Influence of different Levels of NAA and 2, 4, 5-T on fruit drop, fruiting, fruit retention, growth and yield of Indian ber (*Zizyphus mauritiana* Lamk.)

Abstract

The experiment was carried out at Horticulture Garden, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur (U.P.) during the November 2020- March 2021 and November 2021- March 2022. Sixteen treatments viz. four levels of NAA (0, 20, 30 and 40 ppm) and 2,4,5-T (0, 10, 20 and 30ppm) were studies in a Factorial Completely Randomized Design with three replications. Spraying was done on eleventh November, 2020 in first year and fifteenth November, 2021 in second year at fruit setting stage (Pea Stage) with fine nozzle sprayer in each treatment to give uniform spray on all over the treatment of ber plant. Application of (NAA@40 ppm and 2,4,5-T@30 ppm) significantly maximized initial fruit set (162.00 and 163.66), maximum fruit retention (20.39 and 20.43 percent) and maximum initial fruit set percentage (79.60 and 79.56 per cent). The length and width of fruit was significantly (5.35 and 4.99 cm) and (4.24 and 4.27 cm) respectively increased by application same concentration mention above. The maximum (36.62 and 36.82 g) fruit weight and physical properties of fruits like volume (36.57 and 36.42 cc) recorded under treatment (NAA@40ppm and 2,4,5-T@30ppm). The minimum stone length (0.88 and 0.87 cm), minimum stone diameter (0.88 and 0.87 cm), minimum stone weight (0.65 and 0.66 gm) and specific gravity (0.94 and 0.94 g cc^{-1}) significantly found under (NAA@40 ppm and 2,4,5-T@30 ppm). The yield of ber was significantly increased (39.53 and 40.49) kg per plant, yield per hectare (121.30 and 121.33quintal) with treatment combination (NAA@40ppm and 2,4,5-T@30ppm) both the years of experiment.

Keywords: 2,4,5-T, Fruit, Stone, NAA, Length, Width, Fruiting.

Introduction

Ber has changed scenario of horticulture both in arid and semi-arid regions significantly. At present rainfed ber orchards are seen at all the places across the country. Ber (Zizyphus mauritiana Lamk.), a member of family Rhamnaceae, is one of the ancient and common fruits of Indo-China region and has been grown in Indian subcontinent since times immemorial for fresh fruits. In fact it was one of the prominent fruits on which sages in ancient India lived during Vedic ages.Ber is known to be indigenous to the area stretching from India to South western China and Malaya **(Vavilov, 1951).** The genus Zizyphus consists of over 100 species, out of which 18-40 species are found to be grown in India. Ber is evergreen shrub or small tree up to 15 m high, with trunk 40 cm or more in diameter, spreading crown, stipular spines and many drooping branches. The tree is associated with Lord Shiva, whose worship is considered incomplete without offering of jujube fruit, especially during Mahashivaratri.

India ranks first among the ber growing countries of the world with an area of 50,000 ha and annual production of 5.13 lakh MT **(NHB Database, 2018-19).**

Ber tree bears its inflorescence in the axil of leaves on current season's growth. The flowering period lasts for about two and a half months from Sept to Nov. The fruit setting starts in second week of Oct and continues up to first fortnight of Nov. The fruits reach maturity in about 180 days after fruit setting. The fruit growth in terms of length and diameter follows a 'double sigmoid' curve and traces of malic acid, oxalic acid and quercitin. That's why ber is referred to as 'the apple of arid zone'.

The ber fruit is richer than apple in protein, phosphorus, calcium and Vitamin 'C' **(Bakshi and Singh, 1974)** and one hundred gram of edible ber fruit contains moisture (85.9%), protein (0.8g), fat (0.1g), carbohydrate (12.88%), calcium (0.03g), phosphorus (0.03g), iron (0.8g), carotene (70 IU) and vitamin 'C' (50-100mg).Although the research work on these aspects is being carried out by various research workers throughout India yet the detailed information on the effects of growth regulator sprays on fruit drop, fruiting, fruit retention and growth of ber is lacking and there is still no recommendation keeping the above facts in view, the present study has been planned.

Materials and Methods

Experimental Site

The present experiment was conducted at the Horticulture Garden, Department of Fruit Science, College of Horticulture, of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.).during November 2020- March 2021 and November 2021- March 2022. Geographically Kanpur is situated in the Gangetic alluvial belt of central U. P. its lies in altitude and longitude range between 25.26^0 to 26.58^0 north and 79.31^0 to 84.34^0 east and mean elevation of 125.90 m above the sea level.

