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Some effects of grafting on the abscission of leaves of early and late shedding plants of *Corchorus olitorius* L.

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Abstract

In the present study early leaf shedding mutant plants of *Corchorus olitorius* L. were grafted with the mother plants and the analyses of abscission behaviour of the leaves of ungrafted and grafted plants were followed to observe the possibility of abscission regulating factor(s) to be transmitted through grafts. In grafted plants the leaves of scion mother plants with mutant root-stock showed earlier abscission tendencies and delayed abscission tendencies of the leaves of scion mutant plants with mother root-stock were observed as compared to the leaves of ungrafted mother plants and ungrafted mutant plants respectively and this was more pronounced during reproductive phase. Laminar tissues of ungrafted mother plants showed greater amount of total nitrogen and IAA-like compounds compared to the leaves of mutant plants. In grafted plants the leaves of mother scion with mutant root-stock showed decreased amount of total nitrogen and IAA-like compounds and the leaves of mutant scion with mother root-stock showed increased amount of total nitrogen and IAA-like compounds as compared to that of ungrafted mother plants and mutant plants respectively. Free amino acids content decreased in the leaves of mutant scion and increased in the leaves of mother scion compared to that of ungrafted mutant and mother plants respectively and this was more marked during reproductive phase.

INTRODUCTION

Senescence factors and the physiology of abscission of leaves have been extensively studied (Addicott, 1965; Jacobs, Shield and Osborne, 1962; Louie and Addicott, 1970). Role of endogenous auxins in controlling leaf longivity has been studied by a number of workers (Addicott and Lynch, 1951; Jacobs, 1958; Biggs and Leopold, 1958). Chatterjee et al. 1965 and Chatterjee 1966 have stressed the significance of auxin/amino acid balance on the

natural ageing of leaves. Abscission accelerating substances in senesced leaves and fruits have been frequently reported (Osborne 1955; 1959; Jacobs, Shield and Osborne 1962; Hall, Herrero and Kattermann, 1961).

In the present investigation mutant plants of *Corchorus olitorius* L. (cultigen JRO 620) which showed interesting behaviour of rapid rate of leaf fall and formation of early separation layer at the abscission zones compared to mother strain from which the mutants have been isolated were grafted with the mother strain and the analyses of the abscission behaviour of the leaves of ungrafted and grafted mutant and mother plants were followed. The genetical control of abscission is a new line of approach and in the present study the possibility of abscission regulating factor(s) to be transmitted through grafts has been explored.

MATERIALS AND METHODS

The early leaf-shedding mutants commonly called "drooping" isolated from R_2 generation of 70 Kr X-rayed progeny of *Corchorus olitorius* L. (cultigen JRO 620) and the late leaf shedding mother strain from which the mutants were isolated were grown side by side in experimental plot. Reciprocal grafts were made between mutant and mother plants of 30 days old which attained a height of 30—35 cm. After successful graft union, in one series mother strain and in another series the mutants, acted as root stock with mutants acting as the scion in the former and mother strain in the latter. Healthy twigs with expanded leaves collected after 20—25 days from both types of grafts and also from ungrafted mother and mutant plants separately were used as experimental material and the experiments were carried out during vegetative (55—90 days) and reproductive phase (115—170 days) of development. Younger leaves (3—7 days old) and older leaves (16—20 days old) were included in the present study the ages of which were determined from growth studies. Abscission experiments (with at least 10 twigs in each set of experiment) were performed in experimental growth room in a constant temperature of $25° \pm 1°C$; 12 hours photoperiod and relative humidity of 70—80%. Number of leaves abscissing were recorded at 6 hours intervals and hours required for 50% abscission of younger and older leaves of different types of plants were calculated separately. Biochemical analyses on the changes of total nitrogen content, IAA-like compounds and free amino acids in the different aged laminar tissues of ungrafted and grafted plants were made with the progress of ageing. Total nitrogen content were determined colorimetrically following the method of Vogel 1961. Both qualitative and quantitative estimation of free amino acids were made

and the methods of Ventura and Iracema 1959 were adopted. Determination of endogenous IAA-like compounds were done following the methods described by Larsen 1955 and the semi-quantitative estimation of IAA-like compounds were made from the elutes of chromatograms by wheat coleoptile straight growth test (Chatterjee 1972). All the experiments were replicated thrice with comparable results.

RESULTS AND DISCUSSION

Abscission responses of younger (3—7 days old) and older (16—20 days old) leaves of ungrafted and grafted mutant and mother plants during different developmental phases have been entered in Table 1.

