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Effect of Gravity Components on the Basipetal Flow of Endogenous Carbohydrate (Glucose) During Culture Of*Coleus Blumei*L. Stem Cuttings.

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Abstract

An attempt had been made to study the role of gravity components on the basipetal flow of endogenous glucose contents during the formation of adventitious roots in Coleus blumei L. stem cuttings cultured in water for four days at various inclinations viz., 22.5^0, 45^0,67.5^0,90^0 and 180^0respectively.Stem cuttings collected from the base of *Coleus blumei* L cuttings at the initial start (0day) and after four days of culture in water were analyzed for endogenous glucose content. The amount of glucose present at the base of the cultured cuttings showed a variation with various inclinations. At 22.5^0inclination highest (325 µg/g F.W.) amount of glucose was found to be accumulated which was followed by that at 45^0 inclination (256 µg/g F.W.) which however showed early initiation of adventitious roots. This had probably suggested that the components of gravity (g), viz. $p\text{g}\sin\theta$and $p\text{g}\cos\theta$ to which g was resolved had played a major role on the rate of flow of endogenous glucose to the basal end of the cultured cuttings. By application of hormones like IBA (60ppm), IAA (70ppm) and Kinetin(30ppm), it was attempted to see, if possible to minimize the effect of each of $p\text{g}\sin\theta$ and $p\text{g}\cos\theta$particularly in the cuttings cultured at various inclinations. But from the results, it was found that the rate of flow of carbohydrates from the apex to the base of the cuttings depended mostly on the effectiveness of $p\text{g}\sin\theta$of the gravity components which in turn depended on the angle of inclination (θ). Accumulation of carbohydrates (glucose) at the base of the cultured cuttings has a great bearing on the initiation and growth of adventitious roots in inclined *Coleus blumei* L stem cuttings.

Keywords: Cuttings, inclinations, gravity components.IBA, IAA,Kinetin,$p\text{g}\sin\theta$and $p\text{g}\cos\theta$.

1. INTRODUCTION

The orientation in which stem cuttings of easy to root plants and are placed in a rooting medium decides root formation to a great extent. Roots are seen to be produced almost on the entire length of the stem of course on the lower surface of the cuttings if the cuttings are kept horizontally (180^0) but only at the basal ends when they are cultured vertically (90^0). The polar nature of rooting of cuttings is ascribed to the basipetal transport of auxin(Chailakhayan and Nekrassova, 1958; CajlahjanandNekrassova, 1964; Pilet, 1967).Gravity plays a profound influence in the basipetal transport of auxins, which are attributed to initiation of roots on stem cuttings (Lyon, 1962, 1965).Response to gravitational stimulation by geosensitive plant organs is dependent on both the magnitude and direction components of the force of gravity (g)(Dedolph et.el.,1965). Response to gravitational stimulation by geosensitive plant organs is dependent on both the magnitude and direction components of the force of gravity (g) (Dedolph et. a, 1965). Vendrig (1960) has reported that gravity controlled the longitudinal transport of a substance in Coleus stem. Except for these contradictory postulations they have not quantified the hormones responsible for root initiation that accumulated at the basal ends of the cuttings as a result of gravitational pull and such no correlation of hormone and root initiation can be established. Further no work has so far been done on the individual effect of gravity effects ($p\text{g}\sin\theta$ or $p\text{g}\cos\theta$) on the flow and accumulation of endogenous carbohydrate content which plays a major role on the initiation of adventitious roots on stem cuttings. In the present experiments, an attempt has therefore been made to understand the role of individual gravity components on the content of endogenous carbohydrate at the bases of the cultured cuttings. Further to establish a correlation if any, between carbohydrate accumulations with initiation of

adventitious roots at the basal ends of stem cuttings placed at different inclinations in relation to the soil surface. Whether suitable concentrations of substances like IBA,IAA or Kinetin, supplied externally for a short while through the cut end of the cuttings prior to their culture at different inclinations , can liberate the effect of gravity components on the contents of endogenous carbohydrate is also being followed.

2. MATERIALS AND METHODS

Healthy stem cuttings from branches of similar age and size were collected from a single *Coleus blumei* L plant. Cuttings having 4cm length, with intact apical bud and total of five numbers of leaves were used (Das &Boissya, 1994). An arrangement was made to culture the cuttings in water contained in opaque bottles maintained at 22.5^0, 45^0, 67.5^0, 90^0 and 180^0 to the soil surface (Boissya&Das, 1993) and the experimental setup was kept in diffused sunlight for a period of 4 days to investigate the amount of glucose accumulated at the base of the cuttings at the initial start of the experiment (0day) and after their culture for 4 days respectively.It was also tried to see, whether it was possible to minimize the effect of each of $p\sin\theta$ and $p\cos\theta$ acting on the cultured cuttings. A separate set of experiments was performed where the cut ends of the stem cuttings were quickly dipped (quick dip method) for a minute immediately after their excision from the stock plant separately in each of IBA(60ppm), IAA (70ppm) and Kinetin (30ppm) and subsequently cultured in water and maintained different inclinations as reported earlier. The amount of endogenous glucose present was investigated. The suitability of the applied concentrations of the used substances on root initiation was determined from a preliminary experiment(Das & Boissya,1994).

