ABSTRACT

A study was carried out for standardizing the static magnetic field and duration for maximum enhancement in germination characteristics of seeds of different chemical constituents. The effects of the standardized magnetic field exposure of seeds on field emergence, shoot and root characteristics, quality changes during accelerating ageing were studied. Biophysical and biochemical characterization of magnetically treated seeds were also undertaken to elucidate the mechanism of magnetic field enhancement during germination and storage. Maize (Var. Ganga Safed-2), chickpea (Var. Pusa 1053) and sunflower (Var. KBSH-1) were used as the experimental material and magnetic field exposure was done using the electromagnetic field generator "Testron EM-20" with variable magnetic field strength (50 to 500mT). The seeds were exposed to different magnetic fields of strength from 0 to 250mT in steps of 50mT for different duration from 1 hour to 4 hour in steps of 1 hour for all fields. Initial experiments were conducted to standardize magnetic field and duration for maximum enhancement in germination of maize, chickpea and sunflower. Results indicate that magnetic field application enhanced the seed performance in terms of laboratory germination, speed of germination, seedling length and seedling dry weight significantly compared to unexposed control. But the response varied with field strength and duration of exposure without any particular trend. Among the various combinations of field strength and duration best results were obtained with 100mT(2h) and 200mT(1h) in maize with 50mT(2h), 100mT(1h) and 150mT(2h) in chickpea and with 50mT, 200mT and 250mT for 2h exposure in sunflower. Exposure of seeds to these magnetic fields improved seed coat membrane integrity as it reduced the cellular leakage electrical conductivity. In the field, seeds exposed to these treatments showed increased field emergence and significantly increased seedling dry weights of one-month-old plants. The root characteristics of the plants showed dramatic increase in root length, root surface area and root volume. In chickpea there was increase in the number of branches from the magnetically treated seeds.

During artificial ageing magnetically treated seeds had lower leachate conductivity than unexposed control. Age induced reductions in seedling dry weight, shoot /root length, vigour I, vigour II of magnetically exposed seeds were lower than

unexposed control seeds. Magnetic treatment on aged seeds of maize, chickpea and sunflower improved the germination characteristics over aged control. Seeds exposed to different magnetic field strength maintained higher activity of antioxidant enzymes in aged seed as compared to unexposed control. The magnetically exposed seed had higher protein after ageing than unexposed aged seeds. In steady hydration phase III, the magnetically exposed seeds had higher value of spin–lattice relaxation time (T_1) and spin–spin relaxation time (T_2) than unexposed control seeds in all three crops. Proton NMR spin-spin relaxation time (T_2) of magnetically exposed and unexposed control seeds showed two different fractions of slowly exchanging water in seed in the initial periods of imbibition. During the subsequent process of imbibition seed water proton could be classified into a three-component system and after sprouting water protons re-organised into two different fractions. In magnetically exposed seeds, the third component corresponding to hydration water appeared earlier than unexposed control seeds. α-Amylase, dehydrogenase and protease activities were significantly higher in magnetically exposed seeds as compared to unexposed control seeds during germination.

Equilibrating over different relative humidity, the germination characteristics of magnetically exposed seeds were higher than unexposed control. The leachate conductivity of the magnetically exposed seeds was lower than unexposed seeds at all relative humidities. Analyzing water sorption isotherms showed that magnetically exposed seeds had less strong and multimolecular binding sites and more weak binding sites as compared to the unexposed seeds. The germination characteristics were maximum corresponding to maximum negative differential enthalpy and entropy in all three crops.

Hence the exposure of seeds of maize, chickpea and sunflower to specific magnetic fields was found to enhance seedling growth and also reduce the seed deterioration during ageing. The improved functional root parameters suggested that the magnetically treated seeds could be used profitably under rainfed conditions. An increase in the number of branches from the magnetically treated chickpea seeds may be a good index to increase yield. The enhancement effect could be partly explained on the basis of cellular water distribution and activity of germination related and antioxidant enzymes.