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Investigating Effect of Gibberellin Acid on Dormancy Breaking and Germination Speed and Yield of Potato Cultivars

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RESEARCH ARTICLE

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ABSTRACT

BACKGROUND: Growth regulator compounds, especially plant hormones, also affect the plant growth process.

OBJECTIVES: Current research was done to investigate the effect of hormonal treatment (gibberellin acid) and physical (cold) treatment on potato micro tuber dormancy, germination speed and yield of two potato cultivars (Banba and Arinda).

METHODS: This study was conducted according factorial experiment based on a completely randomized design with three repetitions in the research laboratories of the Institute of Seed and Seedling Production. The first factor included of the potato variety at two levels (Banba and Arinda), and growth stimulant including gibberellin acid at four levels (0, 25, 50, 100 $mg.l^{-1}$) belonged to second factor.

RESULT: The examined traits included the day until the appearance of the sting, the number of micro tubers, the fresh weight of the tubers, and the length of the stolen. Based on the results obtained from the effect of gibberellin acid concentration on important traits such as the number of micro tubers, stolon length, which shows a high correlation with the fresh weight of the tubers, and the number of days until the appearance of the first bite, which will indicate the effectiveness of this substance in breaking dormancy.

CONCLUSION: The concentration of 50 mg of gibberellin acid has the best results and can be recommended to increase the speed of breaking dormancy, as well as more uniformity and more production. Based on the general results of the cultivars used in this experiment, except for the trait of tuber wet weight, which was more in the case of Arinda than Banba, they did not differ much and showed high genetic similarity in the measured traits.

KEYWORDS: *Growth regulators, Leaf area, Micro tubers, Phytohormone, Stolon length.*

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1. BACKGROUND

Seed dormancy is one of the limiting factors of germination and plant growth. This issue is considered important for survival. Seed dormancy is the cause of non-uniformity in germination, greening and increase in production cost; therefore, control of seed dormancy is one of the most important management aspects in agricultural products, especially potato (Bajji *et al.*, 2007). Dormancy is one of the important physiological characteristics in the seed tuber (Rastovski and Van Es, 1987) and it occurs simultaneously with the tuber enlargement (Fernie and Willmitzer, 2001) and its duration is important in the potato tuber and is affected by the growth conditions of the mother plant and other factors such as photoperiod, temperature, nitrogen fertilizer and genotype (Otroshy, 2006). The end of tuber dormancy is when at least one bud longer than 2 mm appears in the tuber (Rehman and Seung, 2003). Serrano *et al.* (1992) reported a significant difference in the percentage of germinated seeds and dormancy of several bromus species (*bromus spp*) during the same period of storage. Gibberellin acid (GA_3) is one of the important growth hormones that play a very important role in breaking seed dormancy, substituting chilling in hard-shelled seeds, and ultimately plant germination (Nadjafi *et al*., 2006). There are many reports that the use of gibberellin acid is effective in other plants, such as breaking dormancy and germination of the seeds of Thymus daenensis species (Gasemi Pirbalouti *et al*., 2007), five different populations of Yarrow (*Achillea millefollum*) (Shariati *et al*., 2013) and two medicinal species Galbanum (*Ferula gummosa boiss*) and Germander (*Teucrium polium*) (Nadjafi *et al*., 2006). Foliar spraying and soil application of paclobutrazol in potato increases the length of tuber dormancy; the mechanism of this action is by blocking the path of gibberellin acid synthesis and reducing the catabolism of abscisic acid (Tekalign and Hammes, 2005).

2. OBJECTIVES

Current research was done to assess the effect of hormonal treatment (gibberellin acid) and physical (cold) treatment on potato micro tuber dormancy, germination speed and yield of two potato cultivars (Banba and Arinda).

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

This study using 2-factor factorial test including the first factor of cultivar type at two levels (Banba and Arinda) and second factor of growth stimulants including gibberellin acid (0, 25, 50, 100 $mg.l^{-1}$) on micro tubers 12-20 mm in the form of a randomized completely design was done in three replications.

3.2. *Lab Management*

Each plot contains 10 tubers in the weight group (12-20 mm). The tubers were placed in gibberellin acid solutions of 0, 25, 50 and 100 we immersed PPM for 2 hours and then placed the sample in a plastic tray at the tested temperatures to investigate the process of dormancy and germination percentage and the measurement lasted for 40 days. At

the end of the experiment, the traits related to the number of days until the appearance of the bite, the number of germinated tuber, the number of buds in each tuber, and the length of the bud were recorded. After breaking dormancy, micro tubers were planted in greenhouse conditions in a soil bed, a mixture of disinfected soil with fungicides and insecticides and perlite in a ratio of 1:1 and after making a small hole inside the bed, the distance between two plants is 15 cm. And the distance of the row was considered to be 50 cm to determine the plant growth and performance characteristics of micro tubers treated with gibberellin acid.

