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RESPONSE OF ROOT GROWTH AND YIELD OF RICE (BRRIdhan28) UNDER DIFFERENT IRRIGATION FREQUENCIES AND PLANT GROWTH REGULATOR

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ABSTRACT

An experiment was conducted to study the effect of Napthalene Acetic Acid (NAA) and three irrigation frequencies on root growth and yield of BRRIDhan28. The treatments were control Ho; tap water-control, H_1; 50 ppm NAA, H_2; 100 ppm NAA and H_3; 150 ppm NAA for growth regulator. Irrigation frequencies were W_1: always flooded condition, W_2: flooded 10 days interval and W_3: flooded 20 days interval. Root length, root volume and root weigh (dry & fresh) markedly increased using 100 ppm NAA under flooded condition. The highest root length, root volume, root weight (fresh and dry), dry plant weight and yield was obtained from 100 ppm NAA. It was also observed that the combined application of NAA and flooded irrigation were more effective than the treatment of H_2+W_2 and H_2+W_3. The present findings inferred that the combined 100 ppm NAA+flooded irrigation were found to be superior to other treatments for yield, root length and other growth parameters.

Key words: Growth Regulator, Naphthalene Acetic acid, Root Growth, Yield, and Irrigation Frequencies

INTRODUCTION

Rice is one of the major food crops of the world. Worldwide rice is cultivated in 150 million hectares, which is more than 10% of the earth's arable land. It is also the staple food crops of nearly half of the total population of the world. Rice is extensively grown throughout the year in Bangladesh. Boro rice has gained much importance in Bangladesh, as the average yield per hectare is much higher than that of Aman. Plant growth regulators (PGR) are being used as an aid to enhance yield of different crops (Nickell, 1982)**.** NAA is one of the growth promoting hormones, which may play significant role to change growth characters and yield in boro rice. Foliar application of growth regulator such as, Indole Acetic Acid (IAA), Naphthalene Acetic Acid (NAA), Ethylene, 2,4-D, Gibberellic Acid (GA_3) and Malic Hydrazide (MH) produce more fertile grain/hill. Lee (1990) examined the foliar application of NAA has increased plant height, number of leaves per plant, fruit size in different crops and are being advised to use PGRs to get higher rice production. But the research on examining the combination effect of NAA and water stress for better rice yield is still in initial stage. Yield is the cumulative effect of a variety with its inherent characteristics, management practices and the environment in which it is grown. Variety is one of the most important factors for increasing yield. Thus a study was undertaken with the objectives of identify the suitable dose of NAA in order to achieve both quantitative and qualitative effect on rice production. IAA is environment friendly. IAA is of advanced broad spectral and highly effective for root growth promoting agent used for improving the production of cereal, vegetables and some especial economically important crops. The studies of NAA on crop production in Bangladesh for principle cereal crops are very scanty. Most of our land is medium high land. For Boro rice cultivation in the Rabi season its need continues water logging condition. But water source in our country there is very insufficient and water pump is not available in everywhere. So farmers can not supply sufficient amount of water to cultivate Boro rice. If it is possible to cultivate Boro rice by applying Plant Growth Regulators (PGRs), it might be very helpful

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for our farmers by increasing yield of Boro rice. PGRs may increase the root growth and also help promoting new roots. The studies on NAA for rice production is limited in our country, but other countries of the world although provide useful information, that cannot be recommended or practiced without trial in our local condition. Therefore, more researches or trials are necessary to prove the efficacy of NAA. Therefore, keeping these in view, the present investigation was undertaken to identify the suitable dose of NAA in order to achieve quantitative effect on rice production. The specific objectives are to evaluate the effect of NAA on root growth and yield of rice BRRIDhan 28.