Soil and Climate Condition

Kanpur is characterized by semi and sub-tropical climate with hot dry summer and cold winters. The annual rainfall is about 80-85 cm. the major portion of rain received between July to September, with scattered shower in winter, from the North-East monsoon. The pH of experimental field was determined by electric pH meter as described by **Piper (1966)** while organic carbon was determined by **Walkley and Black (1967)** rapid titration method. The available Nitrogen was determined by alkaline permagnate method as reported by **Piper (1966)** and available phosphorus and potash by Olsen's method **Olsen *et al.* (1945)** and flame photometer **Meston (1956)**, respectively. The E.C. was determined by Conductivity Bridge as described **Jackson (1968)**. Sulphur determination was done by method described by **Richard (1968)** and available zinc was determined as per the method suggested by **Lindsey and Norvell (1978).**

Detail of treatments and design

The experiment comprised 16 treatments consisting of foliar spray of Naphthalene Acetic Acid (NAA)and 2,4,5-T (A). The following treatments were compared. Experiment was laid out in Factorial Randomized Block Design with three replications.

Table -1: detail of the treatment combinations:

Symbols Used	Treatment Combination
T_1	N_0A_0 (NAA – 0 ppm+2,4,5-T – 0 ppm)
T_2	N_0A_1 (NAA – 0 ppm+2,4,5-T – 10 ppm)
T_3	N_0A_2 (NAA – 0 ppm+2,4,5-T – 20 ppm)
T_4	N_0A_3 (NAA – 0 ppm+2,4,5-T – 30 ppm)
T_5	N_1A_0 (NAA – 20 ppm+2,4,5-T – 0 ppm)
T_6	N_1A_1 (NAA – 20 ppm+2,4,5-T – 10 ppm)
T_7	N_1A_2 (NAA – 20 ppm+2,4,5-T – 20 ppm)
T_8	N_1A_3 (NAA – 20 ppm+2,4,5-T – 30 ppm)
T_9	N_2A_0 (NAA – 30 ppm+2,4,5-T – 0 ppm)
T_{10}	N_2A_1 (NAA – 30 ppm+2,4,5-T – 10 ppm)

T_{11}	**N_2A_2** (NAA – 30 ppm+2,4,5-T – 20 ppm)
T_{12}	**N_2A_3** (NAA – 30 ppm+2,4,5-T – 30 ppm)
T_{13}	**N_3A_0** (NAA – 40 ppm+2,4,5-T – 0 ppm)
T_{14}	**N_3A_1** (NAA – 40 ppm+2,4,5-T – 10 ppm)
T_{15}	**N_3A_2** (NAA – 40 ppm+2,4,5-T – 20 ppm)
T_{16}	**N_3A_3** (NAA – 40 ppm+2,4,5-T – 30 ppm)

Preparation of solution:

For preparation of NAA stock solution one gram NAA was dissolved in appropriate alcohol and adding water that was converted in one liter. Thus, stock solution was prepared. For obtaining 20 ppm solution of NAA 20 ml solution of NAA was taken out from stock solution and with adding water, 1000 ml solution was prepared. Thus, it was obtained 20 ppm NAA solution. Further 40 ppm NAA solution was prepared as similar method. Similarly, stock solution of (2,4,5-T) was made and from this stock solution 10 ppm, 20ppm and 30 ppm (2,4,5-T) solution were prepared as per above method.

Method of Application:

Above solutions with different concentration were sprayed by foot sprayer in the morning hours and selected branches were fully drenched. For control there was only water spray is allowed.

Time of Application:

Spraying was done on 11th November, 2020 in first year and 15th November, 2021 in second year at fruit setting stage (Pea Stage) with fine nozzle sprayer in each treatment to give uniform spray on all over the treatment of ber plant.

Statistical analysis:

Statistically Analysis:

Data were analyzed according to the method described by **Panse and Sukhantme (1985)** and **S.R.S. Chandel (1984)**.

Results and Discussion

1.1 Initial fruit set

Regarding different NAA and 2,4,5-T concentrations on initial fruit set of fruit are an expression of fruiting parameters of the plants which was influenced by NAA and 2,4,5-T growth regulators over control. It is obviously appeared with vision of the data that all the concentration of NAA significantly influenced to fruit sets in ber trees. Interactive effect of NAA and 2,4,5-T also influenced significantly on initial fruit set in ber but interactive treatment gave further improvement in fruit set was over main effect. The maximum of (162.00 and 163.66) initial fruit set was noted under N_3A_3 treatment (NAA@40 ppm and 2,4,5-T@30 ppm) treatment over interactive control i.e. N_0A_0 recorded (151.00 and 152.00) initial fruit set during both the years of experiments. The effect of NAA on plant growth is greatly dependent on the time of admission and concentration. NAA has been shown greatly increased in plant by exogenous application. Due to these causes fruit setting was enhanced in present investigation. These findings are in accordance with the reports of **Sandhu and Thind (1988), Chaurasiya *et al.*, (2019), Chaudhary *et al.*, (2020) Das *et al.*, (2020)** in ber, **Badal and Tripathi (2021a)** in guava, **Saraswat *et al.*, (2006)** in litchi. The 2,4,5-T probably might be due to providing of right concentration of 2,4,5-T during investigation causing enhancement of vegetative growth of the plants hastening the production of more photosynthesis towards the fruit bearing area which contributed to increase fruit set in plant. These findings are collaborated with the reports of

Pandey (1999) in ber, **Bhat *et al.,* (1997)** in litchi, **Maurya *et al.,* (1973)** in mango, **Kumar *et al.,* (2017) , Singh and Sharma (2020)** in ber.

