

BRIEF COMMUNICATION

The Effect of Potassium on Germinating Wheat Embryos at Different Viability Levels

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Abstract. The effect of potassium administration in early germination of wheat (*Triticum durum* L., cv. Appulo) was studied by incubating isolated embryos at different viability levels with 1 mM KCl. The stimulation of germination and growth in aged embryos by K^+ was accompanied by a significant increase in (3H) leucine incorporation into protein and in phospholipid synthesis as evidenced by TLC analysis of embryo phospholipids extracted after 24 h of imbibition. The metabolic improvement mediated by the cation would in turn repair aging damage occurring at subcellular sites including membranes.

The requirement of plant cells for potassium is attributed to its role as an osmotic, specific metabolic factor and to its effects on membrane (WYN JONES *et al.* 1979). There is evidence indicating that K^+ is also relevant at the beginning of plant life (see, for example COCUCCI *et al.* 1981). In a number of seeds, germination is correlated with a rapid development of K^+ uptake and a progressive extrusion of H^+ . The activation of this mechanism was assumed to be a primary event triggering a complex series of metabolic changes characteristic of seed germination.

This hypothesis is consistent with the reported control of protein synthesis by intracellular potassium in different eucaryotic cells (ALONSO and CARRASCO 1981). In higher plants, in particular, HARU *et al.* (1982) reported the effect of K^+ on DNA, RNA and protein synthesis, and chlorophyll content in cucumber cotyledons. More recently, COCUCCI *et al.* (1986) showed that the administration of K^+ to *Phacelia tanacetifolia* seeds, incubated under conditions when no germination takes place (30 °C, dark), can induce an early increase in RNA and protein synthesis, thus supporting the fundamental role of potassium in triggering seed metabolism.

These findings led us to a more critical examination of the previously found (PETRUZZELLI *et al.* 1982) stimulating effect of K^+ treatments on ger-

mination and H^+ extrusion capability of a wheat seed lot aged under laboratory conditions.

To this purpose, embryos isolated from the same (PETRUZZELLI *et al.* 1982) unaged and aged wheat lots previously used (*Triticum durum* L., cv. Appulo) were incubated at 20 °C in Petri dishes (5.5 cm in diameter) with 5 ml sucrose 2 % and 10 $\mu\text{g ml}^{-1}$ chloramphenicol with and without 1 mM KCl.

To measure protein synthesis, embryos were treated as already described (PETRUZZELLI and TARANTO 1985) after 5 and 24 h of germination. Phospholipid analysis was carried out on dry embryos and after 24 h of germination, following the procedure previously reported (PETRUZZELLI and TARANTO 1985).

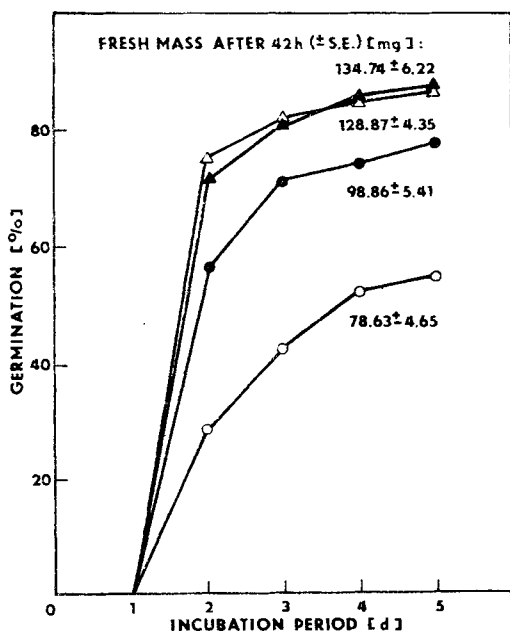


Fig. 1. Effect of K^+ on germination and growth of unaged (Δ $\blacktriangle$) and aged ($\circ$ $\bullet$) embryos. All the values are the means of three experiments performed with ten replicates of ten embryos each: standard deviation not greater than 5 % for all values.

The presence of potassium in the incubation medium can stimulate germination and growth in aged embryos, thus confirming previous data, (PETRUZZELLI *et al.* 1982) (Fig. 1). It is evident that seed viability loss induces a detectable damage in the protein-synthesizing system. On the other hand, in the presence of K^+ there is a remarkable increase in labelled leucine incorporation into proteins, especially after 24 h of germination (Figs. 2, 3).

