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# Response to pre- sowing seed treatment on germination indices, seedling growth and enzymatic activities of chickpea (*Cicer arietinum* L.) seed

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**Abstract**
In the present investigation, two seed lot (one year old and freshly harvested) of chickpea variety PG 114 were treated with the strength of 100 and 200 mT (mili tesla) of magnetic field (MF) for one hour and for hydro-priming seeds were hydrated in tap water for 8 hours then dehydrated in shade upto original moisture content. Germination indices, seedling growth and enzymatic activities of treated chickpea seeds were evaluated along with untreated (control) seeds of both the old and freshly harvested seed lots. Germination indices and seedling growth were recorded significantly higher in seed treated with magnetic field of 100 mT while lowest increment was found in untreated seeds. Values of α amylase enzyme activity recorded in terms of mg of starch hydrolyzed per gram of seed were also significantly higher in magnetically seeds treated with 100 mT field for one hour. Seed invigoration treatments significantly improved membrane integrity over untreated seeds recorded in terms of electrical conductivity (EC) of seed leachates.

**Keywords:** chickpea, magnetic-field, seed germination, α amylase, electrical conductivity

## Introduction

Uniform crop establishment under favourable as well as in stress environmental conditions is significant pre- requisite for better yield. Crop seeds show resistance in germination due to low vigour, hard seed coat and abiotic stressed conditions (high temperature, lack or excess of moisture, soil salinity). Seeds also lose their viability and vigour during storage due to aging, storage conditions and post- harvest handlings. Aging is considered as natural occurrence and causes deterioration in seeds which ultimately reduce vigour of seed, germination per cent, seedling growth and yield of crop. High vigour seeds ensure high germination and proper growth of plant while low vigour seeds resulted in low germination along with abnormal seedlings. To overcome all these concerns, pre- sowing seed treatments also termed as seed priming, play imperative role in all kind of crops. Seed priming stimulates repairing of cell organelles, metabolism essential for germination and various antioxidant activities inside the seed [1]. One of the very traditional pre sowing seed treatment is hydro-priming which includes hydration of seeds in tap water for an ideal interval of time and dehydrated them back for further sowing. In hydro-priming seed imbibe adequate amount of water to initiate germination process but elude protrusion of radicle and plumule. Seeds are hydrated for a known interval which jerks metabolic actions inside the seed but dehydration after priming avert completion of germination. At the time of sowing this seed absorb moisture from substrate and results in quick and synchronized emergence. Hydro-priming reduces magnitude of germination failure and also strengthen vigour of feeble seeds. This conventional method significantly enhances activities of hydrolytic enzymes which brings breakdown of food material available in endosperm and deliver energy to the living embryo for further growth. Alterations in seed cell membrane integrity occur due to aging and storage which causes decline in viability and vigour of seed. Hydro-priming invigorate seeds through repair mechanism by creating oxidative stress. In this oxidative stress condition reactive oxygen species originates and synthesise catalase which diminish cell injury. On the other hand, activity of super oxide dismutase (SOD) also get heightened which reduce free radicles in cell. Catalase and SOD, both enzymes combindly protect cell membrane from damage due to adversative situations [2]. Hydro-priming consist of huge advantages in the area of seed germination, crop establishment and growth but it also possesses some drawbacks. Soaking of huge quantity of seed lot is practically tedious work and requires high amount of water. Dehydration of seed to the desirable moisture percentage is also difficult during hydro-priming.

So, some other advanced seed invigoration treatments are advisable for improving seed germination and seedling vigour of a crop. Among them, magnetic treatment is based on magnetic field (MF) which energizes seed and boosts its vigour under controlled condition of laboratory as well as on farm conditions. Magnetic field surrounds the earth and considered as unavoidable factor of environment. It remains present in low intensity and affects the whole eco system including plants. Change in intensity and frequency of MF around biological entities amend their physiological activities and growth pattern also. Exposure of seeds to magnetic field before sowing is termed as magneto-priming. Magneto- priming for seed invigoration is one of the safest methods in crop production system [3]. Magneto- priming reduces overall time of radicle and plumule emergence, expansion and successfully improves germination speed and plant stand, adaptability and tolerance of plant and ultimately yield of many field and cash crops. Improvement in growth of

seed is linked with innumerable modification in biochemical, cellular, and molecular events occurring inside the cell of seed [4]. Variations in seed surface structural properties were noticed due to exposure of seeds to magnetic field in comparison to untreated seeds. This change makes the seed surface eroded and makes it more efficient to absorb the water [5]. MF influences $Ca^{+2}$ ions entrenched in plasma membrane and increase access of calcium inside the cell [6]. This calcium plays a dynamic role in activation of many hydrolytic enzyme especially amylase. The greater activities of hydrolysing enzymes are associated with improved disruption of food material and accelerate seed germination. MF has been found to improve food mobilization efficiency of seed too. The consequences of magnetic treatment depend upon strength, length of exposure and crop species. Every crop seed respond in dissimilar pattern after exposing to magnetism. Optimization of treatment frequency and duration for better results in terms of improved germination, growth and vigour is compulsory.

