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Effect of 6-Benzyl Aminopurine Different Concentration on Potato (*Solanum tuberosum* L.) Minitubers in Net House and in Field

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ABSTRACT

Background: 6-benzyl aminopurine (BAP) is a dominant regulation in minitubers formation. BAP treatment enhances both Crop quantity and quality parameter like days to emergence, number of shoots, shoot length, root length, number of stolons, number of minitubers, potato shape index and fresh weight of minitubers. The purpose of this study was to optimise the effect of different concentrations of BAP on potato (*Solanum tuberosum* L.) minitubers in a net house and in field.

Methods: The present investigation, effect of BAP different concentration on potato (*Solanum tuberosum* L.) microtubers and minitubers were done at Central Potato Research Institute Campus, Modipuram, Meerut during 2012-13 and 2013-14. This experiment design was split plot with five replications and three treatments. *In vitro* BAP treatments for microtuber growth parameters included three doses (0.75 mg/l, 1.5 mg/l and 2.25 mg/l). BAP treated microtubers were planted in net house, again in next season BAP treated minitubers were planted in field. Growth and yield parameters were recorded.

Result: The concentration of BAP (1.5 mg/l) led to decrease in all parameters as compared to BAP at (2.25 mg/l) treatments in both the varieties. Same result was also observed in field.

Key words: 6-Benzyle aminopurine, BAP, *In vitro*, Field minitubers, G-0, G-1, Growth hormones, *In vivo,* Kufri Bahar, Kufri Surya, Microtubers, Net house minitubers.

INTRODUCTION

The volume of potato produced in India was estimated to be around 53.69 MMT in fiscal year 2021. This represented an increase of more than five million metric tonnes over the previous fiscal year. The northern state of Uttar Pradesh supplied the majority of Indian potatoes. (India: Potato production volume in 2021). Potato is an important food crop (World Book, 2000) and is a good source of carbohydrates, vitamins and proteins (Gabre and Sathyanarayana, 2001). It is a good source of antioxidants (Chen *et al*., 2007). Generally, seed potato tubers are used for multiplication and production in conventional systems (Struik and Wiersema, 1999). Although this system is quite effective (Singh *et al.,* 2012) and have several disadvantages like low rate of multiplication, high risk of catching various fungal, viral and bacterial diseases and it also intensive control (Struik and Wiersema,1999). Cytokinins are plant hormones which, including cell division and leaf senescence. Plant Physiological activities influenced by cytokinins. BAP and BA can improve plant growth by cell division, break bud dormancy and promotes the growth of the lateral bud (Hossain *et al.,* 2006). Therefore, the current study was aimed to optimization the effect of 6-benzyl aminopurine different concentration on potato minitubers in net house and in field.

MATERIALS AND METHODS

The research was carried out at the Central Potato Research Institute (CPRI), Modipuram, Meerut Campus and India between 2012 and 2013 (Experiment work period 2013-2016 and written work period 2016-17). Potato virus-free certified micro plants were collected from (CPRI) Modipuram, Meerut. Two varieties, kufri Bahar and kufri Surya, were chosen for tissue culture studies in the lab (Fig 1a, 1b and 1c). (Meenakshi, 2020). Harvested microtubers were washed with sterile distilled water and remove the adhering constituents and dipped for 10 minutes in a dilute fungicide solution (Bavistin, 0.2 per cent), dried on filter paper and preserved in petri dishes in the light at 20°C for 2 days (Fig 1d and 1e). Petri dishes were wrapped in parafilm and refrigerated at 4°C for 4 months in dark. After three months, the microtubers were removed from the refrigerator and brought to room temperature for 12 days. Microtubers were sprouted within 12 days and planted directly into the seedbeds at a spacing of 10 × 30 cm during the first week of November 2012 and 2013 in net house where Plot size was 1.5 m × 2 m = 3 m^2/ treatment. In this experiment used Split Plot Design with five replications and three treatments. The net house soil was sandy loam texture, organic carbon (0.47 per cent),

