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Efficacy of Plant Growth Regulators (PGRs) on Potato mother Plant for the production of Hybrid True Potato Seed

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Abstract:

Male sterility and flower drooping are the main drawback for production of true potato seed under prevailing climatic condition of Bangladesh. Plant growth regulators (PGRs) may show the positive effect on true potato seed in potato mother plant. From this point of view, the experiment was carried to investigate the response of different plant growth regulators (PGRs) on hybrid true potato seed production. Experiment was conducted with 3 growth regulators viz., Gibberellic Acid (GA_3), Benzyl Adenine (BA) and Planofix (NAA) with 3 replications. The experiment revealed that, all growth regulators used

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in this experiment had marked effect on plant height, flower production, yield component and yield of TPS. The application of GA_3 @ 100 ppm in flower buds and inflorescences of female parent (MF II) resulted higher retention of flowers. Result also showed that, application of 200 ppm GA_3 on flowers buds and inflorescences of female was best for the reduction of flower shedding and to get a higher yield of hybrid TPS(118.0 kg ha^{-1}).

Key words: True Potato Seed, Plant Growth Regulators.

Introduction

The potato (*Solanum tuberosum*) is one of the most important food crops of the world. It is used as a vegetable crop in Bangladesh and alone contributes as much as 85% of the total annual vegetable production [1]. But the average yield of potato is very low (19.22 ton ha^{-1}) [2] compared to many potato growing countries of the world. The Farmers of Bangladesh cannot get the highest yield of table potato, mainly due to the use of low quality potato seed on their field and The Government of Bangladesh could not supply all amount of certified potato seed to the farmer. TPS derived from seed tubers are high quality plant materials, and are able to give higher or equivalent yields with those of seed tubers of standard varieties [3, 4]. Research results [5]. and on-farm trials [6]. have shown that growing of potato using TPS could be a useful complementary technology in the production of potato in Bangladesh, as in some other countries like India, Egypt, Indonesia and China. The TPS technology becoming popular in Bangladesh but major drawback are the flower abortion and berry dropping. So under prevailing climatic and short day conditions of Bangladesh, it is possible to produce hybrid TPS with efficient use of PGRs by enhancing the flowers and berry set. [7] reported that application of 40 ppm GA_3 increased the percentage of flowering plants in potato and number of flowers

per plant. Using growth regulators,[8] found that cultivars varied widely in their response to the application of GA_3. [9,10], in this regard, found that number of flowers plant^{-1} was increased due to 25, 50, 75 and 200 ppm GA_3 spray applications. On the other hand, open pollinated berry set in GA_3 treated plants were sharply reduced [11, 8]. The principle objective of this study is to evaluate the most promising doses of PGRs to enhance the flower and berry setting to get good quality TPS.

Materials and Methods

This study was carried out at Agronomy field of Sher-e Bangla Agricultural University, Dhaka-1207, Bangladesh from November 2013 to March 2014, which was belonging to the Madhupur Tract (AEZ-28). For production of hybrid TPS, parental lines were MF 2 as female and TPS 67 as male. There were 7 treatments of growth regulators were used in this study such as, T_1 = Control, T_2 = GA_3-100 ppm, T_3 = GA_3-200 ppm, T_4 = Benzyl Adenine (BA) -100 ppm ,T_5 = Benzyl Adenine (BA) - 200 ppm,T_6 = Planofix (NAA) - 2.5 ppm and T_7 = Planofix (NAA) - 5.0 ppm with three replication. Well sprouted whole tubers for both parental lines were planted by maintaining 75 cm line to line and 25 cm plant to plant distance. Furadan 5G @ 15 kg ha^{-1} was added to soil to prevent the infestation of cutworm before planting. At the rates of 125 kg urea, 250 kg Triple Super Phosphate (TSP), 125 kg Murate of Potash (MOP), 100 kg gypsum, 15 kg zinc sulphate, 100 kg magnesium sulphate and 6.5 kg borax per hectare were applied at the time of planting in the furrows made on both sides of the rows. Cowdung and mustard oil cake were applied @10 tons and 500 kg per hectare, respectively, during final land preparation. After 30 DAP, 62.5 kg urea and 62.5 kg MOP per hectare were applied on both sides of the plant rows. After side dressing, the second earthing up was done. The rest 62.5 kg and 62.5 kg urea hectare^{-1} were

