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Effect of Thiourea on Dormancy Breaking and Yield of Potato (*Solanum Tuberosum* L.) Minitubers Marfona cv. in Greenhouse

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Abstract. This experiment was conducted for studying thiourea application effect on potato minitubers dormancy breaking in Marfona cultivar in greenhouse in 2008. Thiourea in three levels as 0, 0.5, and 1% arranged in a completely randomized design in three replicates. After dormancy breaking, attributes like as days to sprouting, length of the longest sprout, and sprout number measured. Then minitubers planted in pots and days to emergence, main stem numbers, and plant height measured. Tuber number per plant, yield and mean tuber weight was calculated after harvesting. Results showed that thiourea had significant effect on all attributes except of sprouts number and length of sprouts. Applying 1% thiourea decreased days to sprouting date from 102 to a bit less than 90 days, decreased days to emergence from 38 to 28 days, increased stem number from 1.2 to 2.1, increased plant height at least 28 cm, increased tuber number per plant from 4 to 8, decreased mean tuber weight per plant at least 25 g and increased total tuber weight per plant from 150 to more than 185 g. Therefore, applying 1% thiourea is recommendable for minitubers dormancy breaking because of its effect on rapid dormancy breaking, rapid emergence, and increasing minituber number per plant and increasing tuber yield in Marfona minituber production.

Key words: dormancy period, thiourea, total tuber weight.

1. Introduction

Potato (*Solanum tuberosum* L.) is considered as an important and strategic product, having the second rank in terms of production and third one according to its importance among other produced foods in Iran (1). In recent years, the most efficient way of controlling and removing viruses in potato is producing healthy plantlets in laboratory conditions through combining heat-therapy and culturing meristematic cells of this plant in order to produce micro and minitubers (12). Potato minitubers are not plant able immediately after harvest and during unknown period after that, so they have dormancy period during which the tubers will never germinate. Duration of dormancy in potato minitubers depends on cultivar, ripening time, growth condition, maintenance condition in store and the tuber size. Minitubers' Dormancy period is longer than normal seed tubers (3, 9, 20 and 21).

In some regions, it is possible to cultivate potato more than one time in a year or the time between planting and harvesting of minitubers is shorter than seeds dormancy period, and seed tubers may still be dormant and do not produce sprout even in suitable conditions. In these conditions and in breeding and producing virus-free seeds programs in commercial production, it is essential to break down the dormancy period. Minitubers dormancy period can be removing by setting the store temperature, cutting the tubers, and treating by chemicals. Treating minitubers with chemicals is a safe and confident method. Among the

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chemicals applied for breaking down the potato nodes dormancy, one can refer to GA_3, thiourea, ethylene, ethyl bromide, and carbon disulphide (11, 13 and 18).

Thiourea is a catalyse inhibitor, which triggers potato tubers germination and healing tubers injuries. Thiourea solution in an appropriate concentrate not only facilitates germination, but also produces more than one sprout in each eyes of potato, so that, thiourea dominates over inhibiting effects of major sprout on minor ones in each eye, and neutralizes terminal buds capacity to stop lower buds growth in seeding tuber. It is reported that using thiourea treatment and/or applying H_2O_2 enables one to remove tubers dormancy (2). In addition, it is pointed out that treating cut tubers or newly harvested ones by 1-2% thiourea solution for 1 to 2 hours (18) and by 3% for 1 hour (16) breaks dormancy. Studies on morphological alterations in tubers sprouts have shown that expression of 2 to 3 mm of primary sprout is a trustable criterion for determining the end of dormancy period (19). Hassan-Panah et al. (5), surveying GA_3 treatment effect with a concentration of 1500 ppm and 5% thiourea to break dormancy of Agria minitubers, concluded that this treatment decreases dormancy period from 63 days to 39 days, also they showed that the tuber yield and its weight per plant are declined after sewing seeds in the greenhouse. Ju et al. (7), studying different chemicals in breaking minitubers dormancy, found that thiourea effect is better than other treatments (IAA and GA_3) and, through sinking minitubers in thiourea solution with 1% concentration for 1 hour in 25ºC, the fast germination occurred and strong sprouts were produced.

Kasrawi and Alfayyad (8), also, reported that using GA_3 hormone with 5 ppm concentration by itself or in combination with 1% thiourea is more efficient in increasing sprouts number and length in 5 varieties of normal tubers of potato than control treatments. In another experiment performed by Pietkiewicz (14) to compare the effects of some chemicals on potato normal tuber dormancy period, it was declared that treating the tubers by mixing GA_3 with 1 ppm concentration and thiourea with 1% concentration increases the plant growth and decreases dormancy period significantly in comparison with other treatments.

2. Materials and methods

2.1. plantlets production:

Using a combination method of heat-therapy and meristem isolation, and tissue cultured in a liquid media of M.S on a paper bridge, and then transferred the cultures to an appropriate growth condition in a growth chamber, and virus-free potato plantlets of Marfona cultivar were produced. The plantlets cultured on the solid Agar MS culture media, and then transferred to the growth chamber with 24 ºC, 16 hours light as 4500 lux intensity, and kept there for 4 weeks until complete growth (11).

