International Journal of Agriculture and Medicinal Plants
www.isciencepub.com
Volume 2, Number 2, Pages 16-23, 2021

ISSN: 2789-262X (Print)
ISSN: 2789-2638 (Online)

Effect of 6-Benzyle aminopurine on morpho-physiological properties and grain yield of aromatic rice (cv. Kataribhog)

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Research article

Article history
Received: 20.02.2021
Accepted: 28.04.2021
Published:
Online: 30.04.2021

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ABSTRACT

Kataribhog is one of important fine aromatic rice cultivars in Bangladesh for its pleasant aroma, fine grain and better palatability. A field experiment was conducted to investigate the morpho-physiological and yield characteristics of aromatic rice (cv. Kataribhog) using 6-Benzyl aminopurine (6-BAP). Five levels of 6-BAP were 0, 50, 100, 150 and 200 ppm were exogenously applied at vegetative and pre-flowering stages. The morpho-physiological properties, yield and yield characteristics were significantly varied due to different levels of BAP. The plant height, leaf length, leaf breadth, leaf number plant^{-1}, flag leaf chlorophyll content, tiller number hill^{-1}, panicle length, panicles hill^{-1}, 1000-grain weight, grain yield (t ha^{-1}) and biological yield were increased markedly due to the application of 6-BAP. The highest grain yield was 2.45 (t ha^{-1}) with spraying 150 ppm 6-BAP. The 6-BAP, a synthetic cytokinene stimulated plant height, leaf length, number of tillers hill^{-1}, total chlorophyll content, panicle number hill^{-1}, grain yield (t ha^{-1}), and harvest index at positive way which might be a supportive tool for aromatic rice production in Bangladesh.

Key words: Aromatic rice, BAP, chlorophyll, kataribhog, yield

INTRODUCTION

Agriculture is an utmost important factor of the Bangladesh economy, contributing to 12.65% in 2020 of the country's Gross Domestic Product (GDP) and serving as the major employment sector in Bangladesh (ONeill 2021). Approximately 87% of rural people derive at least a portion of their income from agricultural activities (World Bank 2016). Rice is a major food which holds the key for food and nutritional security of Bangladesh and has been given the highest priority in meeting the demands of its ever-increasing population. Rice covered an area of 11.8 million hectares with a production of 35.3 million metric tons while the average yield of rice in Bangladesh is around 2.92 t ha^{-1} (BBS 2019).

Generally grain of aromatic cultivars are fine with attractive flavour. There are many local and high yielding varieties are cultivated in Bangladesh. Kataribhog is the most important aromatic fine rice in Bangladesh and the rest of the world due to its attractive flavor, fine grain and good taste. Aroma and taste are caused by the chemical compound 2-acetyl-1-pyrroline (Ghareyazie et al. 1997). Aromatic rice is an important commodity in international trade having small grain with pleasant aroma. The demand for aroma rice is increasing day by day. Unfortunately, the aromatic rice often has undesirable agronomic characters, such as low yield, susceptibility to stem lodging and pest attack (Faruq et al. 2011). The production of aromatic fine rice in Bangladesh is profitable due to its high price over low price coarse milled rice. Aromatic rice of Bangladesh on

To cite this article: Sarker BC, Roxy AA and Islam MS. 2021.Effect of 6-Benzyle aminopurine on morpho-physiological properties and grain yield of aromatic rice (cv. Kataribhog). Intl. J. Agric. Med. Plants. 2(2): 16-23.

account of its high export potential and better edible quality like *polau, khir, firny, chiramkhoi, biriany*, etc. has high demand.

Plant growth regulators (PGRs) which have shown to modify the canopy structure and physiological functions resulted in enhanced yield attributes. PGRs are widely used in contemporary agriculture to promote plant growth, yield, and grain quality in many field crops (Sarker et al. 2020a, Noor-E-Ferdous et al. 2020, Husain et al. 2018, Bakhsh et al. 2012). The introduction of chemical growth regulators has added a new dimension to the possibility for improving the growth and yield of rice corp. Both beneficial and adverse effects of PGRs on growth and development as well as plant metabolism have been addressed extensively (Ashraf et al. 2011).

