Type of mortar	Water : cement ratio	Strength at various ages (days) after fabrication					
		Modulus of rupture (lb./sq. in.)			Compressive (lb./sq. in.)		
		7	14	28	7	14	28
Pozzolana *A*	0·24	433	499	546	3,850	4,100	5,350
Pozzolana *B*	0·24	276	342	503	2,250	3,100	4,450
Lime	0·33	92	83	101	770	730	1,000

cement. The results also suggest that other similar volcanic deposits may be potentially valuable. Further work on the behaviour of blended portland–pozzolana cements is in progress and will be reported elsewhere.

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Amino-Acids and the Growth of Isolated Oat Embryos

There have been numerous reports of interactions between amino-acids in their effects on the growth of bacteria and fungi, while relatively few interactions of this type have been reported in studies with higher plants. Mixtures of amino-acids have been found to interact in their effects on the growth of immature *Datura* embryos[1]. Antagonisms have been reported between canavanine and structurally related amino-acids in their effects on the growth of *Avena* coleoptile sections[2] and immature embryos of maize[3]. Experiments reported here extend these observations in so far as they expose a series of interactions between amino-acids in their effects on the growth of mature embryos of oat. These interactions have been observed as antagonisms between individual amino-acids in their effects on root growth.

Embryos of oat (var. Victory) were grown in sterile culture in the dark at a temperature of 25 ± 1° C. Each embryo was grown in a separate culture vessel, in which it was supported at the surface of 50 ml. of liquid medium. The basal medium, to which the amino-acids under test were added, contained: (1) inorganic salts as used by Burström[4] for the culture of excised roots of wheat but with potassium chloride and calcium chloride substituted for the corresponding nitrates and with ferric sulphate omitted; (2) organic growth factors as used by White[5] for the culture of excised roots but with glycine omitted; (3) 0·2 *M* sucrose. The initial *p*H of all media was adjusted to a value of 6·2 ± 0·2 by the addition of suitable quantities of 0·01 *N* sodium hydroxide. The media were sterilized by autoclaving at a pressure of 15 lb. for five minutes.

It was found that the total linear growth of the embryos could be substantially increased by the addition of a vitamin-free casein hydrolysate to the basal medium. The effect of the hydrolysate could be simulated by supplying a synthetic mixture of eighteen amino-acids in its place. The effect of twelve of these amino-acids was studied by supplying them alone and in pairs, at the same concentrations as those used in the mixture. The table shows the effects of the amino-acids supplied alone (Exp. 1) and in combination with phenylalanine (Exp. 2) and with valine (Exp. 3) on the growth in length of the roots. When supplied alone, eleven out of the twelve amino-acids were inhibitory to root growth, while one, arginine, had little effect. In the majority of cases where amino-acids were supplied in pairs, the pair proved to be less inhibitory to root growth than was the most inhibitory of its constituent amino-acids supplied alone. In certain instances interactions were very marked. Phenylalanine was particularly effective as an antagonist for tyrosine and also showed marked interactions with serine and with threonine. Valine, which was the most inhibitory of the amino-acids when supplied alone, was effective in relieving the inhibition of growth produced by leucine and by isoleucine. These two interactions involving valine were striking in that the growth value obtained with the combination of acids exceeded that obtained with either alone.

The Effect of Amino-Acids Supplied Alone and in Combination with Phenylalanine and with Valine on the Length of the Roots of Isolated Oat Embryos Measured at the End of a Seven-day Culture Period. All Values are Based on the Means of Measurements Made on at Least Ten Seedlings

Amino-acid	Conc. mgm./l.	Length of roots as percentage of control (basal medium) in each experiment		
		Exp. 1. No addition	Exp. 2. Addition of L-phenylalanine, 17·5 mgm./l.	Exp. 3. Addition of DL-valine, 35·2 mgm./l.
None	—	100	70	14
L-Arginine	17·5	106	86	23
L-Phenylalanine	17·5	72	—	22
L-Aspartic acid	26·3	66	79	20
L-Glutamic acid	87·6	64	58	20
L-Proline	35·2	47	62	28
L-Lysine 2HCl	30·4	39	33	18
DL-Threonine	17·5	30	59	25
L-Leucine	21·9	29	37	41
DL-Isoleucine	21·9	28	42	44
L-Tyrosine	26·3	27	64	23
DL-Serine	26·3	21	45	17
DL-Valine	35·2	15	22	—
Length of roots in basal medium (control) in mm.		317	308	304

The results of further experiments have confirmed the existence of a marked interaction between DL-valine and DL-isoleucine and have indicated that no similar interaction occurs between DL-isoleucine and L-leucine. Evidence has also been obtained for interactions between glycine and DL-serine and between L-arginine and L-lysine.

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