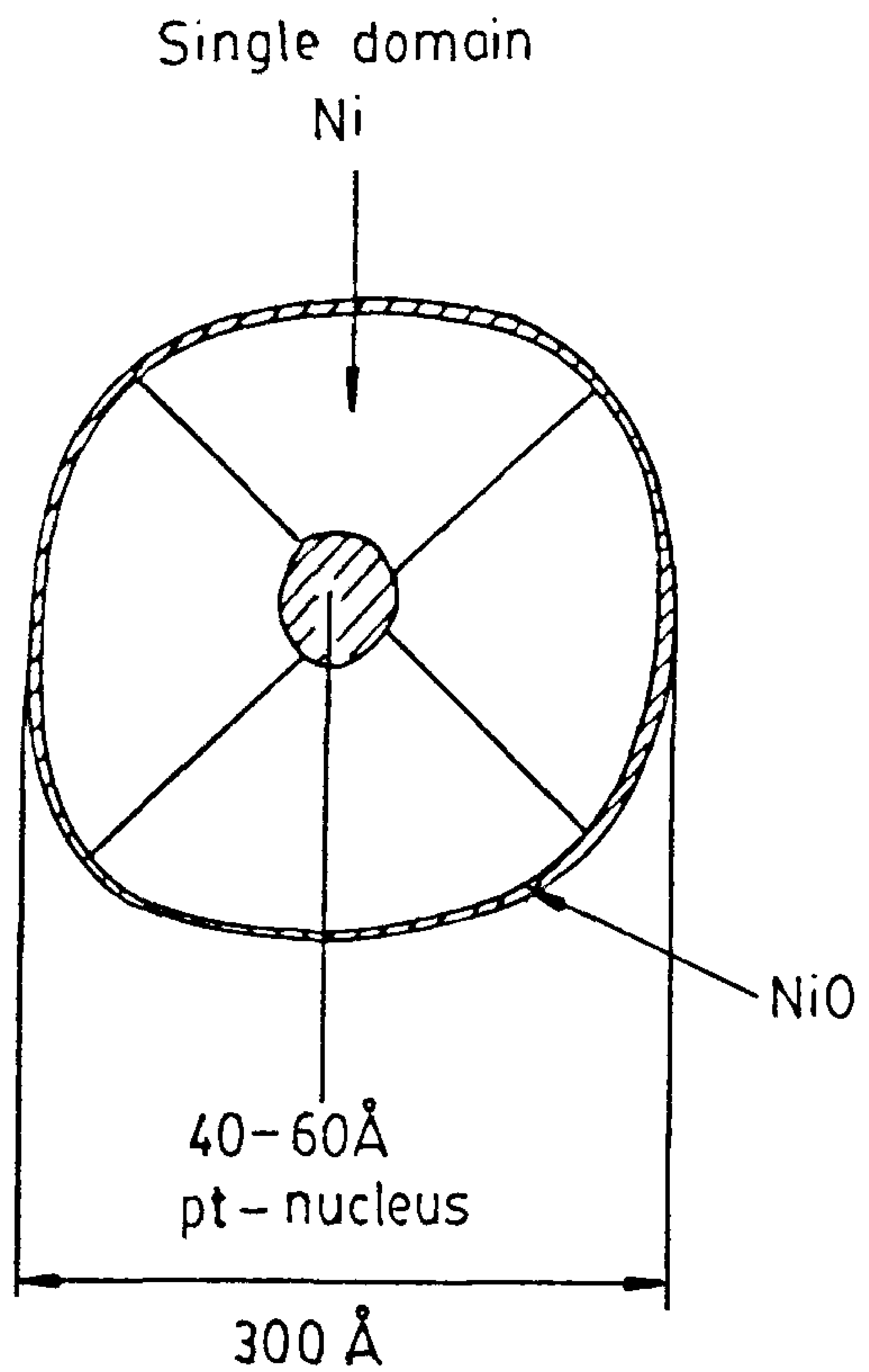

Figure 6. Schematic representation of general microstructure of the Ni polymicrocrystal.

(Figure 5). The identification of the nucleus itself is of special significance to the field of nucleation by Pd/Pt to form nano Ni, Co and such materials.