Keeping all this in view, this investigation was conducted to find out impact of MF and hydro-priming on various physiological and biochemical seedling vigour parameters of chickpea and to evaluate the suitability of ancient as well as modern priming technique for enhancing viability and vigour of seed.

## Materials and methods

### Seed sample

Chickpea crop was chosen due to its higher nutritive value and greater consumption as a pulse. Two seed lots (one year old and freshly harvested) of chickpea variety PG 114 were acquired from Breeder Seed Production Centre of G. B. Pant University of Agriculture and Technology, Pantnagar. Seeds were visually scanned for physical impurity and pest damage. Four seed lots from each year harvest were arranged for magnetic treatment of 100 and 200 mT, hydro-priming and control.

### Treatment execution

### Magnetic field (MF)

Seeds were exposed to magnetic strength of 100 and 200 mT for 1 hour. The magnetic treatment to chickpea seeds was given at Physics laboratory, College of Basic Sciences and Humanities, G.B.Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. A machine named "omega electro- magnetic (input 0-4 Amp, output 7.5 kg gauss) was used to treat the seeds for different magnetic field and required durations. The coils used in equipment was having diameter of 9 cm and the space of five cm was there between two poles.

To measure the magnetic strength in the middle of both poles digital gauss meter was used. Nisco electro- magnet power supply machine was used to supply current which create magnetic field between the poles for mandatory duration. For producing magnetic field of 100 and 200 mT, 2.1 and 3.8 Amp current of 23 and 42 volt respectively were delivered. A unit of $10^{-4}$ gauss measure one tesla strength. The strength of magnetic field among the poles was determined before treatment.

### Hydro-priming

Chickpea seeds were immersed in $HgCl_2$ solution to remove physical impurities like dust particles. After ten minutes seeds were cleaned with normal tap water and dried back. Seeds of chickpea were soaked in the ratio of 1:2 (seed: water ratio) for 12 hours at 20 ºC and then dried in shade upto original moisture content was achieved. After the exposure of seeds to the treatments seeds were packed in polyline cloth bags for further studies.

### Physiological studies

### Germination test

Treated and untreated seeds were placed on two layers of moist germination papers to measure various physiological seedling vigour parameters of chickpea. Each set of germination paper contained hundred seeds. These seeds were covered with another sheet of moist germination paper. Before placing, seeds were treated with thiram @2.5g/kg of seed to control surface borne fungi. Then it was rolled and fastened with rubber band. Seed germination was calculated according to the rules of ISTA [7]. The rolled towel paper samples were kept in an incubator in upright position maintained at 20 ±2 °C temperature for germination. The samples were evaluated after 8 days of incubation. The germination percentage was considered on the basis of given formula:

$$\text{Germination percentage } (\%) = \frac{\textit{Number of normal seedlings}}{\textit{Total number of seeds placed}} \times 100$$

### Speed of germination

Speed of germination was calculated by using following formula as suggested by Manguire (1962) [8].

$$\text{Speed of germination} = £ \frac{n}{di}$$

Where, n = number of newly germinated seeds on day di,
di= $i^{th}$ day after incubation

### Time taken to 50% germination ($T_{50}$)

It was analysed according to Dezfuli *et al.* (2008) [9].

Where,

N = Total germinated seeds

Ni and nj = cumulative no. of seeds germinated next to times ti and tj.

### Radicle and plumule length

For recording radicle and plumule lengths, the normal seedlings of germination test were used. Five normal seedlings were indiscriminately selected from the sample and then radicle and plumule of the seedlings were separated. Thereafter, the length of radicle and plumule (cm) of the individual seedling was measured and averaged them and seedling size was also calculated by adding radicle and plumule length and expressed in cm/seedling.

### Seedling vigour index (SVI)

It was calculated according to Abdul-Baki and Anderson (1973) [10]

$$\text{SVI I} = \text{Germination percentage} \times \text{seedling size}$$

$$\textit{SVI II} = \textit{Germination percentage} \times \textit{radicle and coleoptile dry weight}$$

