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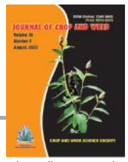

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Effect of girdling, etiolation and IBA on sprouting and rooting characteristics of kiwifruit

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ABSTRACT

The kiwifruit (Actinidia deliciosa) is an edible berry of a woody vine in the genus of Actinidia. It is grown successfully in north western Himalayan states of India. There is a potential scope to grow in Darjeeling hills of West Bengal. Stem cutting is the onlymethod of vegetative propagation which is commercially used. An experiment was conducted at the Experimental farm of Darjeeling Krishi Vigyan Kendra, Uttar Banga Krishi Viswavidyalaya on Kiwifruit cv. Hayward having sixteen treatment combinations with three factors (girdling, etiolation and growth promoter) using factorial randomized block design. Girdling on etiolated shoot with application of IBA @5000 ppm (T16) showed better response for total number of days taken for sprouting (77 days), length of the sprout (2.07 cm), sprouting percentage (68.33%), rooting percentage (68.33 %), days taken for rooting (87.33 days), longest root length (5.90 cm), survival percentage (64.53 %), mortality rate (46.02 %).

Keywords: Cuttings, etiolation, girdling, growth promoter, kiwifruit

The kiwifruit (*Actinidia deliciosa*) is an edible berry of a woody dioecious vine having some chilling requirement under the family of Actinidiaceae and native to China (Ali *et al.*, 2017; Cangi*et al.*, 2006). It has been considered as nutritionally important fruit with high amount of minerals (potassium, magnesium), vitamins having low energy (Richardson *et al.*, 2018) and it is believed that the consumption of kiwifruit has preventive effect against some cancer and cardiovascular diseases. It is grown mainly in north western and few parts of north eastern Himalayan states with an estimated area coverage of 4000 ha and production of 12000 MT (Anon, 2018). It has also the potentiality to grow in the Darjeeling and Kalimpong districts of West Bengal. However, the availability of planting materials with reasonable cost is one of the limiting factors in the non-traditional area under kiwifruit cultivation. Practicing of girdling and exposure in etiolated condition improves rooting in many plant species

Considering the foregoing points and to gain a thorough understanding of the optimal type of cutting for the location and economic importance of kiwifruit the present experiment was conducted with the objective of finding out the effect of girdling, etiolation and growth promoter (IBA) for sprouting and rooting characteristics of kiwifruit cv. Hayward and to find out the most suitable combination of treatments for the Hill Agro-climatic Zone of West Bengal.

MATERIALS AND METHODS

The present investigation was carried out at Darjeeling Krishi Vigyan Kendra, Uttar Banga Krishi Viswavidyalaya during the year 2020 to determine the effects of girdling, etiolation and Indole butyric acid as growth promoter (IBA) on rooting characteristics of stem cuttings of kiwifruit cv. Hayward. Girdling was done by removing a ring of bark of 4mm wide and 25-30 m below the shoot tip. Etiolation was done as pre treatment before taking the cuttings by wrapping the shoots with a black plastic around the shoot that is going to be the base of the cuttings. Design of the experiment was factorial randomized block design (FRBD) with sixteen numbers of treatment combinations replicated thrice (twenty cuttings per replication). Treatments included control, girdling and etiolation with two levels each and rooting hormone as growth promoter with four levels (0,3000, 4000, 5000 ppm) of IBA (Indole 3-Butyric Acid). Preparation of rooting hormone as growth promoter with concentrations of IBA (Indole 3-Butyric Acid) of 3000, 4000, 5000 ppm were prepared by dissolving 0.3, 0.4, 0.5 g of respective growth regulator in small quantity of ethanol. Preparation of semi hardwood cuttings (30 cm length and having at least three nodes) from kiwifruit cv. Hayward aged 6 years old was taken from the Kiwifruit Orchard, Darjeeling Krishi Vigyan Kendra, Dalapchand, Kalimpong during

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December, 2020. Each cutting was given a slanting cut at the basal end with a sharp razor blade to expose maximum observing surface for effective rooting. The cuttings were then bundled and then taken for hormone treatment by dipping it for thirty seconds. After that cuttings were planted on the 15 cm raised nursery beds. Beds were prepared by mixing of repeatedly washed sand, soil and FYM (2:1:1). The parameters like, time taken for sprouting (days to sprout), length of the sprout(cm), the number of leaves per shoot(120 days after cutting), shoot sprouting percentage (120 days after cutting),time taken for rooting (days to root), rooting percentage, Number of roots per cuttings (150 days after cutting), longest root length (150 days after cutting).For Statistical interpretation, analysis of variance for each parameter was performed using Proc Gim of Statistical analysis System (SAS) Software (Version 9.3). Means separations for different accessions under different parameter were performed using Least Significance Difference (LSD) test ($P \leq 0.05$). Normality of residuals under the assumption of ANOVA was tested using Kolmogrov- Smirnov test using Proc- Univariate procedure of SAS (Version 9.3) and data transformation was followed by (Gomez and Gomez ,1984).