In conclusion, the transmission electron microscopic exploration embodying both the imaging and diffraction reveals the presence of multi-domain structure of Ni-particle. Ni particle is coated by thin NiO layer due to surface oxidation. TEM micrographs taken at high magnification show the presence of a nucleus. These core regions presumably appear to be due to Pd or Pt which were used for the nucleation of the Ni-particles. Keeping these observation in view, a schematic diagram of polyol prepared Pd/Pt nucleated nano Ni is shown in Figure 6.

1. Glicksman, H. D., in *Materials Handbook*, American Society for Metals Park, Ohio, 9th edn, 1984, vol. 7, p. 147.
2. Larry, J. R., Rosenberg, R. M. and Unler, R. G., *IEEE Trans. Compon.*, Hybrids Manuf. Technology, 1980, vol. 3, pp. 211.
3. Fisher, G., *Cernum Ind. (Chicago)*, 1983, **120**, 80.
4. Figlarge, M., Felevet, F. and Lagire, J. P., French Patent No: 8221483; Europe No: 0113281; USA No: 4539041; Finland No: 74416; Japan Application No: 24303738.
5. Figlarge, M., Ducamp-Sanguess, C., Flevet, F. and Lagire, J. P., *Adv. Powder Metall. Particul. Mat.*, 1991, **1**, 179.
6. Felevet, F., Lagire, J. P., Blin, B., Beaudoin, B. and Figlarge, M., *Solid State Ionics*, 1989, **32/33**, 198.
7. Hegde, M. S., Larcher, D., Dupont, L., Beaudoin, B., Tekaia-elhsissen, K. and Tarascon, J. M., *Solid State Ionics*, 1997, **93**, 33.

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Surface electrical potential changes of saline tolerant and sensitive wheat varieties differ with sodium chloride treatment

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Surface electrical potential (EP) of wheat varieties was measured by a conventional microelectrode method. Wheat seedlings had a surface EP of – 7 to– 10 mV at the shoot apex. Addition of NaCl to the root zone suddenly changed the EP at the shoot apex. The change in EP depended on the concentration of NaCl added to the root zone, i.e. 1000 mM NaCl changed the EP with a greater amplitude (6.8 mV) within a few seconds whereas 100 mM NaCl changed the EP with a smaller amplitude (3 mV) gradually. Interestingly, salinity-tolerant variety 'kharchia' produced less noticeable change in EP at the shoot apex, while in salinity sensitive variety 'moti' the amplitude of EP rose sharply and then gradually levelled off to the addition of NaCl in the root zone. The change in EP of kharchia was accompanied by an increase in shoot potassium and calcium content whereas moti showed a larger increase in sodium content.

LIVING plant cells have a resting potential with a net negative charge localized on the inner side of the membrane. This potential difference is caused by unequal distribution of positive and negative ions between the opposite sides of the membrane[1]. When a plant cell is subjected to

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different kinds of stresses, its ionic composition will be altered which in turn changes the cell electrical potential (EP)[2]. For example in saline conditions, most salt-tolerant monocotyledonous plants accumulate lower amount of sodium in their leaves than salt-sensitive monocotyledonous plants[3]. Salt sensitive varieties of barley had higher Cl^- and Na^+ content than those of tolerant varieties[4]. Tomato on the other hand, had a higher uptake and accumulation of Na^+ (ref. 5), thus confirming both variety as well as species variation in uptake and transport of ions under saline conditions. In this study surface EP of wheat varieties differing in salinity tolerance was measured with the assumption that the differential uptake and transport of ions between these two varieties would have caused a change in EP.

Wheat seedlings known to differ in their salinity tolerance, viz. kharchia (tolerant) and moti (sensitive) were raised in small plastic pots (30 mn in diameter and 70 mm high). A single plant was maintained in each pot and grown in a net house. Twenty-day-old seedlings were transferred to the laboratory for measurement of EP.