Among the plant growth regulators, 6-benzylo amino purine (BAP) a cytokinins proved to stimulate cell division, induce shoot formation and axillary shoot proliferation and to retard root formation. There are some limitations to cultivate local aromatic rice cultivars at farmer level in Bangladesh due to unavailable high yielding variety, disease or pest attack susceptibility, and higher lodging tendency. If it is possible to cultivate aromatic rice by applying 6-BAP, it will be useful techniques for increasing grain yield. Recently, the rice scientists are being suggested to use PGRs for higher rice grain production. But the research on examining the effect and profitable concentration of 6-BAP for better rice yield is still in initial stage, specially, aromatic rice cv. Kataribhog. Therefore, this study was undertaken to find out the morpho-physiological responses and yield potential of aromatic rice cv. Kataribhog to optimum concentration of 6-BAP.

MATERIALS AND METHODS

A field experiment was conducted at the research farm of Hajee Mohammad Danesh Science and Technology University (HSTU) Dinajpur during Aman season (July to December), 2016 to ascertain the response of 6-BAP on the aromatic rice (cv. Kataribhog). Geographically the location of the experimental site is at 25°38' N latitude and 88°41' longitude at an average height of 34.5 m above the mean of sea level. The experimental design was randomized completely block design (RCBD) following three replications. The treatment factors were five levels of BAP viz, 0, 50, 100, 150 and 200 ppm spraying twice at vegetative and pre-flowering stages. Forty-day old healthy seedlings were transplanted on puddle plots. Three seedlings of the selected aromatic cultivars were transplanted in each hill with a spacing of 15 cm×20 cm.

The morphological growth parameters like plant height, leaf blade length, root depth, leaf width, leaves plant^{-1}, tillers hill^{-1} were collected at growth and harvesting stages. The flag leaf samples were collected at grain filling stage for chlorophyll estimation. The flag leaf chlorophyll-a, chlorophyll-b, total chlorophyll and total carotenoid content as physiological parameters were estimated by acetone extract method (Arnon 1949, Porra 2002) while yield contributing parameters like the panicle length, number of effective tiller hill^{-1}, number of non-effective tiller hill^{-1}, grain number panicle^{-1}, filled grains panicle^{-1}, unfilled grains panicle^{-1}, 1000-grain weight, grain yield ha^{-1}, straw yield ha^{-1}, biological yield ha^{-1}, harvest index (%) were recorded during harvest. The data were statistically analyzed to compare treatment means using the STATA 14 (StataCrop 2015). If the treatments were significant the differences between pairs of means were compared by LSD followed by DMRT.

RESULTS AND DISCUSSION

Plant height: Plant height states the nature of any kind of plants, its plant type and nature of leaf or canopy arrangement. It determines the nature of lodging, light, and air penetration. Results showed that plant height (Table 1) was insignificant at their seedling stage. At vegetative stage, the plant height was significantly influenced by the application of different levels of 6-BAP. The highest plant height was 123.8 cm spraying at the rate of 150 ppm 6-BAP, 150 ppm which was statistically different with to 50 ppm (121.0 cm), 100 ppm (115.7 cm), 200 ppm (119.9 cm) and the lowest was 108.1 cm under control. At harvesting stage, plant height was statistically also varied among the different levels.

Table 1. Plant height of aromatic rice cv. Kataribhog under different levels of 6-BAP.

Levels	Growth stages		
ppm	Seedling	Vegetative	Harvesting
0	72.4ns	108.1 b	144.7 b
50	72.8ns	121.0 a	156.7 a
100	73.0ns	115.7 ab	151.1 a
150	71.4ns	123.8 a	149.9 a
200	69.3ns	119.9 ab	148.0 b
SE	2.61	0.55	2.48
LSD	8.92	1.79	8.08

Mean followed by the same letter (ns) did not differ significantly at 5% level.

The highest plant height was 156.7 cm observed in 50 ppm which was statistically similar to 100 ppm (151.1 cm) and 150 ppm 6-BAP (149.9 cm). The lowest plant height was 144.7 cm in control treatment (0 ppm). Rahman et al. (2017) revealed that NAA had more positive impact than that of GA_3 on plant height of boro rice cultivars. It was evident that plant height of different rice cultivars was increased using 100 ppm NAA (Akter 2012, Adam and Jahan 2011) and 100 ppm IAA (Awan and Alizai 1989, Khanam 2016) revealed that application of 6-BAP at the level of 150 ppm increased plant height of Chinigura rice which was in well agreement with the present findings that 6-BAP increased plant height of aromatic rice cv. Kataribhog.