RESULTS AND DISCUSSION

Sprouting Parameters

Girdling and IBA as growth promoter showed significant variation in terms of days taken for sprouting, whereas, etiolation did not show any variable effect (Table 1). Minimum number of days (71.33 days) required for sprouting was recorded in no girdling and etiolation practice coupled with IBA @ 4000 ppm (T_7) and the maximum number of days (88 days) was required in T_1(control). Significant differences in length of the sprouts were observed among interaction of different treatment combinations.It was measured at its greatest (2.7 cm) in girdling and etiolation practice combined with IBA @ 5000 ppm (T16) and at its lowest (0.87 cm) in control (T_1). López *et al*., (2015) discovered similar results, noting that sprouting was abundant following girdling throughout the first month of the trial. Number of leaves per shoot and sprouting percentage were significantly affected by girdling, etiolation, and IBA levels. No girdling and etiolation practiced combined with IBA @ 5000 ppm (T_8) had the most leaves (6.67) and the fewest leaves (2.0) were seen in the control (T_1). The highest leaf number in both hardwood and semi-hardwood cuttings 15.6 and 12.4, respectively was reported with IBA @ 5000 ppm, according to similar findings by Sharma *et al.,* (2015). Maximum sprouting was observed with girdling and etiolation practise in combination with growth promoter IBA @ 5000 ppm (T_{16}), whereas control (T_1) sprouting rate was lowest (35%).

Rooting Parameters

Girdling, etiolation, and IBA each significantly affected a number of rooting characteristics. The treatment that showed the highest rooting percentage (68.33%) was girdling, etiolation and treatment with *IBA* @ 5000 ppm (T_{16}).The individual impacts of girdling and etiolation had no significant impact on the number of roots per cutting or the number of days required for rooting; however, growth promoter had a substantial impact on these parameters (Table 2). T_{16} had the most roots (5), the longest root length (5.90 cm), the highest rooting survival percentage (64.53%), and the lowest mortality rate (51.67%), while T_1 had the fewest roots (2), the lowest rooting percentage (36.67%), and survival percentage (36.77%). The maximum numbers of main roots (8.5 and 12.6) were found in hardwood and semi-hardwood cuttings with IBA @ 5000 ppm, according to Sharma *et al.,* (2015). The minimal number of days required (84.33 days) for rooted cuttings was recorded with girdling, no etiolation, and treatment with IBA @ 4000 ppm, which was statistically at par (87 days) with practice of girdling, etiolation, and treatment with IBA @ 5000 ppm (T_{16}). According to Alam *et al.,* (2007) cuttings of male and female plants treated with 4000/ ppm IBA solution produced the longest roots, measuring 16 and 15 cm, respectively. According to Ali *et al.,* (2018) the control treatment had the shortest root length while the IBA @ 3000 had the longest root length (19.11 cm). Effects of girdling, etiolation, and IBA as a root growth stimulator have a considerable impact on the survival percentage of kiwifruit cuttings both individually and in combination with other treatments. At 5000 ppm (T_{16}) girdling, etiolation, and treatment with IBA as a rooting promoter had the highest survival rate (64.53%), which was statistically equal to (T_8) (63.33%), while (T_1) (36.77%) had the lowest. On hardwood cuttings of the kiwifruit variety Allison treated with IBA (1000 - 6000 ppm) as a short dip (5 seconds) and planted in open field circumstances. According to Ali *et al.,* (2018) the control treatment had the lowest survival percentage (19.00) while IBA@ 3000ppm had the highest survival percentage (81.34). The mortality rate data reported in (Table 2) clearly shows that girdling had a favourable, significant impact. Etiolation displayed variation in a same manner. T_{16} recorded the lowest mortality rate (51.67%). The beneficial effects of girdling on better rooting traits may be attributable to its role in blocking the downward translocation of carbohydrates, hormones, and other potential root-promoting factors. This action causes a series of physiological changes, such as the accumulation of various organic substances above the ring, which affects the hormonal balance of the shoot and encourages root initiation (Hartman *et al.,* 2002, Stoltz and, Denaxa *et*

