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Morpho-physiological and Yield Contributing Characters and Yield of Sesame with 1-Napthalene Acetic Acid (NAA)

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Abstract: The experiment was undertaken in the Farm laboratory of Sher-e-Bangla Agricultural University (SAU), Dhaka, during Kharif 1 season, April to July 2013 to examine the response of different levels of foliar application of 1-napthaleneacitic acid (NAA) on morpho-physiology, yield contributing attributes and seed yield of sesame using variety BARI Til 4. The treatments of this experiment consisted of four different levels of NAA *viz.* A_0 = 0 ppm, A_1 = 25 ppm, A_2 = 50 ppm and A_3 = 75 ppm. The research was laid out in single factors Randomized Complete Block Design (RCBD) with four replications. In this study, NAA significantly increased morphological characters- plant height, leaf number plant^{-1}, branch number plant^{-1}, fresh and dry weight of shoot and root other than leaf and branch number plant^{-1} of at 30 and 40 DAS. As morphological parameters NAA also significantly improves yield contributing characters of sesame-the number of pod plant^{-1}, diameter and length of pod, seed weight plant^{-1} and plot^{-1}, thousand seed weight compared to without NAA. The foliar application of 50 ppm NAA increased seed yield of sesame (1.22 t/ha) which is consistent with the results of morph-physiological and yield contributing characters of this study. Separately, the higher dose of NAA, 75 ppm failed to produce better results of this experiment including seed yield. These results suggest that NAA shows a positive consequence to increase the seed yield of sesame by changing the plant architecture and biomass production. Based on the present results, it can be suggested that the 50 ppm NAA is appropriate for higher yield of sesame var. BARI Til 4 under the climatic conditions of SAU.

Keywords: Sesame, NAA, Growth, Yield, Physiology

1. Introduction

Sesame (*Sesamum indicum* L.) is a flower bearing annually cultivated oil crop under the family of Pedaliaceae. The world harvested about 4.76 million metric tons of sesame seeds in 2013 and the largest producer was Burma. The world's largest exporter of sesame seeds was India and Japan was the largest importer because they use sesame seed in bakery industry [1]. The nutritive value of sesame is excellent due to the most stable vegetable oils, with long shelf life, the high level of natural antioxidants: sesamin, sesamolin, and sesamol which inhibit the development of rancidity in the oil. The flour that remains after oil extraction is called sesame meal which is an excellent high-protein feed for poultry and livestock [2].

According to cultivation and production it occupies third position as an oil crop in Bangladesh followed by rapeseed and mustard [3]. Presently, Bangladesh faces an acute shortage of edible oil due to insufficient production of cooked oil in the country. Our production only ensures 4 g of oil per person whereas every man can consume 10 g of oil day^{-1}, indicates that extra 6 g added through import from other oil producing countries. Separately, it has been recommended that an adult should consume 22 g oil day^{-1} for better health. Thus we are experiencing 70% deficit of edible oil till to date. To meet up the demand of edible oil we are spending 160 million US dollar every year [4]. Sesame is one of the most important oil crops in

Bangladesh and grown in all regions. In the year of 1999-2000, the crop covered an area of 96000 acres in Bangladesh with production of 25000 M tons [5]. Recent BBS (2013) [6] reported that 84310 acres of land cultivated for sesame and production was 30972 metric tons. Therefore, these data suggest that although the land of cultivation of sesame is decreasing whereas the production is increasing trend from 1999 to 2013. But in a view of population growth, the requirement of edible oil is increasing with high in demand than the production. It is therefore, highly expected that the production of edible oil should be increased considerably to fulfill the increasing demand.