Table 1

Abscission behaviour of the leaves of ungrafted and grafted mother and mutant plants of *C. olitorius* during different developmental phases

Experimental material	Times (hrs.) for 50% abscission of different aged (days) leaves during vegetative and reproductive phases			
	Vegetative		Reproductive	
	(3—7)	(16—20)	(3—7)	(16—20)
Mother strain	212	144	202	126
Mutant	194	108	174	76
Scion Mother / stock Mutant	198	114	184	76
Scion Mutant / Stock Mother	198	116	180	82

Times required for 50% abscission was shorter in mutant plants and the effect was more pronounced during the reproductive phase. In graft combination when mutant plants were used as a root-stock, scion mother plants showed earlier abscission tendencies of the leaves as compared to ungrafted mother control. Similarly when mother plants were used as a root-stock and the mutant plants as a scion the abscission tendencies of the leaves of the later was delayed as compared to the leaves of ungrafted mutant control. This change in the pattern of abscission was more marked during the reproductive phase of development. Table 2 shows the pattern of quantitative occurrence of total nitrogen content in younger and older leaves of grafted and ungrafted plants with the ageing during vegetative and reproductive phases. Total nitrogen content in both younger and older leaves remained higher in mother plants compared to mutant plants during both phases. In all the cases nitrogen content decreased with the ageing of

the leaves. Content of total nitrogen decreased in the leaves of mother scion with mutant root-stock compared to the ungrafted mother strain in both phases. On the contrary the nitrogen content increased in the laminar tissues of mutant scion compared to the same of ungrafted mutant plants. In general nitrogen content was higher in younger

Table 2

Total nitrogen content in the laminar tissues of different-aged leaves of *C. olitorius* plants (mother strain; mutant; reciprocally grafted mother strain and mutant) during development phases

Experimental material	Hours after collecting the twigs	Total nitrogen content (μg/100 mg dry weight) of the different aged (days) leaves with the progress of ageing of the leaves during developmental phases			
		Vegetative		Reproductive	
		(3—7)	(16—20)	(3—7)	(16—20)
Mother strain	0	1240	1008	860	384
	72	1105	848	632	262
Mutant	0	864	544	440	96
	72	608	204	192	24
Scion Mother / Stock Mutant	0	908	604	512	104
	72	782	244	240	36
Scion Mutant / Stock Mother	0	1182	804	604	188
	72	988	604	288	92

Table 3

Endogenous level of IAA-like compound in the laminar tissues of different aged leaves ungrafted and grafted *C. olitorius* mother and mutant plants with the increasing age during developmental phases

Experimental material	Hours after collecting the twigs	IAA content (μg/100 gm fresh weight) in different aged (days) leaves during developmental phases			
		Vegetative		Reproductive	
		(3—7)	(16—20)	(3—7)	(16—20)
Mother strain	0	1.44	0,38	1.14	0.12
	72	1.18	0.26	1.02	0.085
Mutant	0	1.22	0.085	0.40	0.024
	72	0.88	0.062	0.22	0.008
Scion Mother / Stock Mutant	0	1.26	0.12	0.45	0.035
	72	1.02	0.096	0.58	0.011
Scion Mutant / Stock Mother	0	1.38	0.25	0.12	0.98
	72	1.10	0.40	0.092	0.090

leaves and during vegetative phase. From table 3 it is evident that the content of IAA-like compounds was higher in younger leaves and during vegetative phase which decreased with the ageing of leaves. The laminar tissues of ungrafted mutant plants showed lesser amount

Table 4

Changes in free amino acid content in younger (3—7 days) leaves with the increase in age during vegetative (V) and reproductive (R) phases

Experimental material	Hours after collecting the twigs	Amino acid content (μg/100 mg dry weight) in the laminar tissues																			
		Methionine		α-Alanine		Arginine		Asp. acid.		Tryptophane		Glutamine		Valine		Lysine		Proline		Glycine	
		V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R
Mother	0	—	20	—	—	—	—	—	16	—	—	—	—	—	—	—	—	—	—	—	—
	72	—	32	—	20	—	10	—	28	14	30	—	—	—	—	—	18	—	20	—	10
Mutant	0	—	12	—	—	—	—	—	—	—	24	—	—	—	—	—	—	—	20	—	—
	72	40	46	20	30	—	18	—	42	20	48	—	40	—	12	—	32	—	32	—	18
Scion Mother	0	—	16	—	—	—	—	—	—	—	12	—	—	—	—	—	—	—	12	—	—
Stock Mutant	72	—	40	—	32	—	16	—	40	—	44	—	38	—	8	—	—	—	28	—	16
Scion Mutant	0	—	12	—	—	—	—	—	12	—	—	—	—	—	—	—	—	—	—	—	—
Stock Mother	72	—	34	8	24	—	20	—	32	20	40	—	8	—	—	—	12	—	24	—	8

Table 5

Changes in free amino acid content in the laminar tissues of older (16—20 days old) leaves with the increase in age during vegetative (V) and reproductive (R) phases