The surface EP was measured by a conventional microelectrode method as described by Hebbar *et al.*[6] in sunflower, except that the reference electrode was connected in the root zone and the measuring electrode was connected to the shoot apex at a distance of 10 cm above the reference electrode. The resting EP was recorded for ten minutes and later NaCl solution of 0, 100, 500 and 1000 mM was applied to the root zone without disturbing the electrode connections. The change in EP with the addition of different concentrations of NaCl was recorded in wheat varieties.

To see the association of ions with electrical changes, the shoot segment 10 cm above the root zone (where the measuring electrode was connected) was cut 1 and 3 min after the addition of NaCl to the root zone. It was digested in a triacid mixture and the potassium, sodium and calcium content was measured as described by Chapman and Pratt[7].

Surface EP in wheat was negative and it varied between – 7 and –10 mV and was quite stable (Figure 1). Marked changes in EP were observed in the shoot apex with the addition of NaCl in the root zone (Figure 1). 100 mM NaCl caused a gradual change in EP of amplitude 2 mV, 3 mV, and 4 mV at 2, 3, and 4 min, respectively. Addition of 500 mM NaCl caused a rapid change in EP of amplitude 5 mV within 30 s and EP returned to – 5 mV within 2 min. Further, it was gradually depolarized to –1.5 mV at 6 min and thereafter there was no change in EP. Similarly, 1000 mM NaCl caused depolarization of shoot surface EP of 6.8 mV within 30 s. Within 2 min the original EP was restored and later it was gradually depolarized and reached – 0.6 mV after 9 min and there was no further change.

Of the two varieties in which EP was measured, moti had the highest resting potential of – 9 mV while kharchia had a resting potential of – 6 mV (Figure 2). Addition of 500 mM NaCl to the root zone changed the resting potential in the shoot apex from – 9 mV to – 3 mV in moti within 30 s (Figure 2 *a*). EP recovered back to – 6.8 mV after 2 min. Two more spikes were seen after 5 min and 8 min respectively, and later EP was stabilized at – 5 mV. On the other hand, in kharchia there was a very small change in surface EP of amplitude 2 mV and it was very slow, i.e. only 2 min after addition of NaCl (Figure 2 *b*). Further, it was maintained more or less constant (– 5 mV) throughout the experimental period.

Shoot K^+, Ca^{2+} and Na^+ content of control plants showed a marked variation between the varieties (Table 1). Kharchia had the highest Ca^{2+} and K^+ content (10.65 and 19.30 mg g^{-1} F.wt, respectively) while it was least in moti (9.20 and 17.95 mg g^{-1} F.wt, respectively). On the other hand, the Na^+ content was highest in moti (4.15 mg g^{-1} F.wt) and it was