Leaf Number: Table 2 represented that there was no significant relationship in leaf number among the different levels of BAP treatment at any growth stages. In harvesting stage, the highest average leaf number was 4.89 obtained from 50 ppm and 200 ppm treatments. The lowest average leaf number was 4.22 produced by 100 ppm treatment. Khanam (2016) observed that 100 ppm 6-BAP was found to be superior to others treatments for increasing the leaf number plant^{-1} of Chinigura rice. Rahman et al. (2017) found that the maximum number of leaves was from HYV cv. BRRI dhan28 while the lowest number of leaves was emerged from cv. Jirashail and cv. Poshushail due to the application of GA_3 and NAA as a plant growth regulators.

Table 2. Leaf numbers of aromatic rice cv. Kataribhog under different levels of 6-BAP.

Levels (ppm)	Growth stages		
	Seedling	Vegetative	Harvesting
0	3.00ns	4.00ns	4.55ns
50	3.00ns	4.33ns	4.89ns
100	3.00ns	3.78ns	4.22ns
150	3.00ns	4.11ns	4.67ns
200	3.00ns	4.00ns	4.89ns
SE	0.00	0.24	0.30
LSD	0.00	0.79	0.98

Flag leaf blade length: Flag leaf blade length at reproductive stage was not statistically significant at all growth stages during the experiment time (Table 3). The blade length increased with the growth stage and time proceeded. In vegetative stage, the highest leaf blade length was 150 ppm (52.22 cm) which was statistically similar to 200 ppm (52 cm). The lowest leaf blade length was 47 cm from 50 ppm treatment. At reproductive stage, the highest flag leaf blade length was 57 cm obtained from 150 ppm treatment while the lowest was 54 cm from 100 ppm. There was no significant relationship in leaf blade length by applying different concentration of BAP treatment in the present study. Khanam (2016) observed that there was no significant relationship in leaf blade length of Chinigura rice variety by applying different concentration of BAP treatment. Sarker (2020a) also found insignificant relationship in leaf blade length by applying different concentration of NAA treatment.

Table 3. Flag Leaf blade length of aromatic rice cv. Kataribhog under different levels of 6-BAP

Levels ppm	Growth stages		
	Seedling	Vegetative	Harvesting
0	47.7ns	51.6ns	55.4ns
50	40.0ns	47.3ns	55.2ns
100	41.1ns	50.8ns	54.0ns
150	42.3ns	52.2ns	57.5ns
200	44.7ns	52.0ns	55.7ns
SE	2.43	1.34	1.22
LSD	7.92	4.36	3.98

Tiller numbers hill^{-1}: Tillering especially the production of effective tiller is the key factors for yield and yield attributes for rice production. Spraying 50 ppm BAP had the better stimulating effect to increase the tiller number hill^{-1} in different plant growth stages (Table 4). Results showed that there was a significant effect of 6-BAP on tiller number hill^{-1} at harvesting stage and vegetative stages but not significant at the seedling stage. The highest tiller number hill^{-1} was obtained using 150 ppm BAP (8.33) while the lowest was in controlled treatment (6.66). At harvesting stage, tiller numbers was also significantly differed among the applied treatments. Likewise vegetative stage, the highest tiller number hill^{-1} was from 150 ppm and markedly varied with other treatments. Rahman et al. (2017) reported that 100 ppm NAA shows the better result to increase the tiller number per hill in different stages of plant growth. Akter (2012) revealed that the combined application of 100 ppm to 200 ppm NAA and residual effect of 1.5 to 2.0 ton lime may be used in the field for obtaining better tiller number hill^{-1} of Kataribhog rice.

Table 4. Tillers number hill^{-1} of aromatic rice cv. Kataribhog under different levels of BAP

Levels ppm	Growth stages		
	Seedling	Vegetative	Harvesting
0	3.00ns	6.66b	6.33c
50	3.33ns	7.33b	7.00c
100	4.00ns	7.33b	8.00b
150	4.00ns	8.33a	8.66a
200	3.00ns	7.00b	7.00c
SE	0.149	0.197	0.197
LSD	0.486	0.643	0.643

Mean followed by the same letter (ns) did not differ significantly at 5% level.