Aged embryos also show a marked increase in phosphatidic acid at zero time of germination and, after 24 h of germination, reduced levels of major phospholipid classes in comparison with the unaged ones (Table 1). However, when the incubation medium contained KCl, the levels of phospholipid components, particularly of phosphatidic acid show a general trend to increase. No evident effects are found in unaged embryos.

The present results focus attention either on deleterious changes occurring

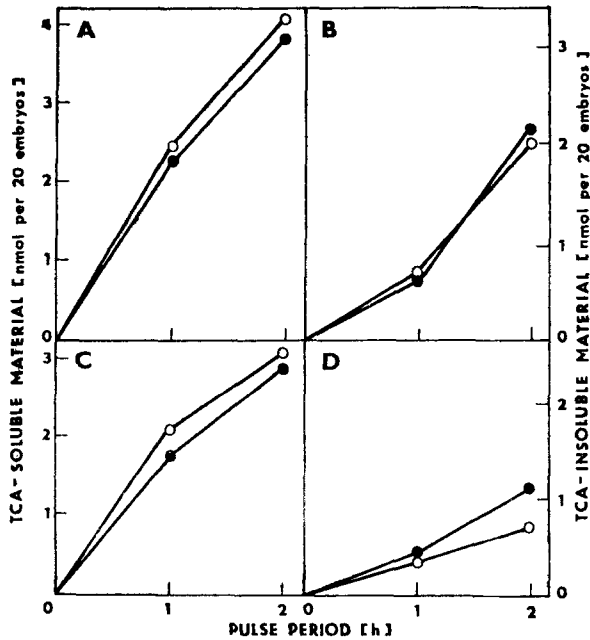


Fig. 2. Effect of K^+ on (^3H) leucine incorporation into protein. The embryos were incubated for 5 h in the presence (●) or absence of 1 mM KCl (○) and pulsed for 1 and 2 h in the same medium plus 10^{-4} M (^3H) leucine (900 MBq mol^{-1}). A, B: unaged embryos; C, D: aged embryos. Values are the means of three experiments run in triplicate. Standard deviation not greater than $\pm 4\%$ for all values.

in embryo cells during seed viability loss or on their ability to partially recover metabolic deficiencies in the presence of potassium.

The protein-synthesizing activity decreases as viability drops from 90 to approximately 50 per cent, in agreement with the view that the embryonic apparatus for protein synthesis is particularly susceptible to damage (BRAY 1979).

Similar conclusions may be drawn from a thin-layer chromatographic analysis of phospholipids. Moreover, dry embryos show two characteristic features of phospholipid deterioration, *i.e.*, an increase in phosphatidic acid and a decrease in other phospholipid species which are indicative of lipid hydrolysis.

On the other hand, the promotion of macromolecular synthesis by potassium in aged embryos corresponds to its stimulation of germination and growth. In fact, after 24 h of germination there is a parallel increase in (^3H) leucine incorporated and in phosphatidic acid level, key intermediate of phospholipid synthesis, suggesting that in germinating wheat embryos, like in other systems (TATA 1970), an increase in protein synthesis may be closely related to the accumulation of membrane constituents.

On the basis of the suggested interaction between changes in potassium fluxes and cellular biosynthetic activity in different systems as germinating seeds (Cocucci *et al.* 1986), it may be suggested that the addition of potassium

TABLE I

Effect of K^+ on phospholipids [$\mu\text{g PO}_4^{3-}$] extractable from wheat embryos at different viability levels. Values are means $\pm$ S.E. of four experiments run in duplicate. For each experiment 50 samples were used