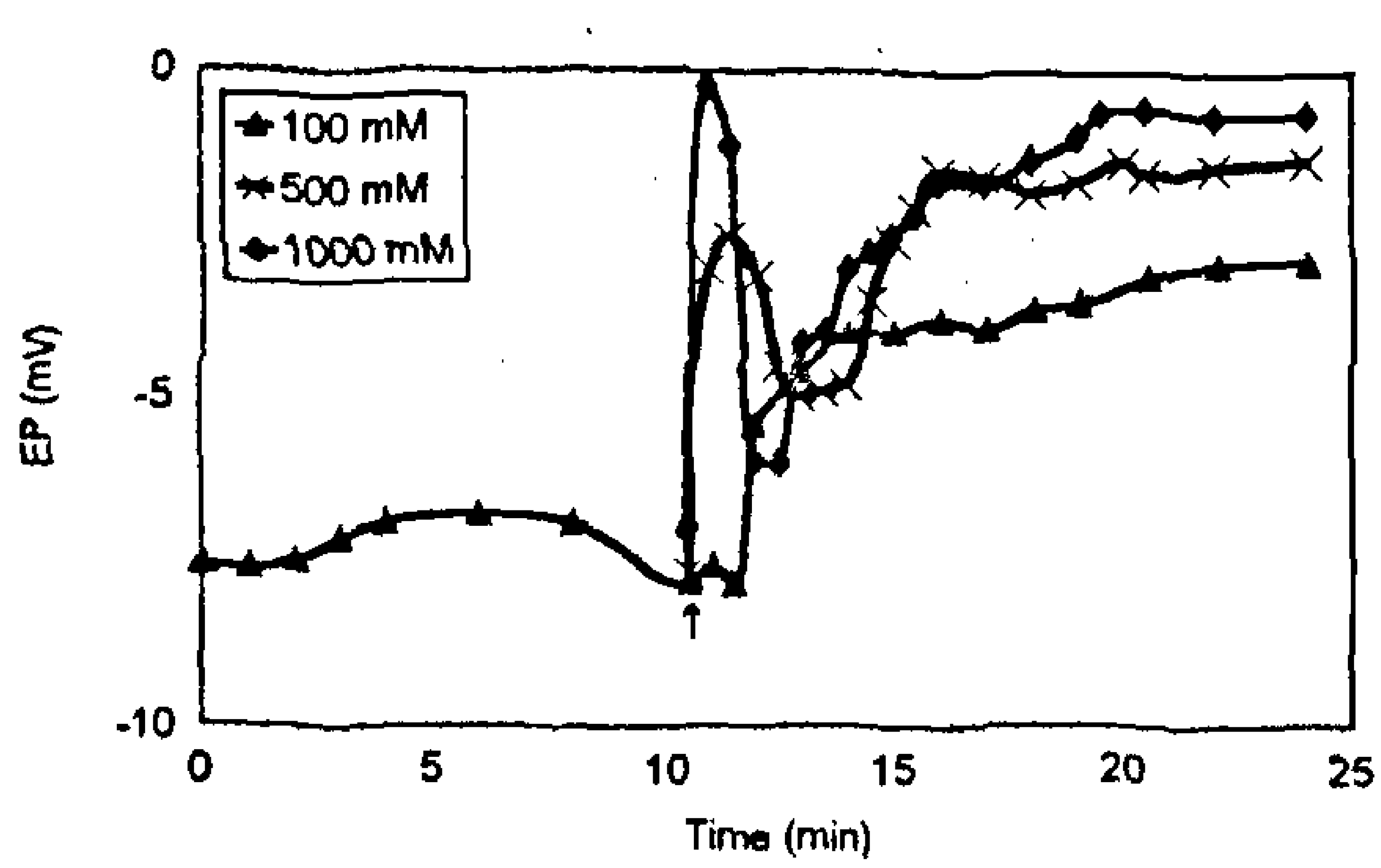

Figure 1. Surface EP change in wheat shoot apex on application of 100, 500 and 1000 mM NaCl in the root zone. (Arrow indicates application of NaCl).