2.2. minitubers production in greenhouse:

After achieving the required plantlets, the 25-30 day ones that have 7-9 leaves were selected to transfer to the greenhouse. Then, the plantlets were taken out of the pot culture media. The cleaned plantlets were carefully moved into a bed containing of soil, sterile with fungicides and insecticides (Captan and Sevin), perlite and pit mass with 1:2:1 ratio. In order to being compatible with greenhouse environment, and to protect them against any injury, the plantlets were covered with plastic caps for a few days. The plantlets were grown up in a greenhouse with 18ºC and 12ºC in day and night temperatures, 12 hours of day length and 85% relative humidity. Approximately, after 100 days, the minitubers were taken out and transferred to the laboratory to do the experiments (6).

2.3. Treating minitubers with thiourea:

This research was based on a completely randomized design (CRD) in three replications. Thiourea was ready in two concentrations (0.5% and 1%). 45 minitubers of Marfona cultivar were washed with distilled water immediately after harvesting to remove surface soils and then each 15 minitubers were selected randomly, and immersed in various treatment of thiourea for one hour in 18ºC of laboratory condition. After applying the treatment, the minitubers were dried and each 5 tuber were put in one replication and kept in a store with 90% relative humidity, absolute darkness in 18ºC until dormancy elimination (17). The control treatment, without thiourea application, being washed with distilled water was put in a standard store

condition immediately after harvesting. Germination of a 2 mm sprout out of minitubers is a good criterion for end of dormancy period, and this time was considered as dormancy breaking time (19). Assays were daily done during dormancy break period in the laboratory. Finally, attributes as day number until sprout germination, number of sprouted minitubers, number of sprouts in each minituber, and the longest sprout were recorded.

2.4. Surveying the treated minitubers in greenhouse:

After breaking dormancy, the minitubers were moved into the greenhouse and cultivated in 5 cm depth of pots soil according to the CRD with three replications. Following germination of sprout and plant growth, maintenance operations including irrigation once every 7 days, fertilization and soil dressing were performed.

During growth period, features such as the days to emergence, number of main stem, and plant height were measured. After 4 months and at the end of growth period, the tubers were collected and features such as number of tubers per plant, tuber total weight, and mean of produced tuber weight per plant were also measured. Data variance analysis were performed by MSTAT-C statistical software. The means were compared by Duncan multi-dimension test at 5% signification level.

3. Results and discussion

Variance analysis of thiourea effect in laboratory condition indicated that thiourea did not have any significant effect on the number of sprouts also length of sprout appeared on minitubers but, had a significant effect on the number of days to sprouting at 5% signification level (table 1). Comparing means of thiourea effects (fig.1) showed that consuming 0.5% of thiourea decreases period of sprout germination from 102 days to 92 days in comparison with control treatment. Results achieved from this research are conformed to those established by HassanPanah et al (5), Rahman et al.(15) Kasrawi and alfayyad (8), Germchi and et al (4) and Ju et al (7) on quick sprout germination in tubers treated with thiourea. However, if the purpose is to make minitubers ready for cultivation, using thiourea solution with 0.5% concentration would be sufficient (fig.1).

Sources of variance	Degree of freedom	Means squares		
		Sprout No.	longest sprout length	No. days till sprout germination
Thiourea	2	0.235	0.581	146.630*
error	6	0.206	0.114	22.515
CV (%)		28.46	12.03	5.06

*and**indicate signification at 1% and 5% probability levels, respectively.

Table 1: variance analysis of Thiourea effect on underlying features in the laboratory condition.

Table of variance analysis of thiourea effect in greenhouse conditions (table 2) showed that thiourea effect is significant on all the features. Comparing means of different levels of thiourea consumption on the germination period (fig.2) showed that using at least 0.5% concentration of thiourea decreased germination period from 39 days to about 32 days in comparison with the control. The least numbers of days until plant germination with 1% solution of thiourea for 29 days was possible which had significant difference with clothes concentration of this material and with control treatment. HassanPanah et al (5) and Germchi et al (4) reported similar results.

Using thiourea with 0.5% concentration increased stem numbers per plant from 1.3 to 1.8. The highest stem numbers per plant with 2.2 were observed in 1% solution of thiourea, which had significant difference with other concentrations (fig.3).

Thiourea various concentrations effect on plant height is indicated in figure 4. As can be seen from the figure, applying at least 0.5% solution of thiourea increased plant height up to 28 cm. There are negative link between plant height and number of days until germination. Using thiourea makes plants germinate 10 days

faster (fig.2). As a result, by decreasing number of days to emergence, plant height increased (fig.4). There was no significant difference between 0.5 and 1% thiourea consumption on plant height.

Using thiourea increased significantly number of tubers per plant (fig.5). According to positive relationship between tuber numbers per plant with plant height, it seems that strong plants produce more tubers. Using 0.5% solution of thiourea increased average tuber number per plant from 4 to 6.5, while using 1% solution increased that to 8. There was a significant difference between various levels of thiourea in terms of this feature (fig.5).