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rich in available phosphorus (51.2 kg/ha) and medium in available potassium (160.4 kg/ha) and had neutral pH. (7.5). The planting depth was 4 cm and planting geometry was 30 cm (row to row)/*10 cm (plant to plant). The, fertilizers applied consisted of 100 kg N, 53 kg P_2O_5 and 67 kg K_2O per hectare, as calcium ammonium nitrate, diammonium phosphate and muriate of potash respectively. Full doses of P and K were applied just before transplantation of *in vitro* microtubers while N was split in three equal applications. A light irrigation was given with the help of a shower just after transplanting of *in vitro* microtubes. Two times irrigations were given daily with the help of a shower for a week and after that need based irrigation was given. Manual weeding was done(Fig 2a and 2b). Haulms of the crop were pulled at 90 days after transplanting while harvesting carried out manually after 15 days (Fig 2c and 2d). Five plants were tagged from each treatment and the growth parameters were measured. Plant emergence was recorded in the net house on alternate days beginning with the first plant's emergence after 7 days of planting. The yield parameters (Fig 2e and 3a) were recorded in the net plot at harvesting minitubers. For potato shape index five tubers per sample were drawn from each treatment in five replications (Fig 3b). Each tuber was measured for maximum length, width and thickness representing three different planes. The maximum value, across a particular plane was taken and PSI formula (Singh *et al.*, 2004). The obtained poll data were statistically analysed using a completely randomised design and the software IRRISTAT (IRRI, 1999). After harvesting, minitubers were transferred in cold storage at 4°C and relative humidity conditions for 190 days.

In the next season the experimental field was ploughed with a tractor-drawn disc plough for burying the Dhaincha crop a month before planting for preparatory tillage. For pre-sowing irrigation, the field was prepared with two cross disc harrowing and two cross tiller operations to achieve the desired tilth. The field was cross-planked to keep the soil moist. The layout was created by hand. The experiment was designed as a split plot with five replications.

Before planting, the amounts of nitrogen, phosphorus and potash were applied. In all plots, phosphorus (Diammonium phosphate 18% N, 46% P_2O_5) and potassium (Muriate of potash 60% K_2O) were applied at a uniform rate of 80 kg P_2O_5 and 100 kg K_2O ha^{-1}. The remaining half doses (90 kg per ha of N) were applied as urea, which was broadcasted in-furrow at the time of earthing up after 25 days of planting. Gross plot size was 5.85 m × 2m = 11.7 m^2 and the ridges were prepared at 65 cm intervals using a tractor-drawn ridger and tubers were manually planted 20 cm apart at a depth of 10.0 cm. After 15 days of planting, experimental plots were gap filled. Manual weeding was used to control weeds by desiccating weeds and improving aeration in the ridges, which was then earthed up. For water management, the crop was lightly irrigated every 8 days after planting and the irrigation was turned off 10 days before tuber harvesting. For the control of whiteflies and insects imidacloprid, ostheon, trizophos and thimethoxam were spread at the different intervals as per requirement. Phorate @ 25 kg a.i ha^{-1} was applied in the soil at the time of earthing up. For the control of late blight metabolix, metalaxyl and cymoxanil were spread at different intervals as per requirement. Harvesting was done manually in the morning hours (Fig 3c and 3d). The tubers were left in the field for 2.5 hours to allow the soil to dry and be removed. The required observations were recorded in the same manner as in the net house. The pooled data were statistically analysed using a split-plot design and the IRRISTAT software (IRRI, 1999).

RESULTS AND DISCUSSION

Days to Emergence in net house

The first emergence decreased with increasing concentration of BAP in both the varieties. There were no significant differences. Maximum days to the first emergence were recorded with control. In 2.25 mg/L of BAP, the shortest time to first emergence was recorded (Table 1). The outcome is similar to that of Hossain *et al.* (2015); Genene *et al.* (2018) and Manokari *et al.* (2021).

Number of shoot in net house and in field

That the number of shoots varied significantly when compared to the control. As BAP concentration decreased to 0.75 mg/L, the number of shoots increased. The maximum



Fig 1: Kufri bahar and kufri surya microtubers, harvesting of microtubers and greening of microtubers.

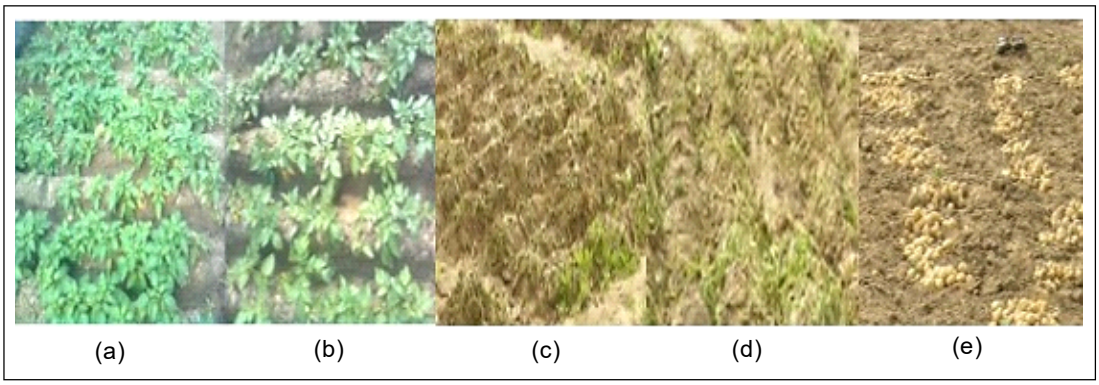

Fig 2: Kufri bahar and kufri surya microtubers transplant in net house; haulm cutting.