Root depth: Table 5 showed that root depth was insignificant at their seedling stage. In vegetative stage root depth was significant. At vegetative stage, the highest root depth was 150 ppm (9.78 cm) which was statistically similar to 50 ppm (8.89 cm), 100 ppm (9.67 cm), and 200 ppm (8.89 cm) while the lowest was in control (7.45 cm). At harvesting stage, root depth was also significant. The highest root depth was observed in 150 ppm (13.0 cm) and the lowest root length was recorded 8.22 cm from control. BAP increased the root growth in relation to length in Kataribhog rice during their growth stages. Khanam (2016) revealed that 200 ppm 6-BAP was found to be superior to others treatments for increasing the root depth of aromatic rice cv. Chinigura rice. Sarker et al. (2020) revealed that root depth was increased in cv. Chinigura by spraying of 150 ppm NAA.

Table 5. Root depth of aromatic rice cv. Kataribhog under different levels of 6-BAP.

Levels	Root depth (cm)		
ppm	Seedling stage	Vegetative stage	Harvesting stage
0	8.78ns	11.45 c	12.22 c
50	8.56ns	12.89 a	13.89 c
100	8.11ns	12.67 b	16.22 b
150	8.67ns	12.98 a	19.00 a
200	8.11ns	13.89 a	19.00 a
SE	0.721	0.341	0.462
LSD	2.353	1.114	1.509

Mean followed by the same letter (ns) did not differ significantly at 5% level.

Chlorophyll content in flag leaves: Leaf chlorophyll content is one of the important physiological traits closely related to photosynthetic ability in rice (Teng 2004). Undoubtedly, understanding the genetic mechanisms underlying the leaf chlorophyll content across different developmental stages of rice has significant implications for improving photosynthetic ability in rice. Chlorophyll content in leaves is one of the major components in photosynthesis that helps in rice growth, development and yield. Application of PGRs (NAA, 2,4-D, IAA, and GA_3) on maize (Sunohara 1997), summer mungbean (Noor-E-Ferdous et al. 2020), aromatic rice (Sarker et al. 2020b) significantly increased in chlorophyll content. Sarker et al. (2020a) obtained similar finding as they concluded that maximum chlorophyll was found in flag leaf by foliar spraying of 6-BAP.

Chlorophyll-a content: Chlorophylls are the most widely distributed plant pigments responsible for the characteristic green color of fruit and vegetables (Almela 2000). It is important to plants because it is the substance that the chloroplast organelles in the cells that carry out photosynthesis. The major chlorophylls in different plants are chlorophyll-a, which has a methyl group at C-3 carbon, and chlorophyll-b, which a formal group is bonded to the same carbon atom. Chlorophylls are known to be easily degraded by conditions such as dilute acids, heat, light and oxygen (Tonucci and Von-Elbe 1992). An optimum temperature ranging from 25ºC to 35ºC is required for a good rate. The effect of different levels of 6-BAP was insignificant on chlorophyll-a content. The maximum amount was found in 50 ppm (17.64 mg $g^{-1)}$ and the lowest amount of chlorophyll- a showed by the treatment 200 ppm 6-BAP(13.93 mg g^{-1}). Khanam (2016) observed that there was no significant relationship in chlorophyll-a content in flag leaves of aromatic rice cv. Chinigura using 6-Benzylaminopurine.

Chlorophyll-b content: Chlorophyll-b absorbs energy from wavelengths of green light at 640 nm. It is the accessory pigment that collects energy and passes it on to chlorophyll-a. It also regulates the size of antenna and is more absorbable than chlorophyll-a. Thus, chlorophyll-a is the primary photosynthetic pigment while chlorophyll-b is the accessory pigment that collects energy. Therefore, the amounts of chlorophyll-b in flag leaves of rice plant have a significant impact on the production of photosynthate resulting in grain production. The effect of different levels of 6-BAP was insignificant on chlorophyll-b content. The maximum amount of it's found at 50 ppm (6.93 mg g^{-1}) and the lowest amount of chlorophyll- b showed by the control treatment (4.91 mg g^{-1}). There was no significant relationship among the levels of 6- BAP on chlorophyll-b content.