Amount of glucose present in 2cm length from the basal end of the cultured *Coleus blumei* L cuttings were analyzed. 2cm length was selected for estimation of carbohydrate contents in view of the fact that in all the used inclinations, initiation of rooting was restricted to a maximum length of 2cm from the base of the cuttings. Glucose contents at the basal ends of the cuttings were extracted by the method described by Loomis and Shull(1937) and finally estimated quantitatively through TLC method using n-butanol: acetone: water::4:5:1 as asolvent system and finally scanned in a" IATRO TH-10" scanner fitted with computer.

The experiments were repeated 3 times and in each experiment 5 replications were taken. The amount of carbohydrate was estimated as µg per gram of fresh weight (F.W.)

The average results of the 3 experiments are presented in Tables I and II

3. RESULTS AND DISCUSSION

From the results presented in Table I it is observed that in cultured Coleus blumei L stem cuttings, inclinations play a major role on the content of endogenous glucose as it change appreciably with different inclinations.

Table I: Showing effect of gravity components on amount of endogenous glucose (µg/g F.W.)Content in Coleus blumei L stem cuttings.

Degree of inclination with soil surface	Amount of Glucose (µg/g F.W.)present	
	0 Day	4 Day
22.5^0	254	412
45^0	254	325
67.5^0	254	256
90^0	254	243
180^0	254	169

It was interesting to note that of all used inclinations, the cuttings cultured at 22.5^0 exhibited the highest (412 µg/g F.W.) amount of glucose. The cuttings placed at an inclination of 45^0, which showed earliest rooting, produced highest number of roots and longest root length (Boissya& Das, 1993) failed to exhibit the maximum amount of glucose. It may be argued therefore that at the basal

end of the cuttings an optimum level of glucose was necessary for an early rooting in Coleus blumei L stem cuttings (Das &Boissya, 1993). Further presence of higher or lower level of glucose in the cuttings delayed the process of root initiation and their subsequent growth. On the other hand, the content of glucose in the cuttings inclined at higher degreesgradually decreased, the minimum amount (169µg/g F.W.) being at the maximum inclination ie.180^0.Gravity plays a general role on the basipetal transport of the glucose synthesized in the leaves to theother regions in an erect plant. However, in case of a cutting having only one branch or stem when cultured at 90^0 to the soil surface is very much different from that of a whole plant having branches at different angles to the main stem. In other words complete I g will be effective in driving a substance glucose , in this case from the apex of the branch to the basal region of a cultured cutting when it is cultured at 90^0 to the soil surface. However, the effectiveness of the gravity which is basically I g will be very much reduced in case of inclined cuttings like those cultured at 22.5^0, 45^0, etc. up to 180^0 as in these cases I g is resolved into two components, viz.$p$gsin$\theta$and $p$gcosθ (where θ is the angle of inclinations of the cuttings).The value of each of $p$gsin θ and $p$gcos θ are therefore dependent solely upon the inclination (θ) of the cuttings, where θ is the only variable factor. Therefore with every change in θ the values of $p$gsin θ and $p$gcos θ will vary. Further the flow of glucose from the upper part to the base of cultured cuttings depends solely $p$gsin θwhich is more effective than $p$gcos θ so far as accumulation of glucose at the base of the cutting is concerned.

With a view to understand whether substances like IBA, IAA or Kinetin supplemented to the cuttings quickly(1 min) through the cut end prior to culture in water at different inclinations could liberate from the effect of $p$gsin θ and $p$gcos θ in respect of endogenous glucose content, a series of experiments were performed.

The results of the experiments are presented in Table II.

Table II : Showing effect of pretreatments of the cuttings with each of IBA(60ppm), IAA(70ppm), Kinetin(30ppm) and gravity components on glucose accumulation at the base of *Coleus blumei* L stem cuttings((µg/g F.W.) at 0 Day and 4 Day.

Degree of inclination of cuttings	Amount of glucose contents(µg/g F.W) given different treatments			
	0 Day	After 4 Days of treatment		
		IBA	IAA	KINETIN
22.5^0	254	445	480	470
45^0	254	370	440	432
67.5^0	254	330	418	414
90^0	254	297	400	395
180^0	254	287	340	320

From the results it is seen that amongst all the growth regulators viz., IBA,IAA and Kinetin, IAA is most effective as after four days of culture maximum amount of glucose is found to be accumulated (480 µg/g F.W) in the cuttings. So far as accumulation of glucose is concerned in the various inclinations the highest amount is found at angle 22.50 and lowest at 1800 inclination, irrespective of the used growth regulators. However, their quantities vary in relation to treatments. So far as liberation of the cuttings from the effect of less than 1g ($p$gsin θ and $p$gcos θ) is concerned each of the growth regulators has no effect but they enhance accumulation of glucose in stem cuttings of *Coleus blumei* L plants. Although carbohydrate is the first requisite for initiation or cell elongation. From the results it is seen that greater accumulation of glucose does not necessarily accelerate initiation of root process. The results rather suggest that a threshold quantity of glucose is necessary for cell processes for preparation of rooting. More or less than their threshold value of glucose may delay the process of rooting on stem cuttings.

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