

INTERACTION BETWEEN GROWTH REGULATOR AND POLYAMINE EFFECTS ON MEMBRANE PERMEABILITY

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Key Word Index—*Beta vulgaris*; Chenopodiaceae; beet root; polyamines; auxins; gibberellic acid; kinetin; tomatin; ethylene; membrane permeability.

Abstract—Kinetin and tomatin increase betacyanin efflux from discs of beetroot tissue, whereas gibberellic acid and ethrel decrease the efflux. Auxins and chloroethanol have no effect. Spermine enhances the inhibitory effect of gibberellic acid and ethrel, and reverses the effect of kinetin and tomatin.

INTRODUCTION

Several plant growth regulators are known to affect growth by regulating ion transport and membrane permeability [1–4]. We have reported earlier [5] that polyamines, and especially spermine, cause a decrease in betacyanin efflux from beetroot discs by affecting membrane permeability. In the present paper we report the effect of some of the growth regulators and their interaction with polyamines as a possible means of regulating membrane permeability.

RESULTS AND DISCUSSION

Effect of auxins

2,4-Dichlorophenoxy-acetic acid (2,4-D) had no effect on betacyanin efflux in neutral solution but when used without neutralization (pH ca 3) increased the efflux significantly (Table 1) due to the acidic pH of the medium. The effect of acid in increasing the betacyanin efflux is well known [6]. Similar results were obtained with indole-3-acetic acid (IAA). Pickles and Sutcliffe [7] have reported that IAA increased the efflux of betacyanin from beetroot when the solution was prepared in phosphate buffer pH 7. Poovaiah and Leopald [8] have, however, shown that phosphate ions

have a marked stimulating effect on betacyanin efflux and the increase reported by Pickles and Sutcliffe [7] may be due to the presence of phosphate ions in the bathing medium.

Effect of gibberellic acid

Gibberellic acid (GA) was found to decrease the efflux and the inhibitory effect was further enhanced if spermine was present with GA in the medium (Table 2).

Effect of kinetin

Kinetin increased the efflux to ca 170% at 1 mM (Table 3) and the inhibitory effect produced by spermine could be reversed by kinetin. Kinetin and spermine may compete for the same binding site on the membrane.

Effect of ethrel, chloroethanol and tomatin

Ethrel and chloroethanol are known to form ethylene which affects membrane permeability [9]. The exact mode of action of ethylene is not yet known. In the present experiments, although ethrel decreased the efflux (Table 4), chloroethanol, even at 20 times higher concentration, had no effect. It is

Table 1. Effect of 2,4-D on betacyanin efflux

2,4-D (mM)	Betacyanin efflux/hr (Klett units)	
	Without pH adjustment	After pH adjustment
0	102	143
0.2	106	143
0.4	264	142
0.6	450	134
0.8	600	136
1.0	790	137

Table 2. Effect of gibberellic acid on betacyanin efflux in the presence of spermine

Concentration (mM)		Betacyanin efflux/hr (Klett units)
GA	Spermine	
—	—	146
0.1	—	103
0.5	—	95
1.0	—	87
—	0.5	63
0.5	0.5	46

Table 3. Effect of kinetin on betacyanin efflux in the presence of spermine

Concentration (mM)		Betacyanin efflux/hr (Klett units)
Kinetin	Spermine	
—	—	262
0.1	—	302
0.5	—	365
1.0	—	438
—	0.5	110
—	1.0	95
0.5	0.5	174
1.0	0.5	190
0.5	1.0	105
1.0	1.0	145

interesting to note that ethanol had a marked destabilizing effect on the membrane permeability [5] and increased the efflux, but chloroethanol had no effect.

Tomatin in neutral or alkaline pH is highly membranolytic [10] and forms a complex with cholesterol. Since sterols are considered to act as stabilizers of membranes, the binding of tomatin with sterols will result in destabilization of the membrane structure and

Table 4. Effect of tomatin and ethrel on betacyanin efflux in the presence of spermine

Concentration (mM)			Betacyanin efflux/hr (Klett units)
Tomatin	Ethrel	Spermine	
—	—	—	142
0.006	—	—	164
0.015	—	—	250
—	0.3	—	87
—	0.6	—	71
—	—	0.5	82
—	—	1.0	62
0.015	—	0.5	122
0.015	—	1.0	96
0.015	0.015	—	118
0.015	0.015	—	88

cause lysis of the membrane. In the present study tomatin increased betacyanin efflux (Table 4) and the increase in efflux could be reversed by spermine or ethrel.

The results reported above thus suggest that GA and ethrel, like polyamines, produced a stabilizing effect on the membrane whereas kinetin and tomatin cause destabilization which could be reversed by polyamines. Polyamines in the presence of GA and kinetin may contribute to the regulation of membrane permeability by interacting with common binding site(s) on the membrane.

EXPERIMENTAL

Beetroot discs 1–2 mm thick were prepared and processed as reported earlier [5]. Betacyanin efflux was followed at 37° by measuring the pigment leaked out in 1 hr in the ambient soln at 540 nm. The pH of the ambient soln, unless otherwise specified, was adjusted to 7 with KOH. The results, in Klett units, are means of at least 2 independent experiments carried out on the discs prepared from the same beet and repeated with two different beets.

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