Total carotenoid content: The effect of BAP on aromatic rice variety was insignificant in the production of total carotenoid content (Table 7). The highest amount of carotenoid content was 3.46 mg g^{-1} from 100 ppm but the lowest amount was 2.27 mg g^{-1} at 150 ppm treatment. Similar agreement was also in Sarker et al. (2020b) that there was no significant variation of the NAA treatment on total carotenoid content of the flag leaf of three aromatic rice cultivars (Kataribhog, Chinigura and Kalijira).

Total chlorophyll content: Chlorophylls are the most widely distributed plant pigments responsible for the characteristic green color of fruit and vegetables (Almela 2000). It is important to plants because it is the substance that the chloroplast organelles in the cells that carry out photosynthesis. There was no significant effect of BAP on total chlorophyll content presented in Table 7. The highest amount of total chlorophyll content (28.0 mg g^{-1}) in 50 ppm treatment while the lowest amount of total chlorophyll content (22.26 mg g^{-1}) at 200 ppm 6-BAP. There was no significant relationship among the varieties as well as BAP treatment on total chlorophyll content. Akter (2012) revealed that the highest total chlorophyll content of the flag leaf of Kataribhog rice cultivar was obtained from 100 ppm NAA.

Table 6. The effect of different levels of BAP on the chlorophyll and carotenoid content of Kataribhog rice leaf

Levels	Chlorophyll-a	Chlorophyll-b	Total carotenoid	Total chlorophyll
(ppm)		(mg g^{-1} FW)		
0	14.33ns	4.91ns	3.05ns	22.29 a
50	15.89ns	5.31ns	2.27ns	23.47 b
100	13.93ns	5.75ns	2.58ns	22.26 b
150	17.64ns	6.93ns	3.44ns	28.01 a
200	15.56ns	4.67ns	3.46ns	23.69 ab
SE	1.04	0.72	0.60	2.04
LSD	3.39	2.37	1.96	4.87

Mean followed by the same letter (ns) did not differ significantly at 5% level.

Panicle length: Different levels of 6-BAP on panicle numbers $hill^{-1}$ was significant (Table 8). The maximum number of panicle per hill was found in 50 ppm concentration (20.77 cm) followed by 150 ppm (18.33 cm). 100 ppm (17.44 cm) which was statistically similar to 200 ppm (17.11 cm). The lowest number of panicle $hill^{-1}$ was in control (16.22 cm) concentration. Result showed that 50 ppm BAP treatment is suitable for panicle length. Khanam (2016) observed that application of 100 ppm 6-BAP increased panicle length and number of panicles $hill^{-1}$ of aromatic rice cv. Chinigura. Sarker (2020b) observed that 150 ppm NAA was found to be superior to others treatments for increasing the panicle length of Chinigura rice. Pan et al. (2013) revealed that number of spikelets per panicle was significantly increased using 6-BAP at 30 mg L^{-1} and 50 mg L^{-1} pacolobutazol (PBZ) at heading stage.

Number of effective tillers $hill^{-1}$: A significant variation was found in effective tiller production in the studied variety. The maximum number of effective tiller was 10.33 recoded from 150 ppm followed by 50 ppm (8.00) and 100 ppm (6.67), respectively. The lowest number of effective tiller was 6.50 found in control treatment (0 ppm). Akter (2012) revealed that highest effective tillers per hill were found while 150 ppm NAA was applied as treatment with the residual effect of 2 ton lime.

Table 7. Yield and yield contributing characters of aromatic rice cv. Kataribhog under different levels of 6-BAP

Treatments ppm	Yield Contributing Parameters			
	Panicle length (cm)	Effective tillers $hill^{-1}$	Non effective tillers $hill^{-1}$	1000-grain weight (g)
0	16.22 c	6.50 c	1.66ns	12.70 c
50	18.33 b	8.00 b	1.00ns	14.00 b
100	17.11 bc	6.67 c	1.33ns	14.13 b
150	20.77 a	10.33 a	1.33ns	15.30 a
200	17.44 bc	8.00 b	1.33ns	14.18 b
SE	0.5517	0.3837	0.1972	0.2996
LSD	1.799	1.251	0.6431	0.9771

Mean followed by the same letter (ns) did not differ significantly at 5% level.