3.3. Measured Traits

Sampling was done randomly to determine the desired traits in such a way that during the growth period the traits of stem length and diameter and the number of nodes, the number of days until greening, the percentage of green area, the number of sub-stems and at the end of the harvest the number of tubers in each Plant, tuber yield per unit area is recorded. The aerial parts are harvested 10 days before harvesting and after that the micro tubers are harvested and the characteristics of the number, diameter and weight of tubers in crop recorded.

3.4. Statistical Analysis

Data analysis of variance was done by SAS statistical software and Duncan test was used to mean comparison at 5% probability level.

4. RESULT AND DISCUSSION

4.1. Days to bud emergence

The results of the analysis of variance showed that cultivars were not significantly different from each other in terms of days until the appearance of bite (Table 1).

Table 2. Result of analysis of variance effect of treatments on studied traits

S.O.V	df	Days to bud emergence	Number of micro tubers	Tuber fresh weight	Stolon length	Max LAI (1500GDD)
Cultivar (C)	1	0.37^{ns}	0.09^{ns}	4.25**	0.001^{ns}	0.348^{ns}
Gibberellin acid (G)	3	192.36**	6.59*	0.93^{ns}	0.503**	0.021^{ns}
C*G	3	1.38^{ns}	0.40^{ns}	0.38^{ns}	0.015^{ns}	0.007^{ns}
Error	16	5.37	1.76	0.44	0.059	0.606
CV (%)	-	13.15	19.35	4.21	8.68	21.36

$^{ns, *\text{ and }**}$: non-significant, significant at 5% and 1% of probability level, respectively.

According to the results of the mentioned table, the treatment of different concentrations of gibberellin acid had a significant effect at the level of 1% on the number of days until the bite appeared. Also, the results of analysis of variance showed that the interaction effect of variety and gibberellin acid concentration were not significant (Table 1). The results of the mean comparison showed that the treatment of not using gibberellin acid with an average

of 24 days until the appearance of first bite had the longest time to start this process, and concentration of 50 mg.l^{-1} of this substance was able to take an average of 10.5 days until the appearance of the first bite, to have the greatest effect in accelerating this process and as a result breaking dormancy (Fig. 1).

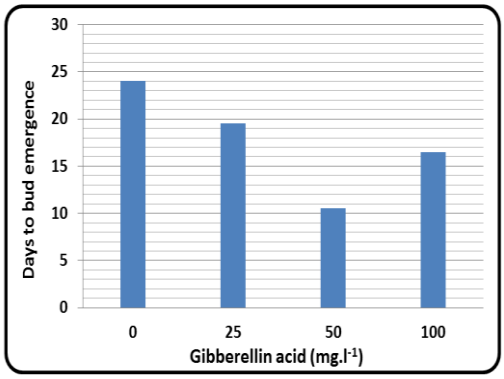

Fig.1. Mean comparison Effect of gibberellin acid on days to bud emergence by Duncan test at 5% probability level.

Considering that one of the goals of this research is to find a method to reduce the number of days until the bite appears and thus break the dormancy of micro tuber, the application of this treatment resulted in the best result. Based on the mean comparison results (Fig. 1), treatment with gibberellin acid with a concentration of 25mg led to the appearance of bites on the 19th day and treatment with 100 mg gibberellin acid on the 16th day. Accordingly, the amount of 25 mg caused a significant acceleration in the time of breaking dormancy compared to control; But it was not close enough to this important amount, and on other hand, amount of 100 mg was less effective than the optimal concentration (50 mg), despite having an effect on this trait, probably due to excessive concentration and negative effects caused by it. There are many reports use of gibberellin acid is effective in other plants, such as breaking dormancy and germination seeds of Thymus daenensis species (Gasemi Pirbalouti *et al*., 2007), five different populations of Yarrow (*Achillea millefollum*) (Shariati *et al*., 2013) and two medicinal species Galbanum *(Ferula gummosa boiss)* and Germander (*Teucrium polium*) (Nadjafi *et al*., 2006).

4.2. The number of micro tubers

The results of the analysis of variance showed that the cultivars were not significantly different from each other in terms of the trait of the number of micro tubers produced (Table 1). Based on this, the treatment using different concentrations of gibberellin acid had significant effect at the level of 5% on trait of the number of micro tubers produced. The interaction effect of treatments on this trait was not significant (Fig.2).