Table 1: Effect of Girdling, Etiolation and IBA on sprouting characteristics

Main factor effect

Treatments	Number of days taken for sprouting	Length of sprouts 110 DAC (cm)	Number of leaves per shoots 120 DAC	Sprouting percentage (%)
G_0	79.88b	1.56a	4.37a	53.12b
G_1	82.25a	1.65a	4.50a	57.91a
SEm(±)	**0.66**	**0.13**	**0.31**	**1.15**
LSD(0.05)	**1.92**	**NS**	**NS**	**3.34**
E_0	81.62a	1.54a	3.83b	51.88b
E_1	80.50a	1.68a	5.04a	59.17a
SEm(±)	**0.66**	**0.13**	**0.31**	**1.15**
LSD(0.05)	**NS**	**NS**	**0.90**	**3.34**
P_O	87.25a	1.21b	3.41b	47.5c
P_1	80.75b	1.61ab	4.25ab	54.17b
P_2	79.00bc	1.76a	4.58ab	58.75ab
P_3	77.25c	1.86a	5.50a	61.67a
SEm(±)	**0.94**	**0.18**	**0.44**	**1.63**
LSD(0.05)	**2.72**	**0.55**	**1.28**	**4.73**

Interaction effect

Treatment Combination	Number of days taken for sprouting	Length of sprouts 100 DAC (cm)	Number of leaves per shoots 120 DAC	Sprouting percentage (%)
$T_1(G_OE_OP_O)$	88.00a	0.87b	2.00c	35.00f
$T_2(G_OE_OP_1)$	79.00cd	1.33ab	3.33bc	50.00e
$T_3(G_OE_OP_2)$	80.67bcd	1.87ab	4.33abc	53.33de
$T_4(G_OE_OP_3)$	78.00cd	1.83ab	5.00ab	56.67bcde
$T_5(G_OE_1P_O)$	86.00ab	1.17ab	3.67bc	51.67de
$T_6(G_OE_1P_1)$	79.00cd	1.93ab	4.67ab	55.00cde
$T_7(G_OE_1P_2)$	71.33e	1.67ab	5.00ab	60.00abcd
$T_8(G_OE_1P_3)$	77.00d	1.83ab	6.67a	63.33abc
$T_9(G_1E_OP_O)$	88.00a	1.23ab	3.67bc	50.00e
$T_{10}(G_1E_OP_1)$	79.00cd	1.67ab	4.00bc	55.00cde
$T_{11}(G_1E_OP_2)$	83.33ac	1.83ab	3.67bc	56.67bcde
$T_{12}(G_1E_OP_3)$	77.00d	1.70ab	4.67ab	58.33bcde
$T_{13}(G_1E_1P_O)$	87.00a	1.57ab	4.33abc	53.33de
$T_{14}(G_1E_1P_1)$	86.00a	1.50ab	5.00ab	56.67bcde
$T_{15}(G_1E_1P_2)$	80.97cd	1.67ab	5.00ab	65.00ab
$T_{16}(G_1E_1P_3)$	77.00d	2.07a	5.67ab	68.33a
SEm(±)	**1.34**	**1.13**	**0.13**	**3.27**
LSD(0.05)	**4.07**	**3.43**	**0.42**	**9.47**

Means with same letter are not significantly differs with each other ,G_O:Non-girdled, G1=Girdled, E_O=Non-etiolated, E_1=Etiolated, P_O=No promoter, P_1=IBA@3000 ppm, P_2=IBA@4000 ppm, P_3=IBA@5000 ppm ***DAC = Days after cutting***

al., 2021). By reducing the amount of total soluble sugars, soluble proteins, and free ABA while increasing the amount of total chlorophyll, free amino acids, polyphenolic acids, and free IAA along with exogenously applied IBA, light exclusion by etiolation, stem banding, or shading can improve the rooting response (; Pacholczak *et al.,* 2005). In general, bioregulators have encouraged the differentiation of callus and root meristem, showing that using IBA has improved rooting qualities compared to control (Cakalli *et al.*, 2017).

T_{16} (girdling + etiolation + IBA @5000 ppm) showed better results in terms of sprouting related parameters, rooting related parameters, survival and mortality rate with respect to all three factors. T_{16}, however, did not differ significantly from T_8 (There was no girdling, etiolation, or IBA at 4000 ppm) in terms of some parameters. Almost all of the parameters were significantly influenced by girdling and etiolation.