Number of non-effective tillers $hill^{-1}$: Table 8 showed the number of non-effective tiller produced in Kataribhog under different levels of 6-BAP. The effect of different levels of 6-BAP was insignificant on non-effective tiller. The maximum number of non-effective tiller at control treatment (1.66) and the lowest number of 150 ppm (1.00). Sarker et al. (2020a) also found insignificant relationship on non-effective tiller by applying different levels of 6-BAP.

1000-grain weight: Table 8 showed the 1000-grain weight of Kataribhog under different levels of 6-BAP. The highest weight of 1000-grain was observed at 100 ppm (15.30 g) followed by 50 ppm (14.18 g) which was statistically similar to 150 ppm (14.00 g) and 200 ppm 6-BAP (14.13 g), respectively. The lowest performance was in controlled treatment (12.70 g). Rahman et al. (2017) revealed that 100 ppm NAA with 1.0 ton lime residual effect showed the best performance in all yield contributing characters in Kataribhog rice such as number of filled grain, 1000-grain weight and yield production. Khan et al. (2011) revealed that application of growth regulator (NAA) at the rate of 90 ml ha^{-1} at panicle initiation stage resulted in highest number of 88 and 90 % normal kernel, 23.00 and 23.20 g 1000-grain weight during 2004 and 2005, respectively.

Grains panicle^{-1}: The effect of different levels of 6-BAP was significant on grain number per panicle (Table 9). The maximum number of grain at 150 ppm (186.3) followed by 200 ppm (162.3), 50 ppm (149.7) and 100 ppm (147.3). It was observed that L2 was statistically similar to 100 and 200 ppm 6-BAP. The lowest grain number per panicle was 133.3 observed in control treatment. Sarker et al. (2020a) reported that150 ppm NAA on aromatic rice cv. Kalijira showed better performance on grain number per panicle which conformed the present study that 150 ppm 6-BAP (L4) stimulated the grain number per panicle.

Grain weight panicle^{-1}: Table 8 showed the grain wt per panicle produced in cv. Kataribhog rice under different levels of 6-BAP. A significant variation was found in grain weight panicle^{-1}. The maximum grain weight was 2.64 g applying 150 ppm 6-BAP) which was statistically similar to 200 ppm followed by 100 ppm (2.48 g) and 50 ppm 6-BAP (2.09 g). The lowest grain wt was in control (1.70 g) concentration. Several author also confirmed the present findings that PGRs increased the grain weight panicle^{-1} in rice (Sarker et al. 2020a, Rahman et al. 2017)

Grain yield (t ha^{-1}): The different concentrations of BAP were interacted significantly with each other in respect of grain yield of cv. Kataribhog which was presented in Table 8. Table 8 shows that lower grain yield ha^{-1} in controlled plants than those of 6-BAP treated plants. The highest grain yield was found 2.45 t ha^{-1} spraying 150 ppm 6-BAP followed by 200 ppm, 100 ppm, and 50 ppm, i.e., 2.10, 1.83 and 1.83 t ha^{-1}, respectively. The lowest yield was found in control treatment produced 1.60 t ha^{-1}. The result showed that 150 ppm 6-BAP concentration is suitable for Kataribhog rice cultivation. Sarker et al (2020b) revealed that grain yield (t ha^{-1}) was significantly increased spraying with 150 ppm NAA on cv. Chinigura. Akter (2012) revealed that 100 ppm NAA with 1.0 ton lime was better for yield contributing characters in Kataribhog rice and increasing yield. Bakhsh et al. (2012) also published that application of NAA increased the grain yield and yield components of rice.

Straw yield (t ha^{-1}): There was no significant variation in straw yield of aromatic rice cv. Kataribhog the present investigation among the treatments which was shown in Table 8. The maximum straw yield at 150 ppm (3.8 t ha^{-1}) and 200 ppm followed by 100 ppm (3.63 t ha^{-1}), respectively. The lowest straw yield was observed in 50 ppm (3.56 t ha^{-1}) and control (3.56 t ha^{-1}) which was not statistically significant.

Biological yield: The biological yield was presented in Table 9. Table 9 shows that the maximum biological yield (6.25 t ha^{-1}) was obtained from the 150 ppm BAP concentration followed by 100 ppm (5.90 t ha^{-1}) and 50 ppm (5.40 t ha^{-1}).