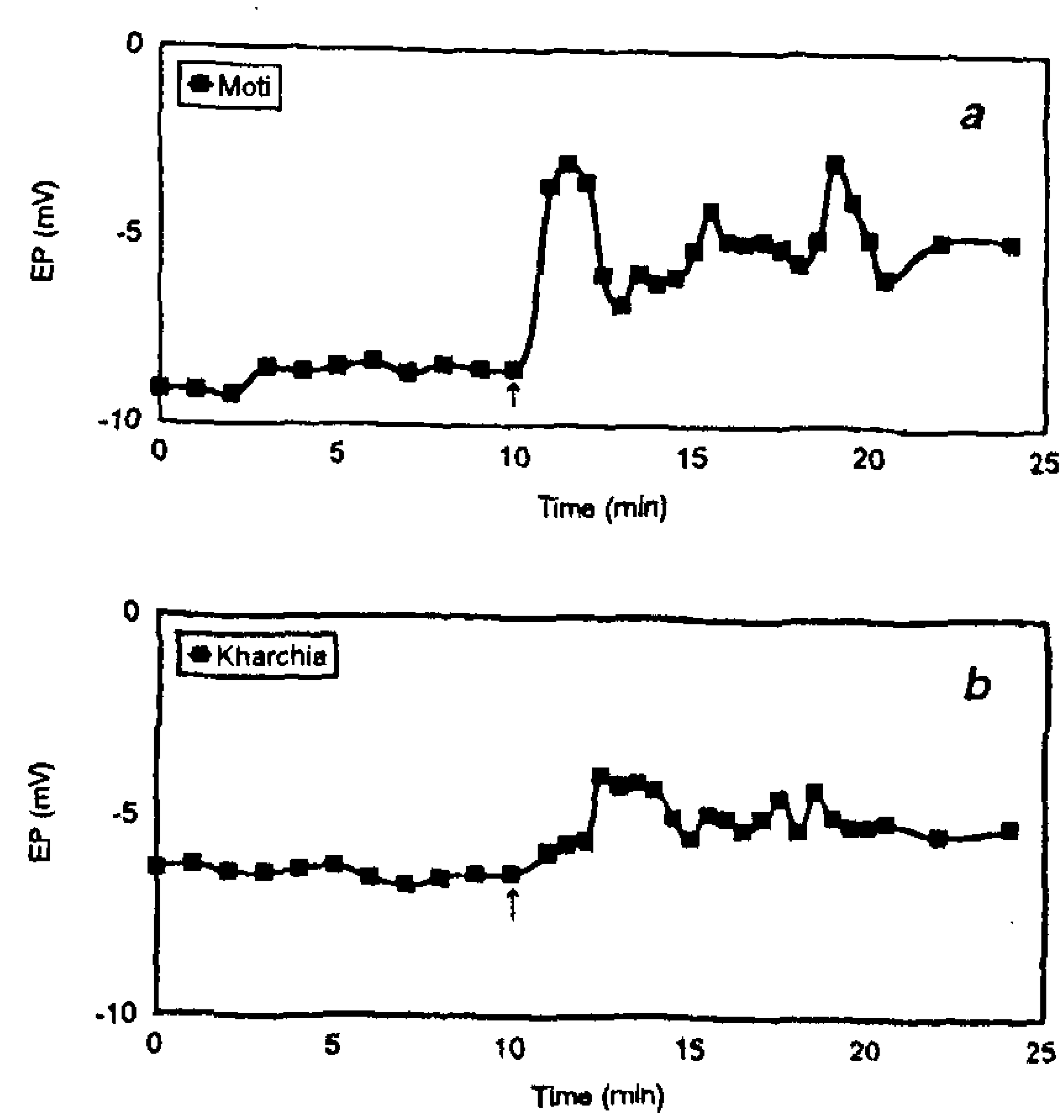

Figure 2. Surface EP change in shoot apex of wheat varieties (*a*) moti and (*b*) kharchia on application of 500 mM NaCl in the root zone. (Arrow indicates application of NaCl).

Table 1. Potassium, calcium and sodium content (mg g^{-1} F.wt) of wheat shoot measured 1 and 3 min after the application of 500 mM NaCl to the root zone (Values in the parenthesis indicate ± S.E.)

		500 mM NaCl	
Variety	Control	1 min	3 min
Calcium			
Moti	9.20 (0.80)	8.60 (0.30)	7.80 (0.01)
Kharchia	10.65 (0.85)	13.30 (0.40)	14.30 (0.70)
Potassium			
Moti	17.95 (1.45)	19.20 (2.61)	15.80 (0.70)
Kharchia	19.30 (0.79)	27.30 (0.60)	27.50 (3.60)
Sodium			
Moti	4.15 (0.35)	4.90 (0.02)	4.90 (0.70)
Kharchia	2.50 (0.10)	3.10 (0.70)	3.00 (0.02)
K/Na ratio			
Moti	4.4	3.9	3.2
Kharchia	7.7	8.8	9.1

lowest in kharchia (2.50 mg g^{-1} F.wt). Marked changes in shoot K^+, Ca^{2+} and Na^+ content were seen at 1 min and 3 min after the addition of 500 mM NaCl to the root zone (Table 1). Kharchia showed highest increase in K^+ and Ca^+ content (27.5 and 14.30 mg g^{-1} F.wt, respectively) and lesser change in shoot Na^+ content (3.0 mg g^{-1} F.wt). Hence it had a higher K/Na ratio of 8.8 and 9.1 at 1 and 3 min respectively. In moti a marginal increase in shoot K^+ and Ca^{2+} content was seen at 1 min but it decreased later, whereas the Na^+ content increased suddenly, thus it had a very low K/Na ratio of 3.9 and 3.2 at 1 min and 3 min respectively.