The yield of sesame may be increased by using numerous improved technologies and practices such as use of high yielding varieties and suitable practices. As practices, proper balanced supply of nutrients and application of plant growth regulators (PGRs) are one of the most important factors to increase higher yield. Plant hormones are produced naturally by plants and are essential for regulating their own growth. They act by controlling or modifying plant growth processes, such as formation of leaves and flowers, elongation of stems, development and ripening of fruit. In modern agriculture, people have established the benefits of extending the use of plant hormones to regulate growth of other plants. The application of PGRs in agriculture has started in the1930s in the USA. The PGRs, auxin is involved in a plethora of different developmental processes during the life cycle of a plant [7]. Auxin (IAA) was identified as a PGR because of its ability to stimulate differential growth in response to gravity or light stimuli [8]. Applications of IAA to plants cause profound changes in plant growth and development. Haque *et al*., (2005) [9] stated that PGRs at 80 ppm as foliar spray have positive regulatory effect on morphological growth and yield contributing attributes of sesame. Sesame yield was increased by application of Planofix through increasing the number of flower clusters plant^{-1} and reduced percentage of flower drop during Kharif 1 in Bangladesh [10]. The NAA enhance endogenous levels of PGRs including gibberellins because auxin is necessary to gibberellins biosynthesis, which affect growth, physiological attributes and finally yield. In contrast, higher auxin concentrations might often be inhibitory, so the optimum endogenous level must be tightly controlled. In this study, we used planofix as a source of auxin, 1-napthaleneacetic acid (NAA) to regulate the growth and yield of sesame using variety of BARI Til 4.

2. Materials and Methods

The experiment was carried out at Sher-e-Bangla Agricultural University Farm, Dhaka-1207, Bangladesh which located at $90^0 22'$ E longitude and 23°4l′ N latitude at an altitude of 8.6 meters above the sea level under the agro-ecological zone of Modhupur Tract, AEZ-28 during Kharif 1 season, April 2013 to July 2013 to examine the response to different levels of 1-napthaleneacetic acid (NAA) on morphology, yield and yield attributes of sesame variety BARI Til 4. A pest and disease resistant and high yielding variety seed was collected from the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. Before sowing of the seed in the experimental plot, germination test was done in the laboratory and results of percentage of germination were over 90%. The experiment was laid out in single factors randomized complete block design with four replications. Treatments of the experiment was four doses of NAA *viz*. A_0 = 0 ppm, A_1= 25 ppm, A_2 =50 ppm and A_3 =75 ppm. The total plot number was 4 x 4 = 16. The unit plot size was 2 m x 1.5 m = 3 m^2. The distance between blocks was 1 m and distance between plots was 0.5 m and plant spacing was 30 cm × 5 cm. The land was ploughed with a rotary plough and power tiller for four times. Ploughed soil was then brought into desirable fine tilth and leveled by laddering. The weeds were clean properly. The final ploughing and land preparation were done on 1 April, 2013. According to the lay out of the experiment the entire experimental area was divided into blocks and prepared the experimental plot for the sowing of sesame seed. In addition, irrigation and drainage channels were made around the plot. Sowing was done on 13 April, 2013 in rows 30 cm apart. Seeds were sown continuously in rows at a rate of 7.5 kg ha^{-1}. After sowing, the seeds were covered with the soil and slightly pressed by hand, and applied little amount water for better germination of seeds. The optimum plant population, 60 plants m^{-2} was maintained by thinning excess plant at 15 DAS. The plant to plant distance was maintained as 5 cm in the row. One weeding with khurpi was given on 25 DAS. Two irrigations were given during immediately after topdressing and 60 DAS with watering can. As per preventive measure seed was treated with a fungicide Vitavex 200 @ 2 g kg^{-1} before showing and fungal disease, Diathen M 45 EC @ 2 ml litre $^{-1}$ of water was applied twice first at 25 DAS and second at 50 DAS. Previous randomly selected ten plants plants from each plot were selected as random and were tagged for the data collection. Some data were collected from 30 days sowing with 10 days interval (Plant height, No. of leaves plant^{-1}, No. of primary branches plant^{-1}) and some data were collected at harvesting stage during 11-16 July, 2013 (No. of pod plant^{-1},Pod length, Pod diameter, Seed weight plant^{-1}, Seed weight plot^{-1}, Seed weight of 1000 seed and Yield). The sample plants were uprooted prior to harvest and dried properly in the sun (Fresh and dry weight of Shoot). The seed yield plot^{-1} was recorded after cleaning and drying those properly in the sun. The data obtained from the experiment were subjected to statistical analysis following analysis of variance technique [11]. The mean differences were tested through, least significant difference (LSD) method.

3. Results and Discussion

The results obtained with different levels 1-napthaleneacitic acid (NAA) are presented and discussed in this chapter. Data about morphological parameters, physiological attributes, yield contributing characters and seed yield of sesame have been presented in Figures.