1.2 Fruit retention (%)

The fruit retention was influenced by various treatments of NAA and 2,4,5- T in present investigation. The combination effect of NAA and 2,4,5-T induced significant variation on fruit retention and its interactive treatment of N_3A_3 significantly maximized (20.39 and 20.43 percent) fruit retention closely followed by N_2A_3 (18.90 and 19.67 percent) over control i.e. N_0A_0 of (9.61 and 9.67 percent) during both the years of experiments. The exogenous application of NAA might have actto prevention of abscission layer and thus, retention of fruit is increased. These findings are in line with the reports of of **Bankar and Prasad (1990), Ghosh *et al.,* (2008), Singh and Ball (2008)** in ber, **Chauhan *et al.,* (2019)** in litchi, **Deepa Lal *et al.,* (2016)** in kinnow, **Tiwari *et al.,* (2017)** in aonla, **Badal and Tripathi (2021a)** in guava**, Tripathi and Vivekanand (2022)** in aonla, **Saraswat *et al.,* (2006)** in litchi. The increase in fruit retention might be due to effective of different chemicals as well as 2, 4, 5-T on metabolic activity of the plant and improved source sink relationship with favorably influenced the metabolic status resulting in better check of fruit drop and enhancing retention of the more number of fruits on the plants. The findings are in agreement with the reports of **Pandey (1999)** in ber, **Bhat *et al.* (1997)** in litchi, **Maurya *et al.* (1973)** in mango, **Kumar *et al.* (2017)**, **Singh and Sharma (2020)** in ber.

1.3 Fruit drop (%)

The fruit drop in ber fruit was significantly influenced with the sprays of NAA and 2,4,5-T treatments in ber fruits. The NAA and 2,4,5-T brought about significant treatment variation on fruit drop and of N_3A_3 expressed significantly minimum of (79.60 and 79.56 percent) fruit drop closely followed by N_2A_3 (81.09 and 80.32 percent). Significantly maximum of (82.16 and 81.43 percent) fruit drop was exhibited under control (N_0A_0) during both the years of experiments. The application of NAA might have increased the concentration of auxin in plants which possibly induced to reduction of fruit drop. These findings are in line with the reports of **Pandey *et al.,* (2011)**, **Naseem *et al.,* (2016), Chaudhary *et al.,* (2020)** in ber, **Haidry et *al.,* (1997)** in mango, **Saraswat *et al.,* (2006)** in litchi. The induction in fruit drop was 2,4,5-T sprays possibly increased auxin synthesis which may cause to prevent fruit drop. These findings are collaborated with the reports of **Deepa Lal *et al.,* (2016)** in kinnow**, Tiwari *et al.,* (2017)** in aonla, **Badal and Tripathi (2021a)** in guava, **Tripathi and Vivekanand (2022)** in aonla, **Pandey *et al.,* (2011)** in ber, **Bhat *et al.,* (1997)** in litchi, **Maurya *et al.,* (1973)** in mango, **Kumar *et al.,* (2017), Singh and Sharma (2020)** in ber, **Deepa Lal *et al.,* (2015)** in kinnow.

1.4 Length of fruit (cm)

The interactive effect of NAA and 2,4,5-T did differ significantly but further improvement was observed over mean values and combined treatment of N_3A_3 (NAA @40 ppm and 2,4,5-T@30 ppm) recorded maximum of (5.35 and 4.99 cm) length against the minimum of (2.62 and 2.69 cm) fruit length was expressed under control (N_0A_0) during both the years of experiment. Enhancement range on length of fruit was fruits indicated caused by NAA treatment might be due to its involvement in cell division, cell elongation and decreased volume of intracellular space in the monocarpic cells which could have boosted plant health there by producing healthy and larger fruit NAA increase the growth rate of fruit which results a bigger fruit size ultimately. These findings are in line with reports of **Tiwari *et al.,* (2017)** in aonla, **Badal and Tripathi (2021a)** in guava, **Tripathi and Vivekanand (2022)** in aonla, **Meena *et al.,* (2013), Arora *et al.,* (2014), Pandey *et al.,* (1999)** in ber, **Rathod *et al.,* (2019)** in aonla, **Patil *et al.,* (2005)**, **Kumar**

***et al.*, (2018)** in mango. The increase in size of fruits with application of 2,4,5-T might be due to significantly increase in cell division and cell elongation also associated with active performance of Photosynthesis in the plant and photosynthetes were translocated to the fruits which caused possibly to increase in fruit size. These findings are collaborated with the reports of **Randhawa *et al.*, (1959)** in sweet lime, **Tripathi *et al.*, (2009), Brahmachari *et al.* (1995)** in guava, **Suman *et al.*, (2017)** in sweet lime.

