 28, 31, 32].

4. Interaction Effects

The results indicated that interaction among cultivars and growth regulator treatments recorded

Table 1: Averages of Germination Index, Coefficient Velocity, Mean Germination Time, Plant Height (cm), Fresh Weight (g/plant) and Dry Weight (g/plant) as Affected by Cultivars, Growth Regulators Treatments and Time of Growth Regulators Soaking and their Interactions

Treatments	Germination index	Coefficient velocity	Mean germination time	Plant height (cm)	Fresh weight (g/plant)	Dry weight (g/plant)
A: Potato cultivars:						
Cara	13.52	0.056	18.01	21.84	55.44	17.77
Draga	9.82	0.054	18.12	22.93	91.22	20.55
Spunta	12.02	0.071	17.68	20.75	79.77	19.66
F-test	*	N.S	N.S	**	**	**
LSD 5 %	2.83	-	-	1.03	4.28	1.29
LSD 1 %	-	-	-	1.37	5.68	1.72
B: Growth regulators treatments						
GA3 10 ppm	16.66	0.084	16.54	23.40	83.70	20.37
IAA 6 ppm	9.83	0.054	18.18	22.14	59.25	17.77
GA3 10 ppm + IAA 6 ppm	16.76	0.062	16.85	23.55	111.85	22.77
GA3 5 ppm + IAA 3 ppm	11.28	0.057	17.41	21.37	76.66	20.00
Control	4.42	0.046	20.68	18.74	45.92	15.74
F- test	**	N.S	**	**	**	**
LSD 5%	3.65	-	1.17	1.34	1.48	1.67
LSD 1%	4.85	-	1.55	1.74	1.36	2.22
C: Time of growth regulators soaking						
10 minutes	12.08	0.070	17.84	21.35	72.11	19.66
20 minutes	11.53	0.057	17.62	22.04	75.00	18.77
30 minutes	11.76	0.054	18.34	22.13	79.33	19.55
F-test	N.S	N.S	N.S	N.S	**	N.S
LSD 5%	-	-	-	-	4.54	-
LSD 1%	-	-	-	-	6.03	-
D: F-test Interaction						
AXB	N.S	N.S	*	N.S	**	**
AXC	*	N.S	N.S	N.S	N.S	*
BXC	N.S	N.S	N.S	**	N.S	N.S
AXBXC	N.S	N.S	N.S	**	N.S	**

significant differences on mean germination time, fresh weight and dry weight. The best value of mean germination time obtained by soaking of Spunta cultivar in GA3 at 10 ppm plus IAA at 6 ppm followed by soaking Cara cultivar in GA3 at concentration of 10 ppm without significant differences between them (Fig. 2). Highest plant fresh weight per plant was obtained from soaking Draga cultivar in GA3 at 10 ppm plus IAA at 6 ppm followed by Spunta cultivar when soaked in the same treatment (Fig. 4). Highest plant dry weight was produced from soaking Draga cultivar in GA3 at 10 ppm plus IAA at 6 ppm followed by Spunta cultivar when soaking in the same treatment (Fig. 5). The results indicated that significant differences due to the interaction between cultivars and times of soaking in growth regulators on germination index (Fig. 1). The highest germination index obtained by soaking Cara cultivar for 30 and 20 minutes, respectively followed by soaking Spunta cultivar for 10 minutes without significant differences between them. Highest dry weight was obtained by soaking Draga cultivar for 20 and 30 minutes, respectively followed by soaking Spunta cultivar for 30 minutes without significant differences between them(Fig. 6). There is a significant

difference in the interaction between growth regulators and times of soaking on plant height as illustrated in (Fig. 3). The tallest plants was obtained by soaking cultivars in GA3 at concentration of 10 ppm for 20 minutes followed by soaking cultivars in GA3 at concentration of 10 ppm plus IAA at concentration of 6 ppm for 20 and 10 minutes without significant differences between them. Seed tubers soaked in GA3 for 10 minutes resulted highest number of sprouts and uncut control produced lowest number of sprouts. Frieslander cultivar produced higher number of sprouts and also more weight of sprouts than other cultivars [20]. Tubers were dipped in 5 or 7 mg/liter for 5 minutes before sowing and compared with tuber dipped in water. GA3 7 mg/liter resulted in a significant increase in average plant height in the first season [15].