MATERIALS AND METHODS

The experiment was conducted in field at the farm of Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the period from January 24, 2008 to May 05, 2008. The experimental site was medium high land and belonging to the Agro-ecological Zone 1 (AEZ-1) named Old Himalayan Piedmont Plain**.** A high yielding variety of Boro rice BRRIdhan 28 is used as test plant. The seeds were collected from BADC farm, Dinajpur and raised the seedling a HSTU farm. Naphthalene acetic acid (NAA) was used for plant growth regulator. Irrigation was applied 10 and 20 days interval to maintain the stress and always flooded condition for control. The irrigation facilities were provided from the deep tubewell which was previously established in the Agricultural farm, HSTU. A total of 36 plots were prepared and each plot was 3 m length and 2 m in wide. There are four doses of PGRs (NAA) and three different irrigation frequencies was used for maintain the treatments. For growth analysis data were collected after 10 days for leaf number, plant height, tiller number and the rice plant were collected after 20 days for fresh dry plant weight, root length, root volume, root fresh and dry weight, and yield at final harvest of the crops.

Preparation and application of plant growth regulator: NAA solution was prepared following the procedure below and the spraying was done at noon by using a hand sprayer. A 100 ppm solution of NAA was prepared by dissolving 100 mg of NAA in a 1 litre cylinder in which 5 ml of ethanol prior to dilution was made in distilled water. The distilled water was added to make the volume 1 liter to get 100 ppm solution. In a similar way 150 ppm and 50 ppm concentrations of the NAA solution were made, by taking 150 mg and 50 mg NAA in liter volumetric flask and the volume was made up to the mark with distilled water. An adhesive namely Tween 20 @ 0.1% was added to each solution**.** Spraying was done 2 times at 20 days interval by using a hand sprayer from tillering to booting stages. After attainment of the maturity, the whole plant was cut at ground level by a sickle. After recording necessary data the harvested crop hills/ was dried in sun and then in an oven at 65^{o}C for 96 h.

Procedure of sampling during crop growth period: The data of root length, root volume, root fresh weight, root dry weight, fresh plant weight, dry plant weight were taken after 20 days intervals. For measuring root length the selected stem was cut above 1 cm from the ground. an augar of 20 cm in diameter was used to collect the layer based root sample. The root and other plant parts were carried to the laboratory in properly labeled polythene bag to prevent transpiration losses. Then the collected plant roots were carefully washed using running tap water to remove soil and blotted with blotting paper to remove the adhering water on them. The plants were separated into leaves and stem. Numbers of leaves and tillers were recorded separated in each time. The root dry weight and dry plant weight were taken after an oven dried at 60 ± 2^{o} C for 72 hours to record constant dry weights. At final harvest, grain was collected and dried. The yield of grain was recorded for the purpose. The collected data were analyzed statistically and the differences among means were compared by using Duncan's New Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Root length: The root length was recorded at 0, 20, 40, 60 and 80 DAT (Table 1). The result recorded that the different concentration of NAA both alone and in combination with water

significantly increased root length over control. At 20, 41, 61and 81 DAT maximum root length was recorded due to the treatment of 100 ppm NAA+ flooded water growth period (12, 24.60, 27.50 and 32 cm for 21, 41, 61 and 81 DAT, respectively) followed by 50 ppm NAA+ optimum water growth period, 150 ppm NAA+ optimum water growth period, 50 ppm NAA+ irrigation at 10 days interval, 100 ppm NAA+ irrigation at 10 days interval, 150 ppm NAA+ irrigation at 10 days interval, 50 ppm NAA+ irrigation at 20 days interval, 100 ppm NAA+ Irrigation at 20 days interval and 150 ppm NAA+ irrigation at 20 days interval for 51, 61, 71 and 81 DAT respectively with same statistical rank. Control plants recorded the shortest root length. Result also revealed that the combined applications of NAA and water were more effective to root growth than the treatment of NAA alone. Wang *et al*. (1986) observed that, rice spraying with 10^{-1} and 10^{-3} ppm NAA at tillering stage significantly increase root dry weight. NAA also promoted new root growth.

Table 1. Root length of BRRIdhan28 at differ stages of growth.

	Root length (cm hill^{-1})			
Treatment	21 DAT	41 DAT	61 DAT	81 DAT
H_0W_1	11.0abc	20.6cd	24.0bcd	28.0bcd
H_1W_1	11.2abc	22.3bc	25.6ab	30.0b
H_2W_1	12.0a	24.6a	27.5a	32.0a
H_3W_1	11.0abc	19.3d	23.0cde	28.0bcd
H_0W_2	10.0c	20.1d	21.0ef	26.0d
H_1W_2	11.0abc	22.0bc	23.3cde	27.0cd
H_2W_2	11.5ab	23.5ab	24.0bcd	30.0b
H_3W_2	10.5bc	22.1bc	20.5f	29.0bc
H_0W_3	10.0c	21.0cd	21.5ef	24.0e
H_1W_3	11.2abc	22.0bc	22.0def	27.0cd
H_2W_3	11.7ab	23.0ab	25.0bc	30.0ab
H_3W_3	10.5bc	22.3bc	23.0cde	28.0bcd
$LSD_{0.05}$	1.197	1.710	0.7071	1.855

In a column, figures bearing same letter(s) do not differ significantly.