1.5 Width of fruit (cm)

The fruit width of ber was significantly induced with NAA and 2,4,5-T combination was found to be significant. Combined treatment of N_3A_3 (NAA@40 ppm and 2,4,5-T@30ppm) induced significantly maximum (4.24 and 4.27 cm) width of fruit while the minimum (2.63 and 2.66 cm) width of fruit was presented with control (N_0A_0) during both years of experiments. The diameter of fruit was enhanced due to sprays of NAA treatments might be due to its involvement in cell division, cell elongation which ultimately induced to width of fruits. These findings are in agreement with the reports of **Tiwari *et al.*, (2017)** in aonla, **Tripathi and Vivekanand (2022)** in aonla, **Singh and Singh (1976), Pandey *et al.*, (1999), Singh *et al.*, (2001), Arora and Singh (2014)** in ber and **Rathod *et al.*, (2019)** in aonla, **Kumar *et al.*, (2018)** in mango. The different concentration of 2,4,5-T might be due to significantly increased cell division and cell elongation. This result may have associated with active performance of photosynthesis in the plant and they were translocated to the fruits which caused to increase in fruit size. These finding are in line with reports of **Randhawa *et al.*, (1959)** in sweet lime, **Tripathi *et al.*, (2009), Brahmachari *et al.*, (1996)** in guava, **Suman *et al.* (2017)** in sweet lime.

1.6 Fruit Weight (gm)

The effect of foliar sprays of NAA and 2,4,5-T positively influenced on fruit weight of ber. The significant variation was observed in interactive treatments of NAA and 2,4,5-T its N_3A_3 (NAA@40ppm and 2,4,5-T@30ppm) treatment induced to the maximum of (36.62 and 36.82 g) fruit weight closely followed by N_2A_3 (NAA@30ppm and 2,4,5-T@30ppm) expressed (30.56 and 31.01 g) fruit weight. Significantly poorest (25.55 and 25.55 g) fruit weight was recorded under control (N_0A_0) during both the years of experiment. The growth regulator NAA might have improved the synthesis of more photosynthetes and their translocation to the fruits which may have increased the weight of fruits in present investigation. These result in conformity with those of **Tiwari *et al.*, (2017)** in aonla, **Badal and Tripathi (2021a)** in guava, **Tripathi and Vivekanand (2022)** in aonla, **Bal *et al.*, (1982), Bal *et al.*, (1986), Singh *et al.*, (2001)** in ber, **Haidry *et al.*, (2001), Singh *et al.*, (2005)** in mango, **Kumar *et al.*, (2018)** in mango. The improvement in fruit weight probably 2,4,5-T enhanced deposition of solids which increased in cell size by increasing the accumulation of water in intracellular space which might be enhanced to fruit weight. These findings collaborated with the reports of **Randhawa *et al.*, (1959)** in sweet lime, **Tripathi *et al.*, (2009), Brahmachari *et al.* (1996)** in guava, **Suman *et al.*, (2017)** in sweet lime.

1.7 Fruit Volume (cc)

The volume of ber fruit was consistently influenced with sprays of NAA and 2,4,5-T treatments. In this regard (36.57 and 36.42 cc) fruit volume was expressed under the interactive treatment of N_3A_3 (NAA@40ppm and 2,4,5-T@30ppm) closely followed by treatment N_2A_3 (NAA@40ppm and 2,4,5,T@30ppm) recorded (35.10 and 35.14 cc) fruit volume. Significantly the lesser (25.49 and 25.59 cc) volume was recorded under control (N_0A_0) during both the years of experiments. It might have also being due to cell division and cell expansion, increased volume of intracellular space in the mesocarpic cell and increase the water absorption with mobilization of sugar and minerals in the expended cell and intracellular space of mesocarp which improve size and volume of the fruit. These findings collaborated with the reports of **Badal and Tripathi (2021a)** in guava, **Patil *et al.*, (2005)** in mango. The volume of fruit was greatly influenced with the application of 2,4,5-T treatments which was possibly might be due to 2,4,5-T which regulates semi permeability of cell wall and mobilization of water extended into fruit which ultimately help to enhancement of fruit volume. These findings are in line with the reports of **Bal *et al.*, (1984)** in ber.

1.8 Stone Length (cm)

The length of stone was significantly enhanced was observed over mean values and combined treatment of N_3A_3 (NAA @ 40 ppm & 2,4,5-T @ 30 ppm) recorded minimum of (0.88 and 0.87 cm) cm length against the maximum of (2.70 and 2.79 cm) stone length was expressed under control (N_0A_0) during both the year of experiments. The superiority on length of fruits indicated caused by NAA treatment might be due to its involvement in cell division, cell elongation and decreased volume of intracellular space in the monocarpic cells which could have boosted plant health there by producing healthy and larger fruit NAA increase the growth rate of fruit which results a bigger fruit size ultimately small size of stone. These findings are in line with reports of **Meena *et al.*, (2013), Arora *et al.*, (2014), Pandey (1999)** in ber, **Rathod *et al.*, (2019)** in aonla, **Patil *et al.*, (2005)** in mango. The increase in size of fruits with application of 2,4,5-T might be due to significantly increase in cell division and cell elongation associated with active performance of Photosynthesis in the plant and photosynthetes were translocated to the fruits which caused possibly to increase in stone size. These findings are collaborated with the reports of **Bal *et al.*, (1984), Tripathi *et al.*, (2009), Pandey (1999), Ram *et al.*,(2005)** in ber, **Kumar *et al.*, (2022)** in guava.