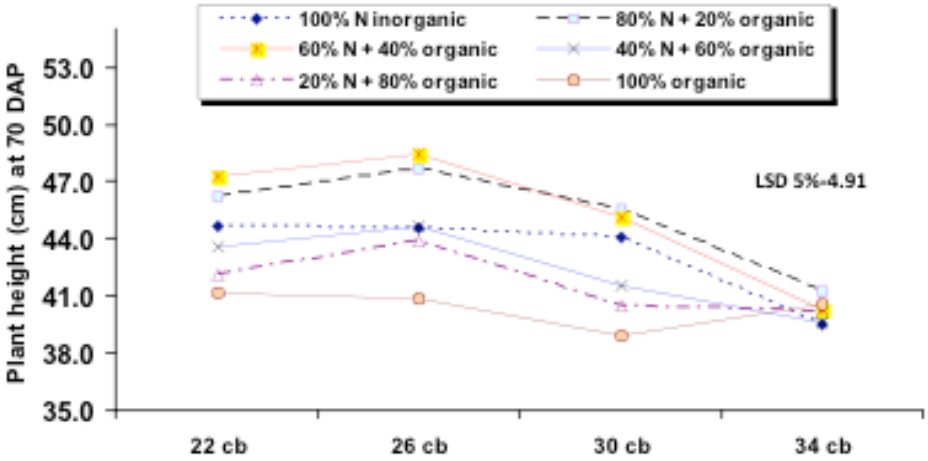

Figure 1: Averages of germination index as affected the interaction between cultivars and times of growth regulators soaking.

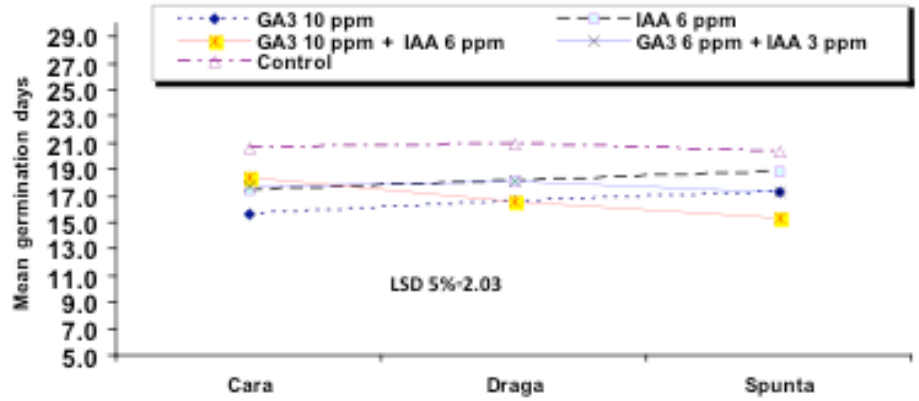

Figure 2: Averages of mean germination time as affected the interaction between cultivars and growth regulators treatments.

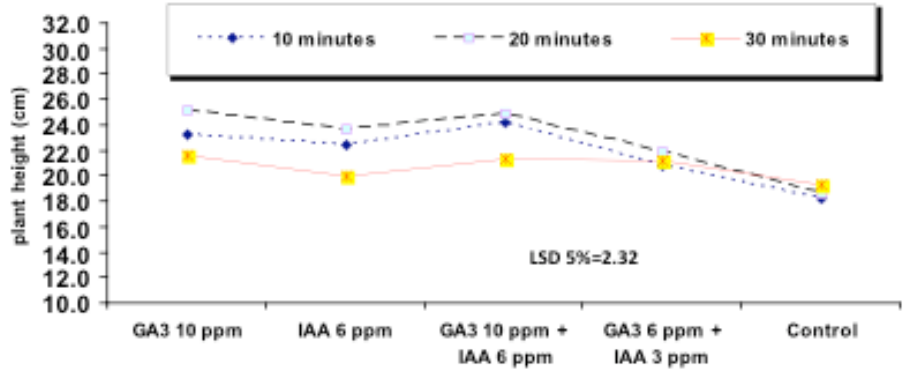

Figure 3: Averages of plant height (cm) as affected the interaction between growth regulators treatments and time of growth regulators soaking.