3.1. Morphological Characters

3.1.1.Plant Height (cm)

In this study, planofix was used as a source of 1-Naphthaleneacetic acid (NAA) to examine the role of planofix on elongation of sesame plant height. Planofix had insignificant effect on plant height of sesame at 30 DAS whereas significant effect at 40 DAS and 50 DAS (Fig. 1). At 30 DAS, the highest plant height (60.98 cm) was observed from the $A_{2,}$ 50 ppm NAA and the lowest (57.31 cm) was observed from A_0 (0 ppm NAA). At 40 DAS, the highest plant height (91.10 cm) was observed from the A_2 (50 ppm NAA) and the lowest (87.06 cm) was observed from A_0 or control which was statistically similar with A_1 (25 ppm NAA) and $A_{3,}$ 75 ppm. At 50 DAS, the highest plant height (123.2 cm) was observed from the A_2 (50 ppm NAA) whereas the lowest (118.0 cm) was observed from A_0 treatment which was statistically similar with A_1 and A_3 treatment. These findings are in agreement with the findings of [12]Bharud *et al.* (1986), [13]Lakshmamma and Rao (1996) and [14]Kelaiya *et al.* (1991) who stated that plant height, were found to increase due to 100 ppm naphthalene acetic acid (NAA).

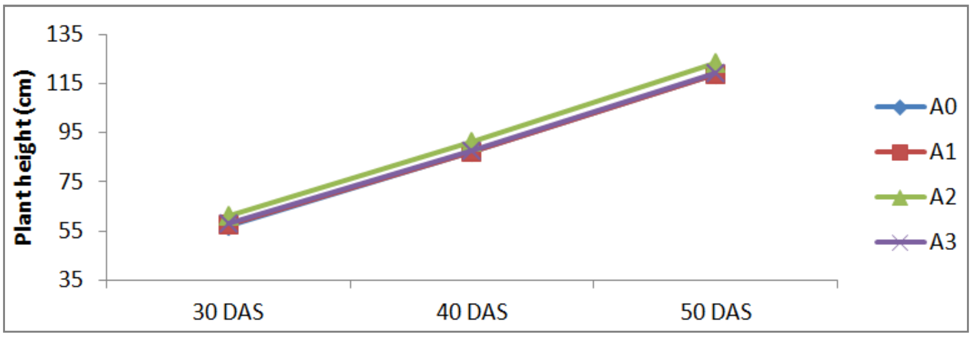

***Fig. 1.** Effect of different levels of NAA at different days after sowing (DAS) on the height of sesame plant.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix
A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix
DAS (Days after sowing)

3.1.2. Number of Leaf Plant^{-1}

The NAA was used to examine the physiological involvement in increasing of leaf number plant^{-1} in sesame. Application of NAA showed an insignificant effect on number of leaf plant^{-1} of sesame at 30 DAS, 40 DAS and 50 DAS (Fig. 2). At 30 DAS, the highest number of leaf plant^{-1} (16.11) was observed from the A_2 and the lowest (14.00) was observed from A_0. At 40 DAS, the highest number of leaf plant $^{-1}$ (17.89) was observed from the A_2 and the lowest (15.44) was observed from A_0. At 50 DAS, the highest number of leaf plant^{-1} (36.56) was observed from the A_2 and the lowest (33.44) was observed from A_0. These results are not consistent with the findings of [15] Deotale *et al.* (1998) and [16] Reddy and Shah (1984) who reported that application of planofix (NAA) at the rate of 200 ppm to groundnut produced higher number of leaves. Altogether these data suggest that NAA increase leaf number in groundnut but not in sesame.

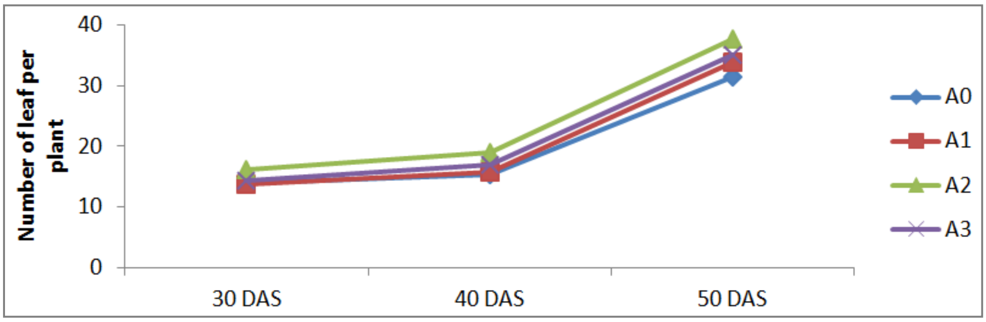

***Fig. 2.** Effect of different levels of NAA at different DAS on the leaf number plant^{-1} of sesame.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix
A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix
DAS (days after sowing)