1.9 Stone Diameter (cm)

The diameter of stone of ber was significantly inducedcombined treatment of N_3A_3 (NAA @ 40 ppm & 2,4,5-T @ 30 ppm) induced significantly minimum (0.73 and 0.70cm) diameter of stone closely followed by treatment N_2A_3 (0.75 and 0.73cm).These findings are in agreement with the reports of **Singh and Singh (1976), Pandey (1999), Singh *et al.*, (2001), Arora *et al.*, (2014)** in ber, **Rathod *et al.*, (2019)** in aonla. This result may have associated with active performance of photosynthesis in the plant and they were translocated to the stone which caused to increase in stone size **Bal *et al.*, (1984), Tripathi *et al.*, (2009), Pandey (1999), Ram *et al.*, (2005)** in ber, **Kumar *et al.*, (2022)** in guava.

1.10 Stone Weight (gm)

The effect of foliar sprays of NAA and 2,4,5-T positively influenced on stone weight of ber with interactive treatments of NAA and 2,4,5-T its (NAA @ 40 ppm and 2,4,5-T @ 30 ppm) N_3A_3 treatment induced to the minimum of (0.65 and 0.66 gm) stone weight closely followed by N_2A_3 (NAA@20ppm and 2,4,5-T@30ppm) expressed (0.77 and 0.78gm) stone weight. Significantly maximum (1.80 and 1.77 gm) stone weight was recorded under control (N_0A_0) during both the years of experiments. Probably NAA enhanced deposition of solids which increased in cell size by increasing the accumulation of water in intracellular space which might be reduced to stone weight. These findings are gets support to the reports of **Bal *et al.*, (1982)**, **Haidry *et al.*, (2001), Singh *et al.*, (2005), Banker and Prasad (1990)** in ber, **Saraswat *et al.*, (2006)** in litchi. The 2,4,5-T result may have due to associated with active performance of photosynthesis in the plant and they were translocated to the stone which caused to reduce in stone weight **Bal *et al.*, (1984), Tripathi *et al.*, (2009), Pandey (1999), Ram *et al.*,(2005)** in ber, **Kumar *et al.*, (2022)** in guava.

1.11 Specific Gravity (g cc^{-1})

The specific gravity of ber fruit was influenced positively with the sprays of NAA and 2,4,5-T treatments. The significant variation was observed in interactive treatments of NAA and 2,4,5-T its (NAA @ 40 ppm and 2,4,5-T @ 30 ppm) N_3A_3 treatment induced to the minimum of (0.94 and 0.94 g cc^{-1}) specific gravity closely followed by N_2A_3 (NAA@20ppm and 2,4,5-T@30ppm) expressed (0.95 and 0.97 g cc-1) specific gravity. Significantly maximum (1.32 and 1.32 g cc^{-1}) specific gravity was recorded under control (N_0A_0) during both the years of experiments. These findings get support of **Tiwari *et al.*, (2017), Tripathi and Vivekanand (2022)** in aonla, **Ghosh *et al.*, (2013)** in ber. The concentration of 2,4,5-T also influenced on specific gravity These findings are in line with the reports of **Tripathi *et al.*, (2009), Pandey (1999), Ram *et al.*, (2005)** in ber.

1.12 Yield (Kg/Plant)

The influences were shown with sprays of NAA and 2,4,5-T growth regulators. The NAA and 2,4,5-T also influenced significantly on yield per plant in ber fruits. The maximum of (39.53 and 40.49 kg) was revealed under the interactive treatment of N_3A_3 followed by N_2A_3 (38.95 and 38.97kg) over control (N_0A_0) during both the years of experiments. The improvement brought about NAA may be attributed to its physiological activities in the plants, which could have checked fruit drop and minimized number of blemished fruits considerably thereby increasing yield. These findings are collaborated with the reports of **Tiwari *et al.*, (2017)** in aonla, **Badal and Tripathi (2021b)** in guava, **Tripathi and Vivekanand (2022)** in aonla, **Saraswat *et al.* (2006*),*** in litchi, **Kumar *et al.*, (2018)** in mango. The increase in yield by growth regulator 2,4,5-T associated with high rate of enzymatic activities as well as involvement of biosynthesis of auxin, increase in number of size of fruit which ultimately enhanced the yield. These findings are in line with the reports of **Tripathi *et al.*, (2009), Kumar *et al.*, (2017)** in ber, **Kumar and Tripathi (2009)** in strawberry.