Experimental material	Hours after collecting the twigs	Amino acid content (μg/100 mg dry weight) in the laminar tissues																			
		Methionine		α-Alanine		Arginine		Asp. acid		Tryptophane		Glutamine		Valine		Lysine		Proline		Glycine	
		V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R
Mother	0	—	22	—	12	—	—	—	—	—	—	—	—	—	—	—	—	—	12	—	8
	72	8	42	—	44	12	18	20	40	18	38	—	20	8	16	—	20	—	30	8	22
Mutant	0	8	32	—	22	—	12	—	18	12	26	—	22	—	18	—	20	—	12	—	12
	72	44	88	32	74	—	34	30	78	40	62	12	38	—	30	—	30	14	48	—	34
Scion Mother	0	—	24	—	12	—	8	—	—	—	20	—	28	—	12	—	—	—	8	—	8
Stock Mutant	72	38	82	20	68	8	32	28	70	36	56	—	32	8	30	—	20	16	44	—	28
Scion Mutant	0	—	26	—	8	—	—	—	8	—	12	—	8	—	—	—	8	—	8	—	—
Stock Mother	72	12	58	20	60	8	28	18	44	22	48	—	24	—	24	—	16	—	34	—	24

of IAA like compound compared to ungrafted mother strain. Lesser amount of IAA-like compounds occurred in the leaves of mother scion with mutant root-stock compared to the leaves of ungrafted mother plants. Laminar tissues of mutant scion with mother root-stock showed increased amount of IAA-like compound compared to ungrafted mutant plants.

Endogenously occurring free amino acids in the leaves of the ungrafted and grafted plants have been analysed with the increasing age during vegetative and reproductive phases and the data given in tables 4 and 5. Only ten amino acids were included in the present study on the basis of predominance of occurrence. In general these amino acids increased in number and quantity with the increasing age of the leaves. Leaves of ungrafted mutant plants had greater preponderance of the amino acids and during the reproductive phase of development, but this, did not occur in the leaves of mutant scion grafted onto mother and the number and quantity of amino acids decreased in leaves of these plants. On the other hand increased number and quantity of amino acids occurred in the leaves of mother scion grafted onto mutant root stock compared to ungrafted mother plants.

The present investigations indicate that mutants of JRO-620 possessed mechanism which caused early formation of separation layer and rapid rate of leaf-fall compared to mother strain. Some changes in the metabolic pathway have taken place in the mutant to accelerate the rate of leaf-fall and in these plants formation of separation layer in the abscission zones occurred at a faster rate from an early stage of vegetative growth, although at that stage there was no appreciable difference in the normal leaf-fall pattern. Leaves of mutant plants indicated predominant occurrence of free amino acids particularly during reproductive growth. The absence of hastened leaf-fall rate in mutant, during vegetative growth might be due to increasing abscission retarding effects of IAA-like compounds present in the laminar tissues during this phase. Comparatively higher level of occurrence of total nitrogen and IAA-like compounds and lesser number and quantity of amino acids in the laminar tissues of mother strain might be associated with retardation of early formation of separation layer and thus causing slower rate of leaf-fall. With the attainment of developmental progress as well as of age, there occurred a decrease of total nitrogen content and IAA-like substance and increase of free amino acids in both mother and mutant plants, but with a higher rate in mutant plants. These biochemical properties characterising the mother strain and mutant plants of JRO-620, could be shown to occur in the scion laminar tissues of reciprocally grafted plants in a manner suggestive of a greater contributory role of early-shedding mutant in two sets of reciprocal graft-combinations. The factor controlling

early shedding property of mutant plants could also be said to be originating from root and lower stem portion of mutant plants, as was evident from the results of reciprocal crosses. These data would thus confirm a clear transmission of abscission regulating factors, whether promotive or inhibitive, from mutant and mother root-stocks which induced a change in the characteristic biochemical character of the leaves mentioned earlier.

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Wpływ szczepienia na proces opadania liści u wcześnie i późno zrzucających liście roślin Corchorus olitorius L.

Streszczenie

Mutanty roślin *Corchorus olitorius* L., zrzucające wcześnie liście, szczepiano z roślinami matecznymi (niezmutowanymi). Obserwowano zmiany w procesie opadania liści, a także zmiany zawartości azotu ogólnego, związków IAA-podobnych i wolnych aminokwasów w liściach roślin szczepionych w porównaniu do nie szczepionych. Badania przeprowadzano dla dwóch wariantów szczepienia: mutant na podkładce z rośliny matecznej i roślina mateczna na podkładce z mutanta. W przypadku wariantu mutant na podkładce z rośliny matecznej stwierdzono: opóźnienie opadania liści, wzrost zawartości azotu ogólnego i IAA-podobnych związków, spadek ilości wolnych aminokwasów w porównaniu do roślin nie szczepionych. W przypadku wariantu roślina mateczna na podkładce z mutanta stwierdzono: wcześniejsze opadanie liści, spadek zawartości azotu ogólnego i IAA-podobnych związków, wzrost ilości wolnych aminokwasów w porównaniu do roślin nie szczepionych. Wszystkie zmiany występowały wyraźniej w czasie trwania fazy reproduktywnej.