3.1.3. Number of Branch Plant^{-1}

Application of NAA had showed no significant effect on number of branch plant^{-1} of sesame at 30 DAS and 40 DAS whereas significant effect showed at 50 DAS (Fig. 3). The results revealed that at 30 DAS and 40 DAS the number of branch plant^{-1} was statistically insignificant and hence was not influenced by different concentrations of NAA. At 30 DAS the highest number of branch plant $^{-1}$ (6.33) was observed from the A_2 and the lowest (5.44) was observed from A_0. At 40 DAS the highest number of branch plant $^{-1}$ (9.00) was observed from the A_2 and the lowest (7.88) was observed from A_0. At 50 DAS the highest number of branch plant^{-1} (14) was observed from the A_2 and the lowest (10.22) was observed from A_0. These results showed that initially there was no significant variation in number branch plant $^{-1}$ but significant variation found at 50 DAS. [17]Mahla *et al.,* (1999) and [15] Deotale *et al.,* (1998) observed significant effect of NAA in increasing the number of branches in plant.

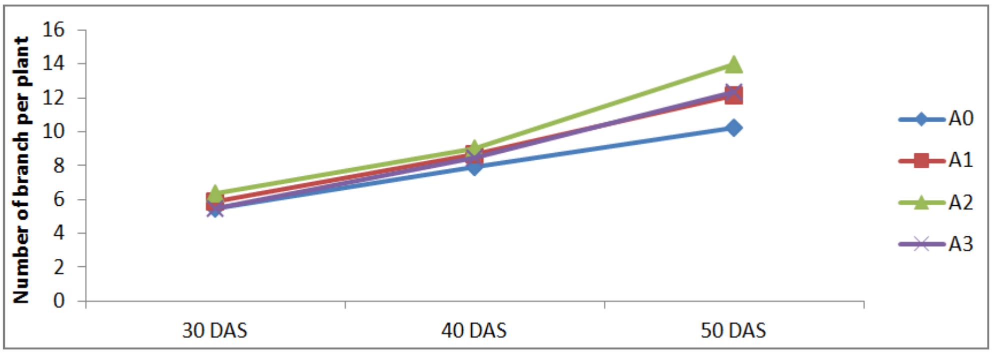

Fig. 3. *Effect of different levels of NAA at different DAS on the number of branch of sesame plant.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix
A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix
DAS (Days after sowing)

3.2. Physiological Attributes

3.2.1. Shoot Fresh Weight (g)

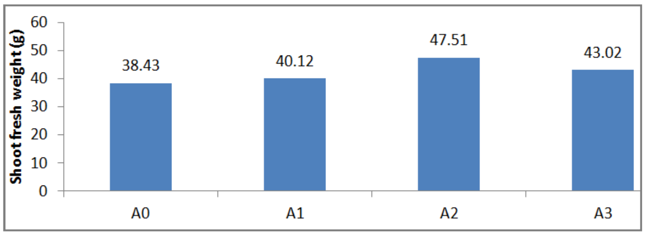

Fig. 4. *Effect of different levels of NAA on shoot fresh weight of sesame plant.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix
A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

It has been reported that NAA increased plant biomass production including shoot weight in agricultural crops. Figure 4 showed different concentration of NAA had significant influenced on fresh shoot weight (g) of sesame as other crops. The highest fresh shoot weight (47.51 g) was obtained from A_2 while the lowest result (38.43 g) was recorded from A_0 which was statistically similar with A_1. These results are in conformity with the findings of [18] Malik *et al.* (1988). [19] Shahrior (2007) also investigated on the effect of NAA on morphological, growth and yield contributing characters of sesame at different concentrations.