1.13 Yield (q/hac)

The interactive effect of NAA and 2,4,5-T also influenced significantly on quintal per plants in ber fruits. The maximum of (121.30 and 121.33quintal) was revealed under the interactive treatment of N_3A_3 (NAA@40ppm and 2,4,5-T@30ppm) followed by (119.61 and 117.87 quintal) treatment N_2A_3 of (NAA@30ppm and 2,4,5-T@30ppm) over control (N_0A_0) (101.40 and 101.48 quintal) during both the years of experiments. The improvement brought about NAA may be attributed to its physiological activities in the plants, which could have checked fruit drop and minimized number of blemished fruits and yield kg per plants considerably thereby increasing yield quintal per plants. These findings are collaborated with the reports of **Ghosh *et al.*, (2013)** in ber, **Kumar and Tripathi (2009)** in strawberry. Increase in yield by growth regulator 2,4,5-T associated with high rate of enzymatic activities as well as involvement of biosynthesis of auxin, increase in number of size of fruit which ultimately enhanced the yield. These findings are in line with the reports of **Tripathi *et al.*, (2009), Kumar *et al.*, (2017)** in ber, **Kumar and Tripathi (2009)** in strawberry.

Conclusion

It may be concluded that the application of NAA and 2,4,5-T resulted in to flowering fruit drop, growth, yield of Indian ber with maximum fruit set and retention as well as yield attributing characters such as size of fruit (length and diameter), weight and volume of fruit which ultimately increased the yield per plant and thereby per hectare in both NAA @40ppm and 2,4,5-T@30ppm.

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Table- 2: Effect of foliar application of NAA, 2, 4, 5-T and their interaction on initial fruit set and fruit retention (%) in ber

Parameter	PGRs Doses 2,4,5-T ppm (A)	NAA ppm (N)									
		2021					2022				
		N_0 Control	N_1 20	N_2 30	N_3 40	Mean B	N_0 Control	N_1 20	N_2 30	N_3 40	Mean B
Initial Fruit Set	A_0 Control	151.00	153.33	155.00	156.66	154.00	152.00	154.33	156.00	157.66	155.00
	A_1 10	157.33	159.00	159.66	159.33	158.83	158.66	160.33	161.00	159.66	159.91
	A_2 20	156.66	155.66	156.66	155.66	156.16	157.66	157.00	158.33	157.66	157.66
	A_3 30	156.66	159.00	160.00	162.00	159.41	158.66	161.00	162.00	163.66	161.33
	Mean A	155.41	156.75	157.83	158.41		156.75	158.16	159.33	159.66	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.44	0.44	0.88			0.65	0.65	1.30		
	C.D.	1.27	1.27	2.55			1.88	1.88	3.76		
	SE(d)	0.62	0.62	1.24			0.92	0.92	1.84		
Fruit Retention (%)	A_0 Control	9.61	10.31	10.86	11.22	10.50	9.67	10.39	10.90	11.26	10.55
	A_1 10	11.59	12.12	12.59	13.17	12.36	11.63	12.16	12.67	13.27	12.43
	A_2 20	13.66	14.10	14.77	15.42	14.48	13.74	14.12	14.83	15.49	14.54
	A_3 30	16.32	17.83	18.90	20.39	18.36	16.39	18.57	19.67	20.43	18.76
	Mean A	12.79	13.59	14.28	15.05		12.85	13.81	14.52	15.11	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.10	0.10	0.20			0.12	0.12	0.24		
	C.D.	0.29	0.29	0.59			0.36	0.36	0.72		
	SE(d)	0.14	0.14	0.29			0.17	0.17	0.35		

Table-3 Effect of foliar application of NAA, 2, 4, 5-T and their interaction on fruit drop (%) and length (cm) of ber fruit

Parameter	PGRs Doses 2,4,5-T ppm (A)	NAA ppm (N)									
		2021					2022				
		N_0 Control	N_1 20	N_2 30	N_3 40	Mean B	N_0 Control	N_1 20	N_2 30	N_3 40	Mean B
Fruit drop (%)	A_0 Control	90.39	89.68	89.13	88.77	89.49	90.33	89.60	89.09	88.73	89.44
	A_1 10	88.41	87.88	87.40	86.82	87.63	88.36	87.83	87.33	86.73	87.56
	A_2 20	86.33	85.90	85.23	84.57	85.51	86.26	85.87	85.17	84.50	85.45
	A_3 30	83.67	82.16	81.09	79.60	81.63	83.61	81.43	80.32	79.56	81.23
	Mean A	87.20	86.40	85.71	84.94		87.14	86.18	85.48	84.88	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.10	0.10	0.20			0.12	0.12	0.24		
	C.D.	0.29	0.29	0.59			0.36	0.36	0.72		
	SE(d)	0.14	0.14	0.29			0.17	0.17	0.35		
Length of ber fruit (cm)	A_0 Control	2.62	2.71	2.78	2.92	2.75	2.69	2.81	2.92	3.01	2.86
	A_1 10	3.00	3.19	3.33	3.43	3.24	3.10	3.26	3.37	3.45	3.29
	A_2 20	3.53	3.71	3.81	3.94	3.75	3.64	3.84	3.92	4.02	3.85
	A_3 30	4.03	4.41	5.01	5.35	4.70	4.19	4.29	4.71	4.99	4.55
	Mean A	3.29	3.50	3.73	3.91		3.41	3.55	3.73	3.87	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.05	0.05	0.10			0.03	0.03	0.07		
	C.D.	0.14	0.14	0.29			0.11	0.11	0.22		
	SE(d)	0.07	0.07	0.14			0.05	0.05	0.10		