Root volume: Root volume per hill was recorded at 21, 41, 61 and 81 DAT. The result revealed that significant variation in root volume per hill due to the effect of NAA and water at different stages of plant growth (Table 2). Among the treatments, NAA alone or in combination with water, 100 ppm NAA+ optimum water growth period induced maximum volume of root (3.60, 20, 45 and 56 for 21, 41, 61 and 81 DAT respectively) followed by 50 ppm NAA. In contrast control produced lowest volume of root per hill 2.93, 11.67, 31.7 and 40 for 21, 41, 61 and 81 DAT, respectively). Ratna *et. al*. (1995**)** observed an increase root dry weight with ABT-6 at 20 ppm in soyabean. Tao and Shiying (1992) revealed higher root volume due to application of ABT, which supported the result of the present study.

Root dry weight: Root dry weight was at 51, 61, 71 and 81 DAT presented in table 3. The Table 3 showed that the stimulation effects of NAA on roots were significantly higher in flood soils. Results further revealed that NAA with water was more effective than NAA alone for root production. 25 ppm NAA showed poor effect on root dry weight. Darmijati *et. al* (1995) revealed an increased root dry weight in peanut with ABT.

Table 2. Root volume of BRRIdhan28 at differ stages of growth.

Root volume (cc hill^{-1})				
Treatment	21 DAT	41 DAT	61 DAT	81 DAT
H_0W_1	2.9D	11.6f	31.70d	40.0e
H_1W_1	3.2bcd	15.8cd	37.0c	46.0c
H_2W_1	3.6abcd	20.0a	45.0a	56.0a
H_3W_1	3.01cd	17.0bc	40.0b	51.0b
H_0W_2	3.6abcd	15.0de	25.0ef	34.0j
H_1W_2	3.7abc	16.0cd	26.0e	36.0h
H_2W_2	4.0a	18.3ab	16.0g	38.0f
H_3W_2	3.3abcd	12.0f	23.0f	36.0h
H_0W_3	3.4abcd	7.50g	30.0d	35.0i
H_1W_3	3.9ab	13.0ef	26.0e	37.0g
H_2W_3	3.9ab	15.0de	27.0e	41.0d
H_3W_3	3.3abcd	12.0f	25.07ef	38.0f
$LSD_{0.05}$	0.6773	2.074	2.074	0.05355

In a column, figures bearing same letter(s) do not differ significantly.

Table 3. Effect of NAA on Root dry weight of BRRIdhan28 at differ stages of growth.

Root dry weight (g hill^{-1})				
Treatment	21 DAT	41 DAT	61 DAT	81 DAT
H_0W_1	0.13a	0.80de	1.50ef	2.49e
H_1W_1	0.19cd	1.0bcde	1.70d	2.68c
H_2W_1	0.35a	1.56a	2.30a	2.87a
H_3W_1	0.30ab	1.85cde	1.65d	2.55d
H_0W_2	0.25bc	1.02bcde	1.45f	2.40f
H_1W_2	0.36a	1.10abcd	2.10b	2.80b
H_2W_2	0.30ab	1.48ab	2.25a	2.80b
H_3W_2	0.20cd	0.85cde	1.54e	2.53de
H_0W_3	0.29ab	0.78de	1.36g	2.35fg
H_1W_3	0.30ab	0.79de	1.35g	2.39f
H_2W_3	0.35a	1.35abc	1.80c	2.56d
H_3W_3	0.34a	0.56e	1.48f	2.30g
$LSD_{0.05}$	0.075	0.460	0.053	0.053

In a column, figures bearing same letter(s) do not differ significantly.