3.2.2. Shoot Dry Weight (g)

1- Napthaleneacetic acid at different concentrations had significant variation on shoot dry weight (g) of sesame (Fig.5). The highest shoot dry weight (8.50 g) was obtained from A_2 while the lowest result (5.78 g) was recorded from A_0. From the results the application of NAA increased of shoot dry weight (g) of sesame at greater level with A_2, 50 ppm NAA. Foliar spray of NAA at 30 ppm concentration had found to be more effective in increasing the total dry weight as reported by [20] Ramanathan *et al*., (2004).

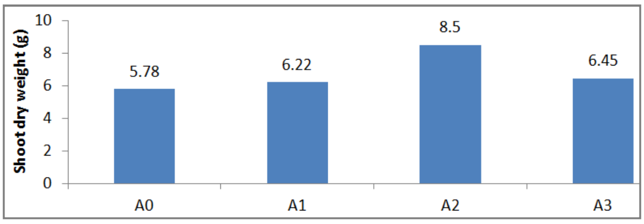

Fig. 5. *Effect of different levels of NAA on the shoot dry weight of sesame plant.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix
A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

3.2.3. Root Fresh Weight (g)

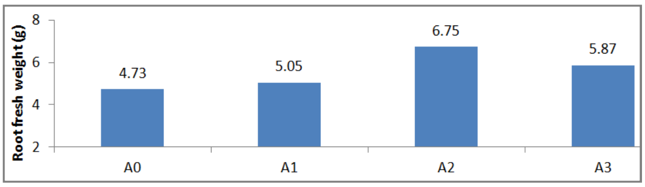

Fig. 6. *Effect of different levels of NAA on root fresh weight of sesame plant.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix
A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

Application of 1-napthaleneacetic acid (NAA) had significant effect on root fresh weight (g) of sesame (Fig.

6). The highest fresh root weight (6.75 g) was obtained from A_2 50 ppm NAA while the lowest result (4.73 g) was recorded from A_0, 0 ppm NAA which was statistically similar with A_1 (5.05).The results showed that fresh root weight (g) increased with the application of NAA as fresh shoot weight (g). Haque (2005) [9] had found that foliar spray at 80 ppm NAA had positive regulatory effect on morphological growth of sesame.

3.2.4. Root Dry Weight (g)

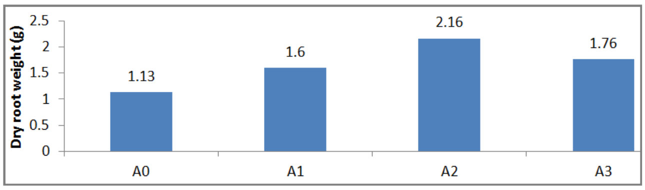

Fig. 7. Effect of different levels of NAA on dry root weight of sesame plant.

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

Significant influenced on dry root weight (g) of sesame had showed by application different concentrations of NAA (Fig. 7). The highest dry root weight (2.16 g) was observed from A_2, (50 ppm NAA) while the lowest result (1.13 g) was recorded from A_0, (0 ppm NAA). These results are consistent with fresh of root (Fig. 10). Sharma et al. (1999) [21] had reported that foliar spray of NAA was found to be more effective in increasing total dry weight of plant which supported these results.

3.3. Yield Contributing Characters

3.3.1. Number of Pod Plant^{-1}

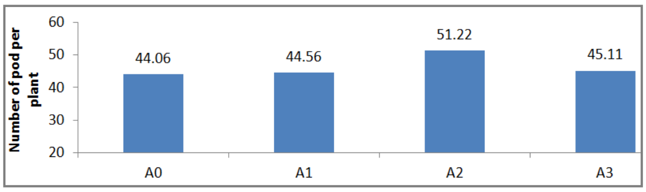

Fig. 8. Effect of different levels of NAA on number pod plant^{-1} of sesame.

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

As N different concentrations of NAA had significant variation in the number of pod plant^{-1} of sesame (Fig. 8).The highest number of pod plant^{-1} (51.22) was recorded for the A_2 (50 ppm NAA) which was statistically similar with A_1 and the lowest (44.06) was observed from A_0 which was statistically similar with A_3. As reported by the scientist, the number of pod plant^{-1} increased significantly due to NAA application on various crops. The spraying of different concentrations off NAA had a great regulatory effect on number of pod per plant and increased the pod yield as suggested by [22] Kalita *et al.* (1995), [23] Gupta and Singh, (1982), [24] Singh *et al.* (1982), [16] Reddy and Shah (1984) and [25] Devasenapathi *et al.* (1987). Studies have also shown the external application of Planofix (NAA) reduces the premature abscission of flowers and young pods, thus increases the pod and consequently the yield of groundnut [26] (Mani and Raja, 1976).