Table-4: Effect of foliar application of NAA, 2, 4, 5-T and their interaction on width of fruit (cm) and fruit weight in ber (g)

Parameter	PGRs Doses 2,4,5-T ppm (A)	NAA ppm (N)									
		2021					2022				
		N_0 Control	N_1 20	N_2 30	N_3 40	Mean B	N_0 Control	N_1 20	N_2 30	N_3 40	Mean B
Width of fruit (cm)	A_0 Control	2.63	2.73	2.78	2.90	2.76	2.66	2.78	2.81	2.88	2.78
	A_1 10	3.00	3.13	3.22	3.30	3.16	3.07	3.15	3.25	3.32	3.20
	A_2 20	3.43	3.52	3.62	3.72	3.57	3.45	3.57	3.66	3.77	3.61
	A_3 30	3.83	4.00	4.12	4.24	4.05	3.89	4.05	4.15	4.27	4.09
	Mean A	3.22	3.34	3.43	3.54		3.27	3.39	3.47	3.56	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.00	0.00	0.00			0.00	0.00	0.01		
	C.D.	0.00	0.00	0.01			0.02	0.02	0.05		
	SE(d)	0.00	0.00	0.00			0.01	0.01	0.02		
Fruit weight (g)	A_0 Control	25.55	25.91	26.42	26.99	26.22	25.55	26.46	26.70	27.66	26.59
	A_1 10	27.55	27.93	28.54	29.14	28.29	27.97	28.25	29.47	29.78	28.86
	A_2 20	30.16	31.27	32.13	32.96	31.63	30.53	31.46	31.99	33.22	31.80
	A_3 30	33.65	34.12	35.16	36.62	34.89	34.86	35.14	35.90	36.82	35.68
	Mean A	29.23	29.81	30.56	31.43		29.73	30.33	31.01	31.87	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.01	0.01	0.02			0.02	0.02	0.04		
	C.D.	0.03	0.03	0.06			0.12	0.12	0.04		
	SE(d)	0.01	0.01	0.03			0.06	0.06	0.08		

Table-5: Effect of foliar application of NAA, 2, 4, 5-T and their interaction on fruit volume (cc)and stone length in ber (cm)

Parameter	PGRs Doses 2,4,5-T ppm (A)	NAA ppm (N)									
		2021					2022				
		N_0 Control	N_1 20	N_2 30	N_3 40	Mean B	N_0 Control	N_1 20	N_2 30	N_3 40	Mean B
Volume (cc)	A_0 Control	25.49	25.87	26.33	26.86	26.13	25.59	25.90	26.38	26.90	26.19
	A_1 10	27.37	27.89	28.49	29.10	28.21	27.47	27.93	28.53	29.08	28.25
	A_2 20	30.10	31.20	32.10	32.84	31.56	30.11	31.22	32.06	32.89	31.57
	A_3 30	33.58	34.10	35.10	36.57	34.83	33.62	34.08	35.14	36.42	34.81
	Mean A	29.14	29.77	30.51	31.34		29.19	29.78	30.52	31.32	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.02	0.02	0.04			0.02	0.02	0.05		
	C.D.	0.06	0.06	0.12			0.08	0.08	0.16		
	SE(d)	0.03	0.03	0.06			0.03	0.03	0.07		
Stone length (cm)	A_0 Control	2.70	2.62	2.52	2.32	2.54	2.79	2.66	2.55	2.38	2.59
	A_1 10	2.20	2.09	1.99	1.86	2.03	2.20	2.06	1.99	1.90	2.04
	A_2 20	1.73	1.59	1.48	1.34	1.53	1.77	1.59	1.42	1.34	1.53
	A_3 30	1.23	1.13	0.97	0.88	1.05	1.21	1.12	1.02	0.87	1.05
	Mean A	1.96	1.86	1.74	1.60		1.99	1.86	1.75	1.62	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.00	0.00	0.01			0.00	0.00	0.01		
	C.D.	0.01	0.01	0.03			0.02	0.02	0.04		
	SE(d)	0.00	0.00	0.01			0.01	0.01	0.02		

Table-6: Effect of foliar application of NAA, 2, 4, 5-T and their interaction on stone diameter (cm) and stone weight in ber (g)