Table 2: Effect of Girdling, Etiolation and IBA on rooting characteristic

Main factor effect

Treatments	**Rooting percentage (%)**	**Number of roots per cutting 150 DAC**	**Days taken for rooting**	**Longest root length150 DAC**	**Survival percentage (%)**	**Mortality rate (%)**
G_0	52.70a	3.25a	93.38a	3.12b	53.23b	55.72a
G_1	56.04a	3.60a	95.12a	4.01a	57.05a	50.77b
SEm(±)	**1.58**	**0.23**	**0.62**	**0.24**	**0.86**	**0.85**
LSD(0.05)	**NS**	**NS**	**NS**	**0.70**	**2.50**	**2.48**
E_0	51.67b	3.25a	93.38a	3.09b	52.77b	55.22a
E_1	57.09a	3.60a	95.12a	4.04a	58.43a	51.27b
SEm(±)	**1.58**	**0.23**	**0.62**	**0.24**	**0.86**	**0.85**
LSD(0.05)	**4.56**	**NS**	**NS**	**0.70**	**2.50**	**2.48**
P_O	46.67c	2.23c	102.83a	2.49b	48.21c	56.13
P_1	52.91bc	3.33b	94.17b	3.28b	54.89b	52.87ab
P_2	55.41b	3.75ab	90.25c	3.41b	57.07b	52.60b
P_3	62.50a	4.33a	89.75c	5.09a	62.21a	51.38a
SEm(±)	**2.23**	**0.33**	**0.87**	**0.34**	**1.22**	**1.21**
LSD(0.05)	**6.45**	**0.95**	**2.53**	**0.99**	**3.54**	**3.50**

Interaction effect

Treatment Combination	**Rooting percentage**	**Number of roots per cutting 150 DAC**	**Days taken for rooting**	**Longest root length 150 DAC**	**Survival percentage (%)**	**Mortality rate (%)**
$T_1(G_OE_OP_O)$	36.67d	2.00e	105.67a	0.50f	36.77e	83.33(65.99)a
$T_2(G_OE_OP_O)$	48.33cd	3.33abcde	96.33cd	2.50de	48.33d	68.33(55.80)bc
$T_3(G_OE_OP_2)$	51.67c	3.67abcde	94.00cdef	2.00ef	51.67cd	65.00(53.89) bcd
$T_4(G_OE_OP_3)$	60.00abc	4.00abcd	92.33defg	4.43abcd	60.67ab	65.00(53.79)bcd
$T_5(G_OE_1P_O)$	50.00c	2.33de	98.00bc	3.17cde	51.67cd	70.00(56.87) b
$T_6(G_OE_1P_1)$	53.33bc	3.00bde	94.33cdef	3.37cde	55.53bc	68.33(55.80) bc
$T_7(G_OE_1P_2)$	56.67abc	3.67abcde	91.33defg	3.47cde	57.93abc	66.67(54.78) bc
$T_8(G_OE_1P_3)$	65.00ab	4.00abcd	89.00fgh	5.53ab	63.33a	56.67(48.86)cde
$T_9(G_OE_OP_O)$	51.67c	2.33de	105.33a	3.43cde	51.67cd	60.00(50.85)bcde
$T_{10}(G_1E_OP_1)$	53.33bc	3.33abcde	92.67def	3.67bcde	55.00bcd	58.33(49.82) cde
$T_{11}(G_1E_OP_2)$	55.00bc	3.00bcd	84.33h	3.70bcde	57.67abc	66.67(54.81) bc
$T_{12}(G_1E_OP_3)$	56.67abc	4.33abc	90.33efg	4.50abc	60.33ab	70.00(56.87) b
$T_{13}(G_1E_1P_O)$	48.33cd	2.50cde	102.33ab	2.83cde	52.77cd	60.00(50.81)bcde
$T_{14}(G_1E_1P_1)$	56.67abc	3.67abcde	93.33cdef	3.57bcde	60.70ab	58.33(50.02)bcde
$T_{15}(G_1E_1P_2)$	58.33abc	4.67ab	91.33defg	4.50abc	61.00ab	53.33(46.94) de
$T_{16}(G_1E_1P_3)$	68.33a	5.00a	87.33gh	5.90a	64.53a	51.67(46.02)e
SEm(±)	**4.47**	**0.66**	**1.75**	**0.69**	**2.45**	**2.42**
LSD(0.05)	**12.91**	**1.90**	**5.06**	**1.99**	**7.09**	**7.01**

Means with same letter are not significantly differs with each other, G_O:Non-girdled, G_1=Girdled, E_O=Non-etiolated, E_1=Etiolated, P_O=No promoter, P_1=IBA@3000 ppm, P_2=IBA@4000 ppm, P_3=IBA@5000 ppm, *DAC = Days after cutting*

As compared to other treatment combinations, girdling increased rooting, and sprouting performance of cuttings with P_3 (IBA @5000 ppm). . In case of growth promoter, it was observed that P_3 (IBA @5000 ppm) was showing the best result in all the parameters, and minimum was observed in P_0.It may be concluded that T_{16} (Girdling + Etiolation + IBA @5000 ppm) and T_8 (No Girdling+ Etiolation + IBA@ 4000 ppm) exhibited most of the desirable sprouting and rooting characteristics of kiwifruit cv. Hayward cutting in hill agro-climatic condition (Kalimpong) of West Bengal.

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