Moreover, significant difference was observed between using 0.5 % of thiourea and control treatment in respect of total weight of tuber per plant, also, increasing thiourea concentration to 1% increased significantly tuber yield per plant to more than 185 g (fig.6). It seems that thiourea by increasing plant height, also stems number and decline emergence period, lead to increase tuber weight (18).

Using thiourea decreased single tuber weight significantly. Although, both tuber number and tuber yield were increased in plant through using thiourea, tuber number per plant had a fast trend or more slope, as a result, single tuber weight per plant was highly decreased and reached from 32 g in control treatment to a bit less than 25g in treatment with 1% of thiourea (fig.7).

Sources of variance	df	Means squares					
		Days to emergence	Main stem/plant	Plant height	Tuber per plant	Tuber weight/plant	Tuber mean weight
Thiourea	2	54.941**	0.671**	15.997**	6.632**	776.748*	52.090**
error	6	0.098	0.018	1/116	0.106	2.248	1.560
CV (%)		0.93	7.79	3.96	5.27	0.90	4.50

*and**indicate signification at 1% and 5% probability levels, respectively.

Table 2: variance analysis of Thiourea effect on underlying features in the greenhouse condition.

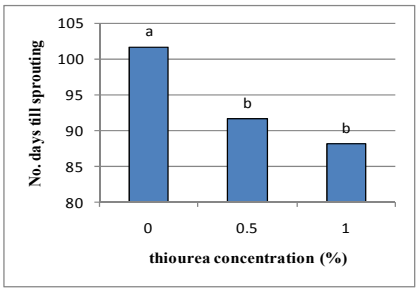

Fig.1: effect of thiourea on days to sprouting in lab

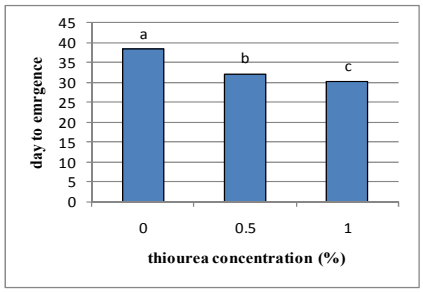

Fig.2: effect of thiourea on days to emergence

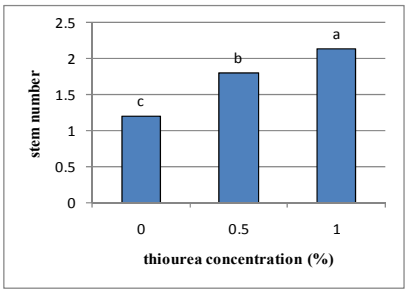

Fig.3: effect of thiourea on stem numbers

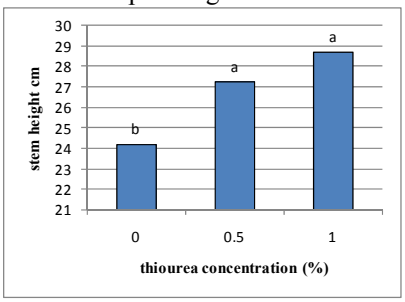

Fig.4: effect of thiourea on plant height

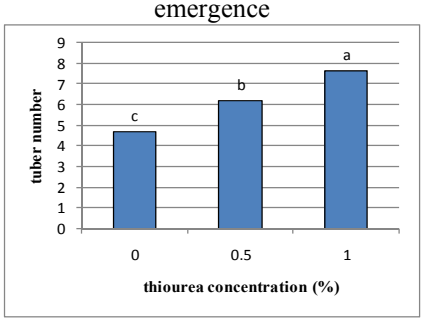

Fig.5: effect of thiourea on tuber number per plant

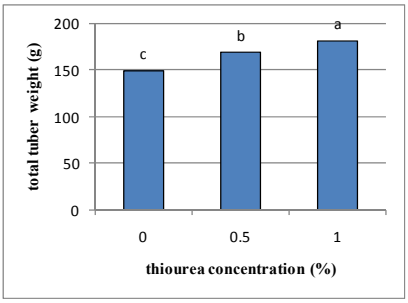

Fig.6: effect of thiourea on tuber weight

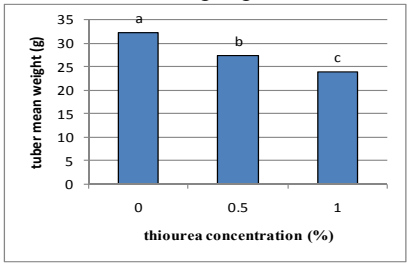

Fig.7: effect of thiourea on tuber mean weight per plant

4. Recommendations

According to above mentioned subject, using thiourea solution with 1% concentration declined emergence time from 102 days to a bit lower than 90 days, increased tuber number from 4 to 8 per plant and also increased total tuber weight per plant from 150 g to more than 185 g in comparison whit the control. If our purpose is to make minitubers ready for cultivation, using 1 % thiourea is suggested for breaking dormancy, accelerating plants emergence, increasing tuber number per plant, and getting maximum yield in potato minitubers of Marfona.

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