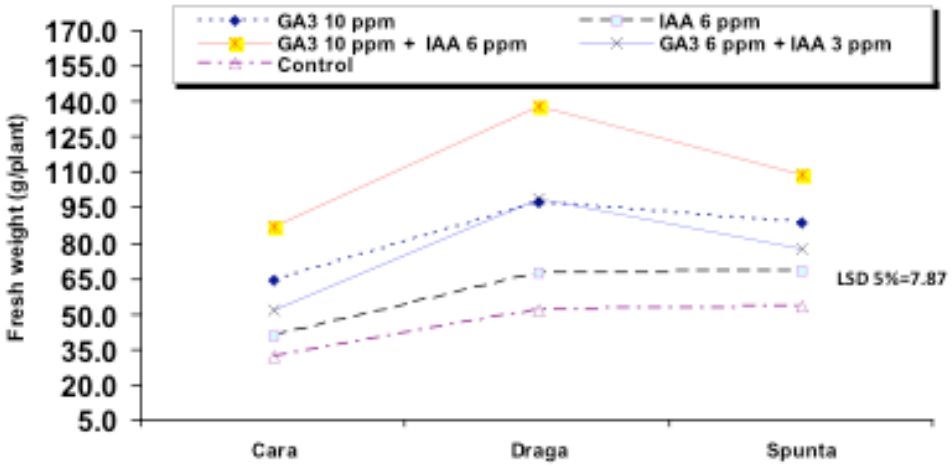

Figure 4: Averages of fresh weight (g/plant) as affected the interaction between cultivars and growth regulators treatments.

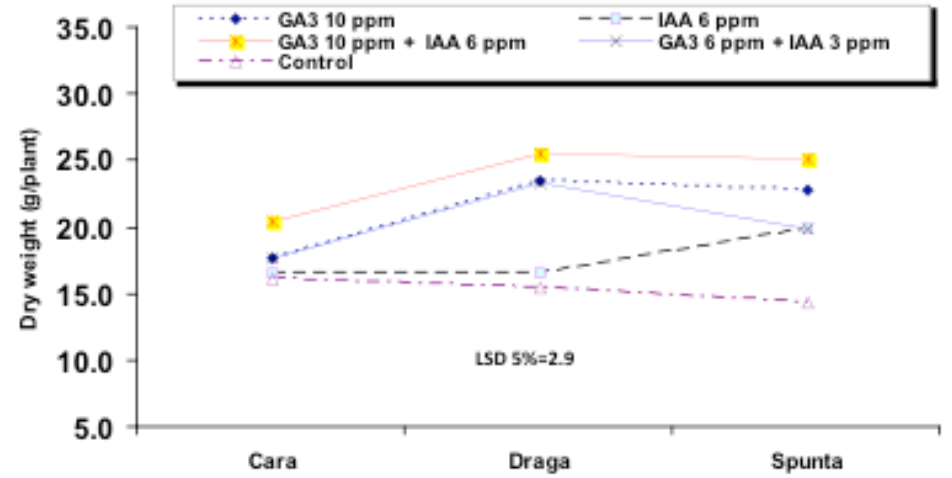

Figure 5: Averages of dry weight (g/plant) as affected the interaction between cultivars and growth regulators treatments.

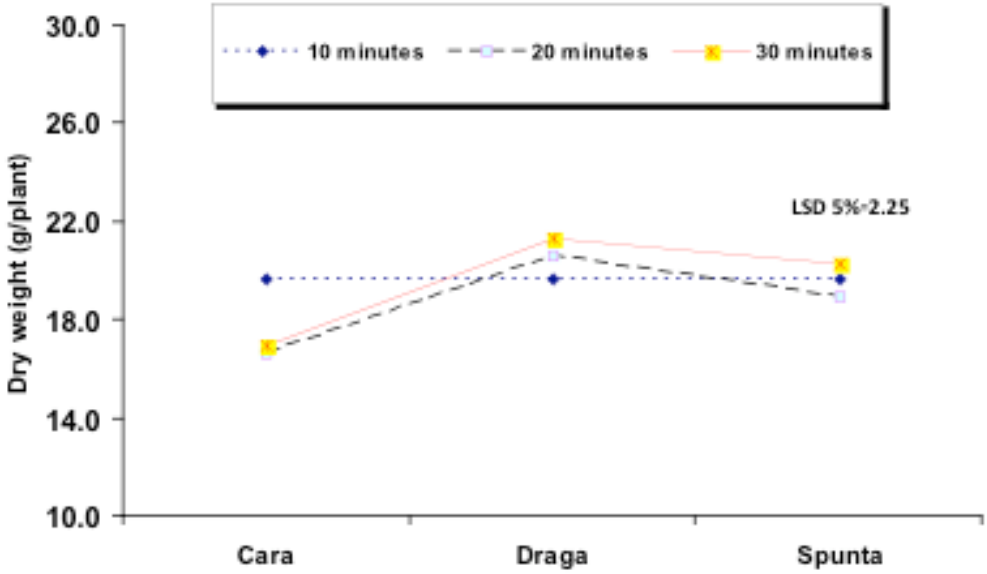

Figure 6: Averages of dry weight (g/plant) as affected the interaction between cultivars and time of growth regulators soaking.

CONCLUSIONS

In general, for encouragements germination and growth of potato seed tubers it could be achieved by sowing Cara cultivar, soaking tubers in GA3 at concentration of 10 ppm plus IAA at concentration of 6 ppm for 30 minutes.

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