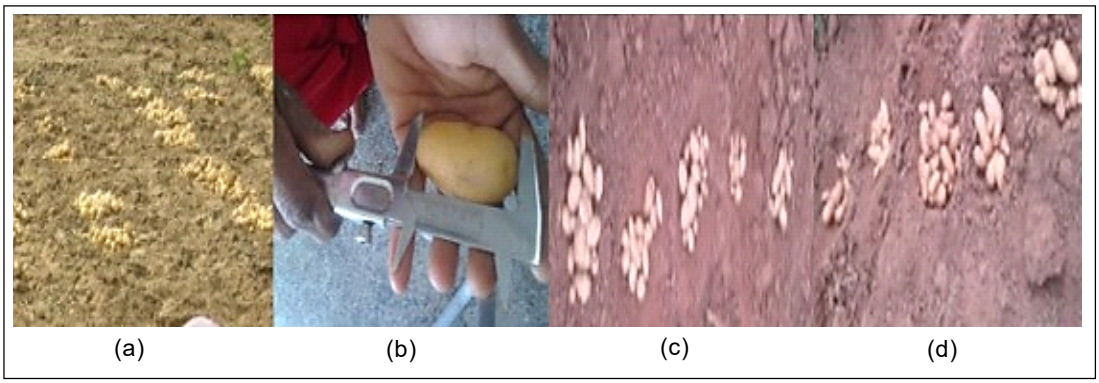

Fig 3: Bahar and kufri surya microtubers in net house; measure PSI (Potato shape index) and minitubers in fields.

shoot number (5.80 G-0) and (9.65 G-1) were significantly higher at 0.75 mg/L of BAP. However, in the net house (G-0), this was at par with 2.25 mg/L and the control and in the field (G-1) was it comparable to the control (Table 1). Number of shoots were also increased in the variety of Gudenie by Genene *et al.* (2018). Boga *et al*. (2012) found that BAP increased the number of shoots.

Shoot length and root length in net house and in field

Shoot length and root length per plant increased with the concentration of BAP up to 0.75 mg/L and control treatment showed the least shoot length and root length. Maximum shoot length (54.8 cm G-0) and root length (29.9 cm G-0) were recorded in 0.75 mg/L, which was significant compared to 1.5 mg/L, 2.25 mg/L and control. Again, maximum shoot length (61.8 cm G-1) and root length (30.8 cm G-1) were recorded at 0.75 mg/L and it was at par with control. The significantly minimum shoot length and root length were found in control experiments (Table 1). Walia *et al.,* 2021 obtained consistent results in the potato variety Kufri Girdhari. Kazemiani *et al.* (2012) discovered that 2 mg/l BAP into culture media increased the number of lateral shoots.Similar result was also observed with (Ahmed *et al.,* 2021). For root length results was similar with Krishnamurthy *et al*. (2001) but in *Polianthes tuberosa* L.

Number of stolons and minitubers in net house and in field

Significantly maximum stolons number (11.5 G-0) and (15.2 G-1) and minitubers number (11.1 G-0) and (14.8 G-1) were recorded in 2.25 mili gram/L treatment. Stolon number was however, comparable to 1.5 mg/L, 0.75 mg/L and the control in the net house (G-0) and in the field (G-1). The number of minitubers was significantly differ from 1.5 mg/L, 0.75 mg/L and control in G-0 and G-1 generation (Table 2 and 3). The minimum number of stolons and minitubers were recorded in control. This result was similar with Kumar and Wareing (1972) regarding stolons numbers, Ahmadi *et al.* (2018) and Ahmed *et al.* (2021) in case of minitubers nimber.

PSI and fresh weight of minitubers in net house and in field

The highest potato shape index and fresh weight of minitubers were recorded in 2.25 mg/L. However, there was no significant difference for PSI in net house and in field, but fresh weight of minitubers were compared to 1.5 mg/L, 0.75 mg/L and control in net house and it was comparable to 0.75 mg/L and control in field. The lowest PSI were recorded in control experiments (Table 3). PSI indicates that potato was oval. This result was supported with Hussey and Stacey (1984). The minimum fresh weight of minitubers was found to be in the net house and in the field in the control

Table 1: Effect of BAP treated *in vitro* microtubers grown in net house (G-0) and in filed (G-1) in respect to growth parameters.