applied at 50 DAP just after 3rd earthing up. Mulching, weeding and irrigation were given as per requirement for proper growth of the plant. Proper plant protection measures were taken to control the fungus, virus and insects as a whole. Being the prevailing climatic condition of Bangladesh is not favored to flower the potato plant, so the natural photoperiod was extended up to 16 hrs with the use of 400 watt high pressure sodium light bulbs placed 8 m above the crop field from 25 DAP up to completion of harvesting of berries. Artificial pollination was done according to the procedures as reported by [12] in parental lines. Staking is done to prevent the lodging of both male and female parent using bamboo sticks. Pruning and trimming was also done to provide the even distribution of light and to facilitate pollination and intercultural operation. After harvesting the berries at 45-50 DAP, seeds were crusted according the procedures reported by [13]. The data on plant height(cm), number of f inflorescence plant^{-1}, number of flowers infloresence^{-1},number of berries plant^{-1} under different sizes, Average yield of seed kg^{-1} berry(g),Average weight of 100 berries(g), Average weight of 1000 seeds(mg), number of seeds berry^{-1} of diff. sizes, weight of 1000 seeds obtained from berries of diff. sizes(mg), total yield of berry (kg ha^{-1}), total yield of seeds(kg ha^{-1}), total yield of berries plant^{-1}(g), total yield of berries plot^{-1} (g), total yield of seed plant^{-1} (mg) and total yield of seed plot^{-1}(g). The collected data were analyzed statistically and means were adjusted by using the Least Significant Difference (LSD) test.

Results and Discussion

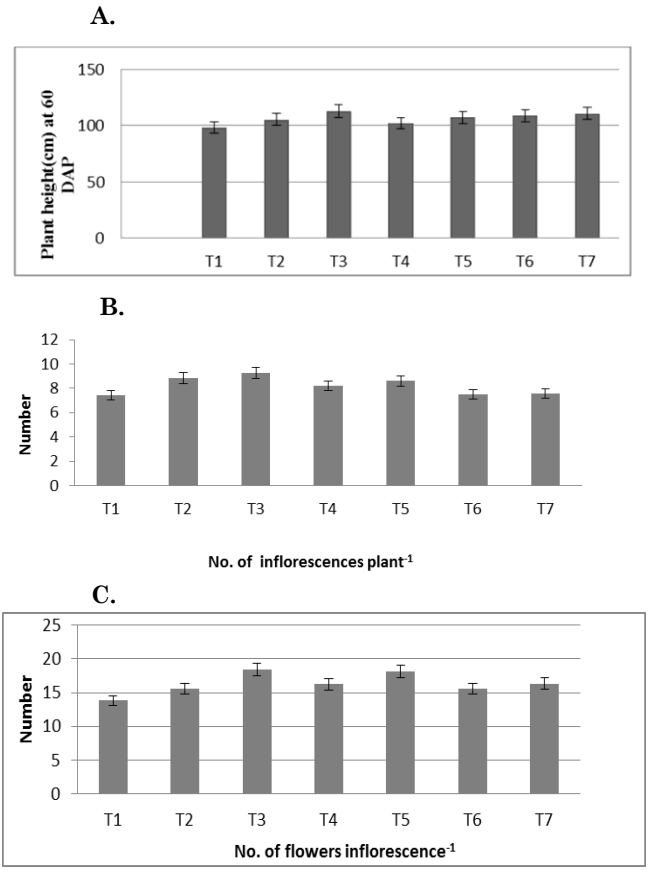

Fig. 1. Effect of different doses of plant growth regulators on A) plant height (cm), B) number of inflorescence plant^{-1} and C) number of flowers inflorescence^{-1} of female parent (MF II). Vertical bar represent LSD (0.05).