Dry plant weight: Various concentrations of NAA alone or with irrigation water had significant effect on dry plant weight (Table 4) at 21, 41, 61 and 81 DAT. The concentration of 100 ppm NAA along with water showed significant highest dry plant weight over the other concentrations. But 100 ppm NAA alone or with water had highest effect on plant matter production at 81 DAT.

100 ppm NAA showed the best effect on plant dry matter production followed by 50 ppm. Plant dry matter weight was higher at 81 DAT over that at 61 DAT. The evidence of increasing dry matter in stem at later stages of growth was revealed by Kumar *et.al*. (1987).

Table 4. Total plant weight (dry) of BRRIdhan28 at differ stages of growth under different irrigation frequencies and NAA.

	Dry plant weight (g hill^{-1})			
Treatment	21 DAT	41 DAT	61 DAT	81 DAT
H_0W_1	0.30bc	6.80bcd	11.98f	18.98d
H_1W_1	0.40abc	7.23bcd	13.20c	19.20c
H_2W_1	0.56a	9.60a	15.50a	20.50a
H_3W_1	0.50abc	6.93bcd	12.98d	18.50f
H_0W_2	0.25c	6.20bcd	11.56g	18.20h
H_1W_2	0.30bc	6.80bcd	11.60g	19.00d
H_2W_2	0.45abc	8.50ab	14.50b	19.50b
H_3W_2	0.36abc	5.90cd	12.35e	18.00i
H_0W_3	0.32bc	5.30d	10.42j	17.42j
H_1W_3	0.39abc	6.20bcd	11.30i	18.20h
H_2W_3	0.53ab	8.20abc	12.30e	18.80e
H_3W_3	0.31bc	7.10bcd	11.50h	18.30g
$LSD_{0.05}$	0.207	2.074	0.053	0.053

In a column, figures bearing same letter(s) do not differ significantly

Table 5. Yield of BRRIdhan 28 conducted at HSTU farm, Dinajpur during 2008.

Treatment	Yield at final harvest (kg/ plot)
H_0W_1	3.12ab
H_1W_1	3.17ab
H_2W_1	3.42a
H_3W_1	3.03ab
H_0W_2	2.48bc
H_1W_2	2.43bc
H_2W_2	2.62abc
H_3W_2	2.45bc
H_0W_3	1.80c
H_1W_3	1.88c
H_2W_3	2.16c
H_3W_3	1.84c
$LSD_{0.05}$	0.7704

In a column, figures bearing same do not differ significantly.

Yield: The effect of NAA + water on grain yield was presented in Table 5. Result revealed that all the treatments had significant effect on grain yield with no significant difference with in the NAA

treatments. The lowest yield (1.80kg/plot) was obtain in the plot where 150 ppm NAA along with irrigation at 20 days interval was applied. 100 ppm NAA+ flooded water growth period produced the highest grain yield (3.42 kg per plot).

The result showed that grain yield increased with increasing NAA concentration up to 100 ppm. It produced more effective tiller per hill. As a result highest grain yield was obtained due to 100 ppm NAA+ optimum water growth period. Singh *et al.* (1994**)** observed that spraying of planofix (NAA) on wheat plant, significantly increased grain yields, which supported the result of the present study.

CONCLUSION

The present findings revealed that all the root morphological parameters were improved in the treated plants compared to the control. Among the doses, 100 ppm alone or with water showed the best performance in all morphological characters but within two treatments (100 ppm NAA+ flooded water at different and 100 ppm NAA+ irrigation at 20 days interval), NAA in combination with flooded water on root growth performed better. The root length increased with the advancement of plant age in all treatments. The NAA in combination with flooded water at different growth period had shown significant effect on root length over control at 41, 61 and 81 DAT. The dose of 100 ppm of NAA+ flooded water produced the highest root length. All the yield contributing characters such as number of tillers, root volume, root dry weight, root fresh weight and yield production were significantly influenced by NAA and water. Amongst the different treatments, there were significant difference in increasing yield and yield contributing characters. NAA 100 ppm+ flooded water recorded 22.95% higher yield than control. The morphological, physiological, yield and yield components parameters were improved in the treated plants than control. It is inferred that NAA 100 ppm + flooded water may be the appropriate combination for on the root growth for water and nutrient acquisition and yield of BRRIdhan28.

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