Treatments BAP	Days to emergence			Number of shoot per plant in net house			Number of shoot per plant in field			Length of shoot per plant in net house			Length of shoot per plant in field		
	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean
0.75 mg/l	14.6	14.6	14.6	5.9	5.71	5.8	9.68	9.63	9.65	54	55.6	54.8	62.2	61.4	61.8
1.5 mg/l	13.7	13.7	13.7	4.73	4.92	4.82	8.09	8.08	8.08	46.2	44.4	45.3	56.3	57.5	56.8
2.25 mg/l	13.2	13.2	13.2	4.28	4.21	4.24	6.44	6.38	6.41	34.2	35.5	34.8	46	46.2	46.1
Control	15.5	15.2	15.3	3.14	3.33	3.23	6.1	6.11	6.1	31.5	34.2	32.9	30	29.9	29.9
S Em ±	1.76	1.75	1.3	0.55	0.53	0.5	1.69	1.47	1.21	2.7	4.23	2.95	6.91	6.9	5.73
CD (P=0.05%)	NS	NS	NS	1.62	1.57	1.47	4.94	4.3	3.53	7.88	12.3	8.62	20.1	20.1	16.7
CV	6.16	5.47	5.69	21.91	19.33	20.59	18.84	18.78	18.81	21.95	20.17	20.96	25.12	25.08	25.12

BAP-6-Benzyle aminopurine; *Significant at P≤0. 0 5; NS- Non-significant at P>0.05.

Table 2: Effect of BAP treated *in vitro* microtubers grown in net house (G-0) and in field (G-1) in respect to growth and yield parameters.

Treatments BAP	Lenght of root per plant in net house			Lenght of root per plant in field			Number of stolon per plant in net house			Length of shoot per plant in net house			Number of minitubers per plant in net house		
	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean
0.75 mg/l	29.4	30.4	29.9	31.3	30.4	30.8	6.87	6.58	6.72	8.58	8.7	8.64	6.3	6.12	6.21
1.5 mg/l	26.5	27	26.7	26.4	26.5	26.5	8.23	8.06	8.14	10.5	10.6	10.5	7.72	7.62	7.67
2.25 mg/l	20.4	20.4	20.4	24.2	24.1	24.1	11.4	11.6	11.5	15.2	15.3	15.2	11.1	11.2	11.1
Control	18.4	18.3	18.3	20.4	21.1	20.7	5.79	5.68	5.73	7.39	7.34	7.36	5.37	5.46	5.41
S Em ±	2.66	2.64	2.31	3.47	2.95	2.51	1.61	1.35	1.13	1.46	1.92	1.37	1.61	1.35	1.12
CD (P=0.05%)	7.77	7.71	6.75	10.1	8.63	7.32	NS	3.95	3.3	4.28	z5.61	4	NS	3.94	3.28
CV	18.8	20.32	19.62	15.4	13.33	14.4	26.09	28.27	27.2	28.56	28.72	28.53	28.53	29.22	28.67

Table 3: Effect of BAP treated *in vitro* microtubers grown in net house (G-0) and in field (G-1) in respect to growth and yield parameters.

Treatments BAP	Number of minitubers per plant in field			Potato shape index in net house			Potato shape index in field			Fresh weight of minitubers per plant in net house in house			Fresh weight of minitubers per plant in field house		
	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean
0.75 mg/l	8.29	8.39	8.33	166	166	166	166	167	166	233	240	237	174	176	175
1.5 mg/l	10.2	10.4	10.3	171	177	174	169	170	169	261	288	275	340	329	334
2.25 mg/l	14.7	15	14.8	185	189	187	187	189	188	364	381	372	443	420	432
Control	7.08	6.63	6.85	163	162	163	161	155	158	123	127	125	157	155	156
S Em ±	1.45	1.89	1.35	5.79	10.6	6.23	7.24	11.1	6.75	24.3	39.7	23.5	49.2	36.2	33.9
CD (P=0.05%)	4.23	5.51	3.96	NS	NS	NS	21.1	32.4	19.7	71	116	68.6	143	105	99.1
CV	28.77	30.92	29.71	4.92	6.05	5.38	5.74	7.16	6.46	34.98	35.33	35.05	42.68	40.58	41.68

(Table 3). This result were supported with Li-Gongi *et al*. (2012) and Ahmadi *et al.* (2018).

CONCLUSION

Potato crop has high nutrition value. 6-Benzyl amino purine (2.25 mg/l) was more effective than other concentrations (0.75 mg/l) and (1.5 mg/l). BAP at (2.25 mg/l) treatment enhances both Crop quantity and quality parameter. BAP at (2.25 mg/l) concentration produced the best results for all parameters of Kufri Bahar and Kufri Surya and also assisted in overcoming the difficulties of conventional vegetative propagation.

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Conflict of interest

All authors declared that there is no conflict of interest.

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