The plant height at 60 DAP ranged from 98.58cm to 112.7 cm among the growth regulator treatments (Fig. 1A). Application of GA3 at 200 ppm produced the tallest plants (112.7 cm), followed by Planofix at 5 ppm (111.0 cm) whereas, the smallest plant (98.58 cm) was recorded from control. This result is partly in agreement with the reports of [8]. They reported that due to

the application of 1000 ppm GA3 after first week of complete emergence of potato tubers, the height of plant increased markedly in 19 varieties studied both in presence and absence of light. Application of growth regulators significantly influenced the number of inflorescences plant^{-1} and number of flowers inflorescence^{-1}. The maximum number of inflorescence plant^{-1} (9.23) and number of flowers inflorescences^{-1} (18.48) were obtained from the application of GA3 at 200 pm. GA3 at 100 ppm produced the next height number of inflorescences plant^{-1}(8.82). On the other hand, the minimum number of inflorescences plant^{-1} (7.42) and number of flowers inflorescence^{-1}(13.84) were recorded from the control treatment (Fig.1B,1C).This result is partly in agreement with the reports of [7, 9,11]. [11] reported that application of 40 ppm GA3 increased the percentage of flowering plants in potato and the number of flowers plant^{-1}. Experimental results from [11] also demonstrated that potato plant treated with 3 applications of GA3 at weekly interval, produced inflorescence in a large portion of stem and more flowers inflorescence^{-1}. [9] also reported that BA and GA3 were very effective in increasing the total number of flowers in potato plant.

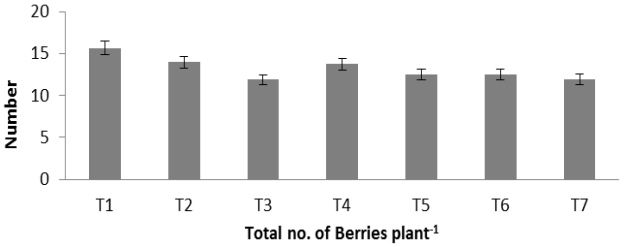

Fig. 2. Effect of growth regulators on the total number of berries plant^{-1}. Vertical bar represent LSD (0.05).

Table 1. Effect of different doses of plant growth regulators on berry production components of female parent (MF II).

Treatment	No. of berries plant^{-1} under different sizes			Total yield of berries plant^{-1}(g)	Total yield of berries plot^{-1} (g)	Total yield of berries(kg ha^{-1})
	<2 cm	2-3 cm	>3 cm			
T_1	7.147	7.243	1.100	86.53	3964	4431
T_2	4.580	6.947	1.657	88.77	4178	4614
T_3	2.463	7.853	2.180	92.20	4667	5185
T_4	5.320	6.720	1.120	82.78	3730	4168
T_5	3.750	7.360	2.223	90.47	3864	4411
T_6	4.013	6.040	1.663	84.87	3868	4281
T_7	2.937	7.270	2.013	87.78	4158	4509
LSD(0.05)	0.7182	1.14	0.2639	16.79	642.4	936.9
CV(%)	9.36	9.07	8.62	10.77	8.89	11.67

T_1 = Control, T_2 = GA3-100 ppm, T_3 = GA3-200 ppm, T_4 = Benzyl Adenine (BA) -100 ppm , T_5 = Benzyl Adenine (BA) - 200 ppm, T_6 = Planofix (NAA) - 2.5 ppm and T_7 = Planofix (NAA) - 5.0 ppm