Table 8. Grain number and grain weight (g) panicle^{-1}, straw yield, grain yield and biological yield under different levels of 6-BAP on

Treatments ppm	Grains panicle^{-1}	Grain wt. panicle^{-1}	Straw yield (t ha^{-1})	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})
0	133.3c	1.70c	3.56ns	1.60d	5.17b
50	149.7bc	2.09b	3.56ns	1.83c	5.40b
100	147.3bc	2.08b	3.63ns	1.83c	5.47b
150	186.3a	2.64a	3.8ns	2.45a	6.25a
200	162.3b	2.48a	3.8ns	2.10b	5.90ab
SE	6.875	0.085	0.194	0.068	0.225
LSD	22.42	0.279	0.635	0.222	0.734

Mean followed by the same letter (ns) did not differ significantly at 5% level.

%Harvest Index (%HI): The %HI differed significantly among the treatments. The highest harvest index was recorded in 50 ppm (39.24%) and the lowest %HI was recorded in 150 ppm (33.58%) (Figure 1). The result also showed that there was no significant difference between 150 ppm and 200 ppm treatments. The result revealed that 50 ppm 6-BAP application obtained the highest %HI. Sarker et al. (2020a) revealed that the highest harvest index (44.64 %) in aromatic rice (cv. Chinigura) by applying 150 ppm NAA. Rahman et al. (2017) found the highest harvest index (49.60 %) which obtained from BRRI dhan28 spraying 100 ppm NAA and the lowest harvest index (42.01%) which obtained from the Nerica-4 without GA_3 or NAA.

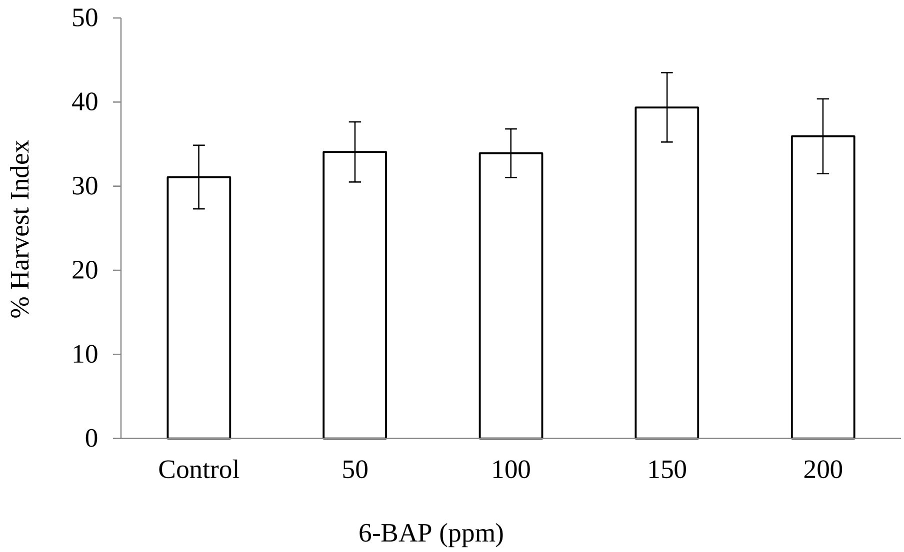

Figure 1. Harvesting index in aromatic rice cv. Kataribhog under different levels of 6-BAP.

CONCLUSION

Morphological growth and physiological parameters of aromatic rice (cv. Kataribhog) was increased by the twice spraying of BAP. The 150 ppm BAP had greater stimulating effect on grain yield of aromatic rice (cv. Kataribhog) producing higher number of tillers $hill^{-1}$, 1000-grain weight, grain number $panicle^{-1}$ and grain weight $panicle^{-1}$. Therefore, 150 ppm 6-BAP may be recommended for the farmers' level due to increased root growth, more effective tiller number, grain number $panicle^{-1}$ and grain yield. It is concluded that 150 ppm 6-BAP spraying twice at vegetative and reproductive stages may be beneficial for increasing grain yield of fine aromatic rice (cv. Kataribhog) which might be a smart management tool for aromatic rice grain production.

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