3.3.2. Pod Length (cm)

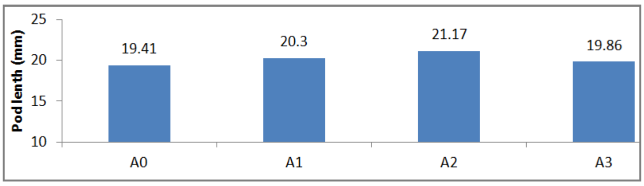

Fig. 9. Effect of different levels of NAA on the pod length of sesame.

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

Different concentrations of NAA had significantly influenced on pod length (mm) of sesame (Fig. 9). The highest pod length (21.17 mm) was recorded from A_2 treatment which was statistically similar with A_1 (20.30 mm) and A_3 (19.86 mm) while the lowest result (19.41 mm) was recorded from A_0. Here results showed that NAA increased pod length as reported by [27] Singh et al. (1995) that application of NAA increased the umbel length and more umbel number in onion. Previous many authors reported that auxin plays an important role on the fruit development and setting in many crops. All together the presented data suggest that NAA had positive functions on pod length (mm) of sesame.

3.3.3. Pod Diameter (mm)

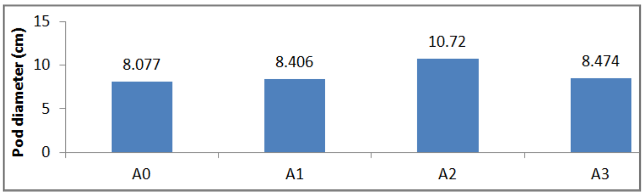

Fig. 10. Effect of different levels of NAA on the pod diameter of sesame.

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

A significant variation was recorded due to the different concentrations of NAA for fruit diameter (mm) of sesame (Fig. 10). The highest Fruit diameter (10.72 mm) was obtained from A_2 treatment while the lowest result (8.47 mm) was recorded from A_0 treatment. Results showed that foliar application of NAA increased the fruit diameter (mm) upto a certain concentration of 50 ppm (A_2).

3.3.4. Seed Weight Plant^{-1} (g)

The NAA showed significant variation in the seed weight plant^{-1} of sesame (Fig. 11). The highest seed yield plant^{-}

^{1}(29.40 g) was produced by A_2 (50 ppm NAA) and A_0 (0 ppm NAA) produced the minimum seed weight plant^{-1}(20.33 g).The presented results indicated that NAA at 50 ppm (A_2) increased seed weight plant^{-1}. [28] Prakash during (2003), [29] Ghosh *et al.* (1991), [30] Sujatha, (2001) and [31] Radhamani *et al.* (2003) had reported that NAA significantly increased the seed weight of plants.

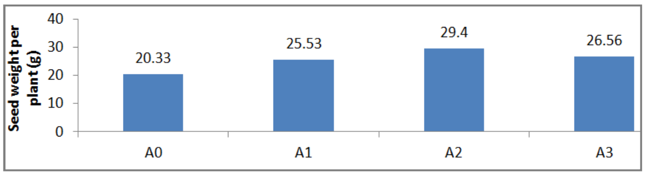

Fig. 11. *Effect of different levels of NAA on the seed weight plant^{-1} of sesame.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

3.3.5. Seed Weight Plot^{-1} (g)

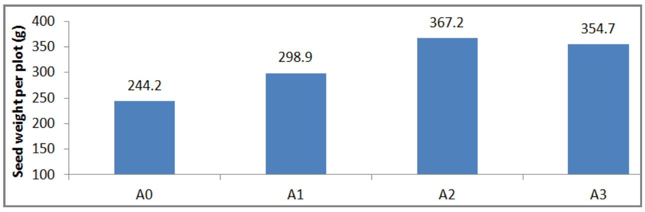

Fig. 12. *Effect of different levels of NAA on the seed weight plot^{-1} of sesame.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