The number of berries produced plant^{-1} was highest (15.65) under the control treatment (Fig.2). This agrees with the reports of [8]. They reported that GA_3 had marked effects on the total floral bud formation and on the number of inflorescence plant^{-1}, but it did not help to retain berries in plants. The number of small size berries plant^{-1} was however, significantly higher under the treatment (Table 1). The proportion of medium and large size berries was highest under the 200ppm GA_3 treatment, followed by 5 ppm Planofix. The control treatment produced the lowest proportion of medium and large size berries plant^{-1}. The yield of berries plant^{-1} was not significantly influenced by the growth regulator treatments (Table 1). The yield of berries ranged from 86.53 g (control) to 92.20 g plant^{-1} (200 ppm GA_3) among the treatments. The control treatment produced the highest proportion of small size berries, compared to produce by the 200 ppm GA_3 treatment. As expected from the yield of berries plant^{-1}, the total yield of berries plot^{-1} was also not significantly influenced by the growth regulator treatments (Table 1). The total yield of berries plot^{-1} ranged from 3730.00 to 4667.00 g among the treatments, the

highest being under the 200 pm GA_3 treatment. When the plot^{-1} yield of berries was converted into hectare^{-1} yield, the highest yielding 200ppm GA_3 treatment was found to produce 5185.00 kg berries hectare^{-1}, compared to 4431.00 kg ha^{-1} produced under the control treatment.

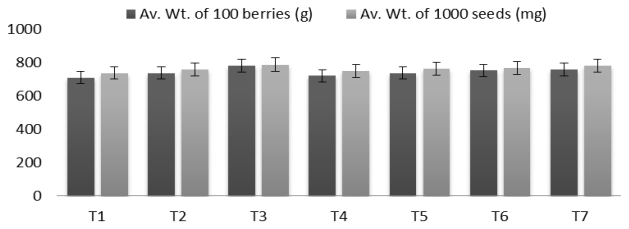

Fig.3. Effect of growth regulators on the Av. wt. of 100 berries (g) and Av. wt. of 1000 seeds (mg). Vertical bar represent LSD (0.05).

The application of growth regulators significantly influence the average weight of 100 berries (Fig. 3) GA_3 at 200 pm produced the highest weight of 100 berries (782.17 g) followed by Planofix at 5 ppm. Control treatment produced the lowest weight of 100 berries (709.72 g).

Table 2: Effect of different doses of plant growth regulators on seed yield attributes of female parent (MF II).

Treatment	No. of seeds berry^{-1} of diff. sizes			Wt. of 1000 seeds obtained from berries of diff. sizes(mg)		
	< 2 cm	2-3 cm	>3 cm	< 2 cm	2-3 cm	> 3 cm
T_1	55.95	240	260.8	725.9	762.6	757.5
T_2	62.40	250.6	286.0	740.7	769.6	770.9
T_3	75.31	275.6	310.4	755.7	799.1	810.5
T_4	59.80	247.1	267.3	734.8	756.6	763.3
T_5	65.48	257.0	263.1	749.9	768.8	780.5
T_6	69.76	264.4	289.6	757.8	776.4	787.9
T_7	72.88	270.0	303.0	764.8	788.2	796.1
LSD(0.05)	11.40	39.22	42.78	128	147.6	116.4
CV(%)	9.72	8.55	8.50	9.63	10.71	8.38

T_1 = Control, T_2 = GA3-100 ppm, T_3 = GA3-200 ppm, T_4 = Benzyl Adenine (BA) -100 ppm , T_5 = Benzyl Adenine (BA) - 200 ppm, T_6 = Planofix (NAA) - 2.5 ppm and T_7 = Planofix (NAA) - 5.0 ppm.

The weights of 100 small, medium and large size berries produced under 200 pm GA_3 were higher than those produce under the control treatment (Table 2). Application of BA was relatively less effective in increasing the weight of 100 berries.