Parameter	PGRs Doses 2,4,5-T ppm (A)	NAA ppm (N) 2021 N_0 Control	N_1 20	N_2 30	N_3 40	Mean B	2022 N_0 Control	N_1 20	N_2 30	N_3 40	Mean B
Stone diameter (cm)	A_0 Control	1.31	1.26	1.20	1.15	1.23	1.29	1.25	1.19	1.14	1.22
	A_1 10	1.09	1.05	1.02	0.97	1.03	1.08	1.04	1.02	0.98	1.03
	A_2 20	0.96	0.95	0.93	0.88	0.93	0.95	0.93	0.91	0.87	0.91
	A_3 30	0.85	0.79	0.75	0.73	0.78	0.82	0.79	0.73	0.70	0.76
	Mean A	1.05	1.01	0.97	0.93		1.03	1.00	0.96	0.92	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.00	0.00	0.01			0.00	0.00	0.00		
	C.D.	0.01	0.01	0.02			0.01	0.01	0.02		
	SE(d)	0.00	0.00	0.01			0.00	0.00	0.01		
Stone weight (gm)	A_0 Control	1.80	1.72	1.65	1.56	1.68	1.77	1.71	1.63	1.55	1.67
	A_1 10	1.50	1.42	1.34	1.26	1.38	1.48	1.41	1.33	1.25	1.37
	A_2 20	1.20	1.09	1.04	0.98	1.08	1.18	1.08	1.03	0.94	1.06
	A_3 30	0.88	0.82	0.77	0.65	0.78	0.91	0.83	0.77	0.66	0.79
	Mean A	1.34	1.26	1.20	1.11		1.33	1.26	1.19	1.10	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.00	0.00	0.00			0.00	0.00	0.00		
	C.D.	0.01	0.01	0.02			0.00	0.00	0.01		
	SE(d)	0.00	0.00	0.01			0.00	0.00	0.00		

Table-7: Effect of foliar application of NAA, 2, 4, 5-T and their interaction on specific gravity (g /cc) and yield (kg/plant)in ber

Parameter	PGRs Doses 2,4,5-T ppm (A)	NAA ppm (N)									
		2021					2022				
		N_0 Control	N_1 20	N_2 30	N_3 40	Mean B	N_0 Control	N_1 20	N_2 30	N_3 40	Mean B
Specific gravity (g /cc)	A_0 Control	1.32	1.16	1.10	1.08	1.16	1.32	1.17	1.11	1.09	1.17
	A_1 10	1.05	1.04	1.05	1.03	1.04	1.06	1.04	1.06	1.05	1.05
	A_2 20	1.02	1.00	0.99	0.98	1.00	1.03	1.00	0.99	0.98	1.00
	A_3 30	0.97	0.98	0.95	0.94	0.96	0.97	0.95	0.97	0.94	0.96
	Mean A	1.09	1.04	1.02	1.01		1.09	1.04	1.03	1.01	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.01	0.01	0.02			0.01	0.01	0.02		
	C.D.	0.03	0.03	0.07			0.03	0.03	0.07		
	SE(d)	0.01	0.01	0.03			0.01	0.01	0.03		
Yield (kg/plant)	A_0 Control	19.92	19.71	19.80	20.42	19.96	19.95	19.73	19.82	20.45	19.99
	A_1 10	20.90	21.14	22.35	23.64	22.01	20.89	21.15	22.36	23.66	22.01
	A_2 20	24.84	25.47	28.15	31.14	27.40	24.87	26.16	28.17	31.17	27.59
	A_3 30	34.23	36.14	38.95	39.53	37.21	34.28	36.17	38.97	40.49	37.47
	Mean A	24.97	25.61	27.31	28.68		25.00	25.80	27.33	28.94	
	Factors	A	B	AXB			A	B	AXB		
	SE(m)±	0.14	0.14	0.29			0.11	0.11	0.23		
	C.D.	0.42	0.42	0.85			0.33	0.33	0.67		
	SE(d)	0.20	0.20	0.41			0.16	0.16	0.32		

Table-8: Effect of foliar application of NAA, 2, 4, 5-T and their interaction on yield in ber (q/ha)

PGRs Doses	NAA ppm (N)									
2,4,5-T ppm (A)	2021					2022				
	N_0 Control	N_1 20	N_2 30	N_3 40	Mean B	N_0Control	N_1 20	N_2 30	N_3 40	Mean B
A_0 Control	101.40	102.47	103.72	105.68	103.31	101.48	102.55	103.98	105.78	103.45
A_1 10	106.76	108.34	109.38	110.96	108.86	106.83	108.52	109.58	110.57	108.87
A_2 20	112.13	113.36	114.78	115.91	114.04	111.54	112.43	113.79	114.90	113.17
A_3 30	116.72	118.10	119.61	121.30	118.93	116.08	116.80	117.87	121.33	118.02
Mean A	109.25	110.57	111.87	113.46		108.98	110.07	111.31	113.15	
Factors	A	B	AXB			A	B	AXB		
SE(m)±	0.05	0.05	0.10			0.13	0.13	0.26		
C.D.	0.14	0.14	0.29			0.37	0.37	0.75		
SE(d)	0.07	0.07	0.14			0.18	0.18	0.36		