Figure 1 shows the change in amplitude of shoot EP on addition of different concentrations of NaCl in the root zone. The change in EP is proportional to the concentration of NaCl. At 100 mM NaCl the change in amplitude of EP and its speed was less compared to the addition of 500 and 1000 mM NaCl wherein the change in EP rises sharply and then begins to level off. This response is a typical variation potential essentially similar to that found in *Lycopersicon* with either heat or wounding[8], wheat leaves with wounding[9] and pea seedlings upon stem exicision[10].

An interesting observation recorded in this study was the change in amplitude of EP and its speed on addition of NaCl between a salinity-tolerant and salinity-sensitive variety of wheat. While addition of NaCl produced less noticeable change of EP in the salinity-tolerant variety kharchia, the amplitude of EP rose sharply and then gradually levelled off in the salinity-sensitive variety moti. Shoot ionic content measured 1 and 3 min after application of NaCl showed that the K^+ and Ca^{2+} content had suddenly increased in kharchia, while moti had higher Na^+ content. This is in conformity with earlier reports that salinity-tolerant varieties transport less sodium from roots to shoots than salt-sensitive genotypes[11]. Thus, kharchia had higher K/Na ratio compared to moti. Similar results were reported earlier in other crops[12]. Thus it is clear that the variation seen in uptake of ions between the wheat varieties under salinity had caused a change in shoot surface EP. It is a preliminary observation and needs to be seen in other crops before generalizing it as a tool for rapid screening of genotypes for salinity tolerance.

1. Fromm, J., *Physiol. Plant.*, 1991, **83**, 529–533.
2. Bose, J. C., *The Nervous Mechanisms of Plants*, Longmans, Green and Co., London, 1926, pp. 123–134.
3. Coleman, H. A., *J. Membr. Biol.*, 1986, **83**, 55–61.
4. Greenway, H., *Aust. J. Biol. Sci.*, 1962, **15**, 39–57.
5. Picciurro, G. and Brunetti, N., *Agrochimica*, 1969, **13**, 347–357.
6. Hebbar, K. B., Kumar, S. and Sinha, S. K., *Curr. Sci.*, 1994, **66**, 936–938.
7. Chapman, D. and Pratt, P. F., in *Methods of Analysis for Soils, Plants and Waters*, Univ. of California, 1961.
8. Van Sambeek, J. W. and Pickard, B. G., *Can. J. Bot.*, 1976, **54**, 2642–2650.
9. Malone, M. and Stankovic, B., *Plant Cell Environ.*, 1991, **14**, 431–436.
10. Stalberg, R. and Cosgrove, D. J., *Planta*, 1992, **187**, 523–531.
11. Albert, R. P., *Oecologia*, 1977, **27**, 157–170.
12. Davis, R. F., in *Membrane Transport in Plants* (eds Kram, W. J., Janacek, K., Rybova, R. and Sigler, K.), John Wiley and Sons, New York, 1984, pp. 489–490.

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Boron isotopic composition in early solar system solids

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Abundance and isotopic composition of boron (B) are determined in refractory silicate phases from the primitive carbonaceous chondrite Efremovka using an ion microprobe. These refractory phases represent some of the earliest solids to condense from the solar nebula. All the analysed phases (anorthite, melilite and fassaite) have very low B content ranging from 0.1 to 1.3 ppm; anorthite has relatively higher B content than melilite and fassaite. The measured values of the $^{11}B/^{10}B$ ratio in anorthite grains are similar and indistinguishable from the normal ratio of 4.04558 within experimental uncertainties. This is at variance with the reported large magnitude B isotopic anomalies within individual meteoritic chondrules[1] whose formation in the nebula postdates refractory silicates. Although B isotopes could have been homogenized during the formation of refractory phases, plausibility considerations suggest that our data are consistent with a uniform distribution of B isotopes of normal composition in the solar nebula.

THE light elements Li, Be and B are not produced in primordial nucleosynthesis, with the sole exception of ^7Li. They are also destroyed by proton-induced reactions during stellar nucleosynthesis at temperatures of two to

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