The different concentrations of NAA showed significant variation in the seed weight plot^{-1} (g) of sesame (Fig. 12). The maximum seed weight plot^{-1}(367.2 g) was produced by A_2 (50 ppm) which was statistically similar with A_3 (354.7 cm) whereas A_0 (0 ppm NAA) produced the minimum seed weight plot^{-1} (244.2 g). These results showed significant variation in seed weight plot^{-1} (g) as similar effect of NAA to seed weight plant^{-1} (g) (Fig. 11). [32] Suty (1984), [33] Bai *et al.* (1987), [34] Varma *et al.* (2009) and many other researchers had reported that NAA had a significant effect on seed yield and yield components. Taken together, these finding indicate that NAA can promote the seed yield of sesame as N.

3.3.6. 1000 Seed Weight (g)

The Fig. 13 showed that NAA had significant influenced on the 1000 seed weight of sesame. The highest 1000 seed weight (11.38 g) was produced by A_2 which was statistically similar with A_3 (11.17 g) and A_0 produced the lowest 1000 seed weight (9.68 g). The results showed that application of NAA as foliar spray increased the 1000 seed weight (g) and the best result found from A_2 (50 ppm). Higher concentration of NAA on grass pea increased 1000 seed weight had reported by [35] Rahman *et al.* (1989) and [21] Sharma *et al.* (1999).

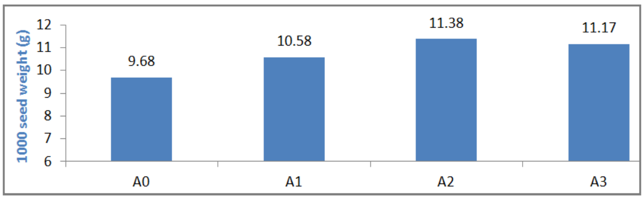

Fig. 13. *Effect of different levels of NAA on the 1000 seed weight of sesame.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

3.3.7. Yield (t ha^{-1})

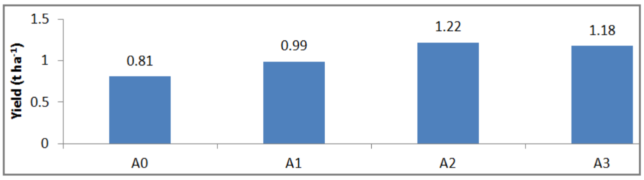

Fig. 14. *Effect of different levels of NAA on the yield of sesame.*

A_0 – 0 ppm NAA applied as Planofix, A_1 – 25 ppm NAA applied as Planofix A_2 – 50 ppm NAA applied as Planofix, A_3 – 75 ppm NAA applied as Planofix

In this study the seed yield of sesame plot^{-1} (g) was converted into hectare^{-1}and has been expressed in metric tons (Fig. 14). The different concentrations of 1-napthaleneacetic acid (NAA) had significant effect on the seed yield of sesame ton hectare^{-1} as similar to seed weight plant^{-1} (g), seed weight plot^{-1} (g) and 1000 seed weight (g) (Fig. 11,12,13). The highest yield of seed hectare^{-1}(1.22 t) was obtained from A_2 (50 ppm) which was statistically similar with A_3 (1.18 t) and the minimum yield of seed per hectare (0.81 t) was obtained from A_0 (control or 0 ppm NAA). These results showed that the foliar application of NAA increased the yield of sesame. The similar findings had stated by [36]Rao (1971). [37] Nawalagatti *et al.* (1991), [38] Segare and Naphade (1987), [39] Venkaten *et al.* (1984) and [40] Subrahmaniyan *et al.* (1999) had observed that foliar spray of NAA in different concentration at different days of interval significantly increased the yield. Application of growth regulators had significantly increased the yield of plant had also reported by [41] Witgenberger *et al.* (1985), [12] Bharud *et al.* (1986), [42] Gundalia *et al.* (1990) and [25] Devasenapathy *et al.* (1987).

4. Conclusion

The morpho-physiological parameters, yield contributing parameters and seed yield of sesame are positively increased with 1-napthaleneacetic acid (NAA) foliar application. Therefore, the present experimental results suggest that the 50 ppm NAA would be beneficial to increase the seed yield of sesame variety BARI Til 4 under the climatic and edaphic condition of Sher-e-Bangla Agricultural University, Dhaka.

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