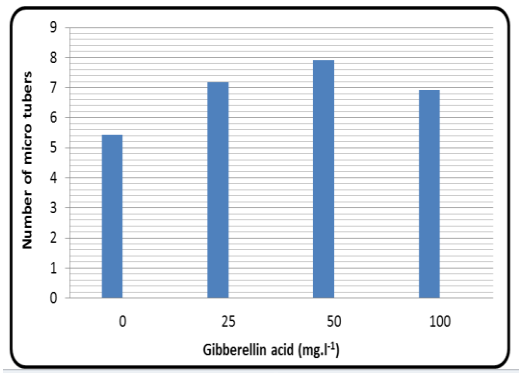

Fig.2. Mean comparison Effect of gibberellin acid on number of micro tubers by Duncan test at 5% probability level.

The means comparison showed that treatment with gibberellin acid with 25 and 50 mg concentrations resulted in the highest production of micro tubers

with an average of 7.17 and 7.92 micro tubers, compared to 5.42 micro tubers. In other words, pretreatment with using 50 mg of gibberellin acid increase the production of tuber by 46% compared to the control. Researchers have provided reports on the effect of breaking dormancy treatments on increasing the number of tubers. Garmchi *et al*. (2013) reported that the number of tubers per plant increased by 1% due to treatment with thiourea.

4.3. Tuber fresh weight

The results of the analysis of variance showed that the cultivars had significant difference at the level of 1% in terms of tuber fresh weight (Table 1). The treatment of different concentrations of gibberellin acid did not have significant effect on this trait. Cultivars and concentrations of gibberellin acid did not have a significant interaction effect for this trait. The comparison of means (Fig. 3) showed that the Arinda variety generally had a higher average tuber fresh weight than the Bamba variety (16.2 grams and 15.24 grams for Arinda and Bamba, respectively. Yazdan Doost Hamdani (2012) announced in his report that the average fresh weight of tubers in different used cultivars showed a significant difference at the level of 1%.

4.4. Stolon length

Treatment with different concentrations of gibberellin acid had significant effect on stolon length, although there was no significant difference between cultivars in terms of this trait (Table 1). The interaction effect of these treatments was not significant on the mentioned trait.

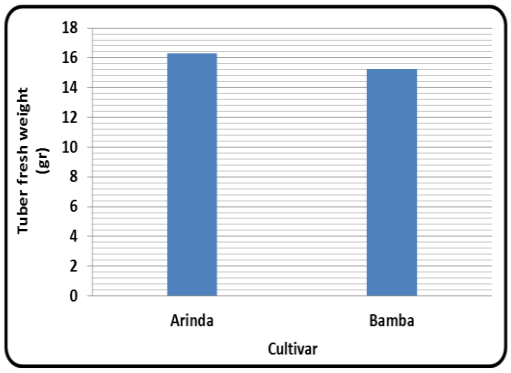

Fig.3. Mean comparison effect of Cultivar on tuber fresh weight by Duncan test at 5% probability level.

Based on the comparison results, the average treatment of 50 mg of gibberellin acid had the longest stolon length with an average of 3.18 cm (Fig. 4).

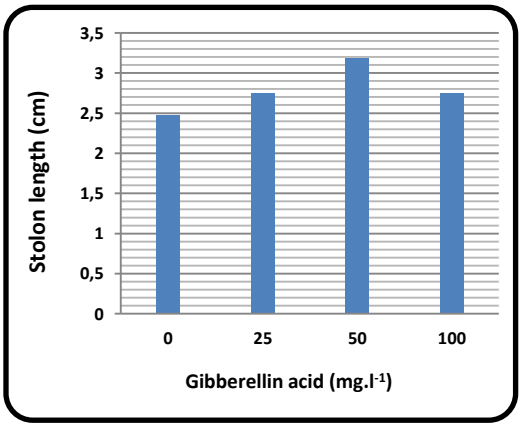

Fig.4. Mean comparison Effect of gibberellin acid on Stolon length by Duncan test at 5% probability level.

As a result, this amount of gibberellin acid is the best option to have the longest stolon length. While the use of gibberellin acid in the amount of 25 and 100 mg, like not using it, will have no effect on this trait. Holmes *et al*. (1970), Hartmans and Van Es (1979) and Nandis *et al*. (2000) stated that gibberellin acid is effective in reducing the dor-

mancy of terminal buds, increasing the number of buds and their activation.

5. CONCLUSION

The concentration of gibberellin acid had significant effect on important traits such as the number of micro tubers, the length of stolon, which showed a high correlation with the fresh weight of the tubers, and the number of days until the appearance of the first bite, which indicates the effectiveness of this substance in breaking dormancy. The concentration of 50 mg of gibberellin acid had the best results and is recommended to increase the speed of breaking dormancy as well as uniformity and more production. The studied cultivars did not differ much except for the tuber weight trait, which was more in the case of Arinda than Bamba, and showed high genetic similarity in the measured traits.

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FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

CONFLICT OF INTEREST: Authors declared no conflict of interest.

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