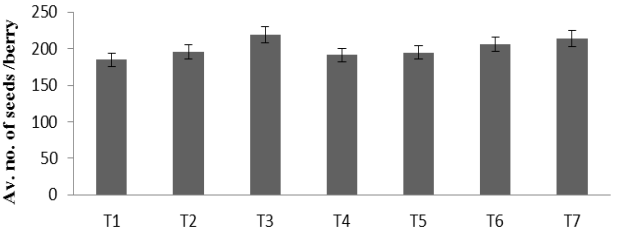

Fig. 4. Effect of growth regulators on the Av. number of seeds berry^{-1}. Vertical bar represent LSD (0.05).

Table 3: Effect of different doses of plant growth regulators on seed yield attributes of female parent (MF II).

Treatment	Av. yield of seed kg^{-1} berry (g)	Total yield of seed plant^{-1} (mg)	Total yield of seed plot^{-1} (g)	Total yield of seed (kg ha^{-1})
T_1	19.15	1831	79.14	94.69
T_2	20.02	2017	87.12	103.0
T_3	22.08	2285	99.17	118.0
T_4	19.83	1822	78.77	94.31
T_5	20.16	1923	82.79	98.68
T_6	20.88	1983	86.80	103.5
T_7	22.05	2158	94.55	111.9
LSD(0.05)	3.166	340.4	11.96	17.89
CV(%)	8.64	9.55	7.74	9.72

T_1 = Control, T_2 = GA3-100 ppm, T_3 = GA3-200 ppm, T_4 = Benzyl Adenine (BA) -100 ppm , T_5 = Benzyl Adenine (BA) - 200 ppm, T_6 = Planofix (NAA) - 2.5 ppm and T_7 = Planofix (NAA) - 5.0 ppm

There was significant variation among the treatments on average yield of TPS kg^{-1} berry (Table 3). The average yield of TPS kg^{-1} berry was highest (22.08 g) under the 200 ppm GA_3 application, followed by 5 ppm Planofix application (22.05 g). Control treatment produced lowest yield of seed kg^{-1} berry (19.15g). The highest number of seeds berry^{-1} in all the size grades of berries were recorded from the 200 ppm GA_3

treatment. On average, the lowest number of seeds berry^{-1} (184.83) was recorder from the control treatment (Fig. 4). The average weight of 1000 seeds was highest in 200 ppm GA_3 application (787.65mg), followed by 5 ppm Planofix application (781.75 mg).The average weight of 1000 seeds was lowest (736.21 mg) under the control treatment (Fig. 3). The yield of seed plant^{-1} was significantly influenced by the growth regulator treatments (Table 3). The highest yield of seed plant^{-1} was obtained from the 200 ppm GA_3 treatment (2285.00mg) followed 5 ppm Planofix treatment (2158.00mg); the lowest yield being obtained from the 100 ppm BA treatment (1822.00 mg/plant). The yield of seed plot^{-1} was significantly influenced by the growth regulator treatments, and ranged from 78.77 g (100 ppm BA) to 99.17 g (200 ppm GA_3) per plot (Table 3). When the plot^{-1} yield of seed was converted into per hectare yields, the highest yielding 200 ppm GA_3 treatment was found to produce 118.00 kg seed ha^{-1}, compared to the yield of 94.31 kg ha^{-1} obtained from the 100 ppm BA treatment (Table 3). The second highest yield of seed was obtained from the 5 ppm Planofix treatment (111.9 kg ha^{-1}). The higher yield of TPS as influenced by GA_3 treatment is in agreement with the report of [8].

Conclusion

From the point of economic production of quality true potato seed under present study it may be concluded that, by applying the plant growth regulators it is possible to enhance the flowering and fruit setting in female parent (MF II). The application of GA_3 @ 100 ppm in flower buds and inflorescences of female parent (MF II), resulted higher retention of flowers. The application of 200 ppm GA_3 in the flower buds and inflorescences of female parent (MF II) demonstrate better performance in respect of quality TPS production.

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