Phospholipid	Time of germination [d]	Growth conditions	Viability level	
			unaged	aged
Phosphatidyletholine	0		19.51 $\pm$ 1.82	12.91 $\pm$ 1.26
	1	2 % Sucrose	23.26 $\pm$ 2.04	13.88 $\pm$ 0.86
	1	2 % Sucrose + 1 mM KCl	22.17 $\pm$ 1.05	17.21 $\pm$ 1.26
Phosphatidylethanol-amine	0		10.41 $\pm$ 0.44	6.69 $\pm$ 0.59
	1	2 % Sucrose	13.63 $\pm$ 0.41	7.58 $\pm$ 0.40
	1	2 % Sucrose + 1 mM KCl	13.41 $\pm$ 0.63	11.91 $\pm$ 1.21
Phosphatidic acid	0		0.22 $\pm$ 0.01	0.95 $\pm$ 0.11
	1	2 % Sucrose	6.97 $\pm$ 0.57	4.26 $\pm$ 0.43
	1	2 % Sucrose + 1 mM KCl	7.94 $\pm$ 0.77	6.94 $\pm$ 0.51
Phosphatidylinositol	0		3.13 $\pm$ 0.37	2.27 $\pm$ 0.07
	1	2 % Sucrose	3.27 $\pm$ 0.28	2.08 $\pm$ 0.25
	1	2 % Sucrose + 1 mM KCl	3.80 $\pm$ 0.17	3.05 $\pm$ 0.14
Phosphatidylglycerol	0		1.08 $\pm$ 0.24	0.85 $\pm$ 0.05
	1	2 % Sucrose	2.72 $\pm$ 0.08	1.44 $\pm$ 0.03
	1	2 % Sucrose + 1 mM KCl	2.88 $\pm$ 0.11	2.03 $\pm$ 0.02

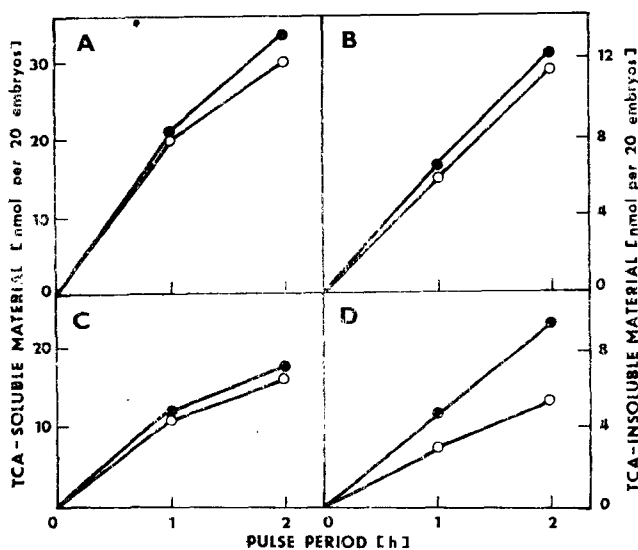


Fig. 3. Effect of K^+ on (^3H) leucine incorporation into protein. The embryos were incubated for 24 h in the presence (●) or absence of 1 mM KCl (○) and then pulsed as described in Fig. 2. A, B: unaged embryos; C, D: aged embryos. Values are the means of three experiments in triplicate. Standard deviation not greater than $\pm 4\%$ for all values.

in the incubation medium could affect macromolecular synthesis, thus enabling aged embryos to recover from metabolic deficiencies including membrane functionality.

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BOOK REVIEW

MCDONALD, M. B., JR., NELSON, C. J. (ed.): *PHYSIOLOGY OF SEED DETERIORATION*. — Crop Science Society of America, Inc., Madison 1986. 123 pp.

The availability of uniform lots of viable seeds of high quality is essential to a successful crop production. The deterioration of seed quality is recognized as a major problem contributing to decreasing crop production. In addition, seed damaging during production, storage and handling due to unfavourable conditions and pathogens causes lower quality and losses of feed and food grains. This booklet, CSSA Special publication Number 11, brings the basic information on the physiological factors associated with seed deterioration, presented at the Symposium held at the annual meeting of the American Society of Agronomy and the Crop Science Society of America at 1984 in Las Vegas. The matter is divided into six chapters. In the first E. E. Roos discusses the effect of temperature and relative humidity on seed viability, and the theories of seed deterioration. The review of present knowledge of membrane changes in seeds as related to germination and perturbations resulting from deterioration in storage (J. D. Bewley) is followed by discussions on nucleotide alterations during seed deterioration (J. D. Anderson and K. Gupta) and nucleic acid and protein metabolism (J. H. Cherry and R. W. Skadsen). The role of micro-organisms in seed deterioration is reviewed by J. M. Hallon. In the last chapter E. H. Roberts integrates environmental parameters into a predictive model which quantifies seed deterioration under given environmental conditions.

The booklet will be of value to all researchers and educators interested in seed quality and factors associated with the seed deterioration.