**Biochemical studies**

**Electrical conductivity (EC)**

After the harvesting, seed loses their viability and vigour in storage due to improper place of storage, high moisture and storage pest. Integrity of plasma membrane gives an indirect indication of seed age, vigour and seed health. In low vigour seeds, deterioration of plasma membrane results in outflow of components of cell from seed when saturated with water which is also characterized as seed leachates. In contrast, high vigour seeds have firm membrane and create less efflux of cell constituents. The analysis of EC of seed leachates gives an accurate estimation of membrane permeability. EC of the seed leachates was measured to know the cell membrane stability of treated as well as untreated seeds. For this purpose, treated and untreated chickpea seeds of about three gram from each year seed lot were taken and surface sterilized for 5 minutes $H_gCl_2$ solution. Then seeds were carefully washed with distilled water for 2-3 times. The seed samples were dipped in 50 ml of distilled water at 25 °C temperature for 12 hours. After 12 hours, the seeds were kept out from the water with the help of forcep. The solution left in the beaker (leachates) was tested for its electrical conductivity with the help of an electrical conductivity meter. The values were expressed as dSm/m/g of seed [11].

**Dehydrogenase enzyme activity**

Dehydrogenase enzyme activity was estimated according to Kittock and Law [12]. Ten seeds from each treatment were soaked in water for 16 hours. After removing the testa, the seeds then dipped in 0.5% solution of tetrazolium for 3 hours at room temperature (25 ± 2 $^0$C). Then the seeds were dipped in 10 ml of methyl cellosolve for 2 hours. After removing the seeds from methyl cellosolve the optical density of solution were measured at 480 nm wave length with the help of spectrophotometer. The data was expressed as OD/10 seeds.

**α- amylase activity**

Activity of α-amylase in chickpea seeds was determined according to Majumdar and Majumdar [13]. Substrate i.e. starch was used for investigating α-amylase activity of seed in a particular time. The enzyme causes degradation of starch by hydrolyzing 1, 4 linkages which is reacted with iodine to give rise to blue coloured complex. The intensity of the colour is then measured in a spectrophotometer and compared with a starch standard curve.

**Proteases activity**

Activity of protease enzyme in chickpea seeds was determined according to Majumdar and Majumdar [13] through enzyme incubation with the substrate protein for a particular span of time. The enzyme releases amino acids which react with the Folin and Ciocalteu's phenol reagent and give rise to blue coloured complex. The intensity of colouration is then measured by spectrophotometer and compared with a standard curve to determine the amount of released amino acids which is proportional to the activity of the enzyme.

**Results**

**Impact of pre-sowing seed treatment on physiological seedling vigour activities**

Under the laboratory condition it was found that, MF 100mT contributed highest germination 97.0% and 95.5 % under both old and fresh seed lot, respectively. Increment was 13.4% and 6.1% in seeds treated with 100 mT magnetic field while higher field of 200 mT did not trigger the germination of chickpea seeds significantly over untreated seeds. On the other hand, hydroprimed seeds showed 4.1% and 6.1% higher germination in old and fresh seeds respectively over untreated seeds. In the same way old seeds treated with MF of 100 mT took 3.2 days to complete 50% germination through germination of 12.6 seedlings/day while new seed lot treated with same intensity took only 2.5 days for 50% germination through sprouting of 15.9 seedlings/day. Magnetically treated old seeds showed 17.8% and new seeds resulted in 30.3% faster seedling emergence in comparison to untreated seeds. All the treatments used in this particular experiment (magnetic field 100, 200 mT, Hydro-priming), the radicle and plumule of treated seeds were elongated higher over untreated seeds. Highest increment in radicle length was obtained in magnetically treated seeds with 100 mT (8.1 cm/seedling) in old seed lot which was not statistically different than other treatments except untreated seeds whereas in new seeds same treatment performed outstandingly in comparison to other treatments with the radicle length of 8.4 cm/seedling. Alternatively, highest value of plumule length was recorded in hydropriming technique (2.5 cm/seedling) in old seed lot and recorded statistically comparable with remaining treatments except control while in new seeds increment was non-significant in all the treatments. In case of radicle & plumule length, lowest addition was attained in untreated seeds (control).

Hydro-priming considered advantageous due to bringing in advancement of reactions inside the cell and leading to germination. Repairing of cell organelles and biochemical activities boost up inside the seeds. Faster biochemical actions rapidly construct metabolites responsible for germination and quick restoring of cell components at the time of seed hydration encourages speedy germination and enhanced seedling vigour. On the other hand magnetic strength energizes seeds through activating ions inserted in plasma membrane which activates various enzymes and stimulates metabolic activity of seed. This stimulation consequences rapid sprouting of seeds, protrusion of radicle and plumule and higher final germination percentage.

One of the best methods to quantify vigour of seedling is through the analysis of seedling vigour index. On one hand, SVI I gives indication of germination and growth of seedling through germination per cent and seedling length while SVI II advocates about the robustness of seedling via germination percentage and seedling dry weight. During this experiment it was observed that old seeds treated with 100 mT of magnetic strength resulted in highest SVI I (882) due to more germination percentage and longer seedlings but the difference was non-significant in new seed lot. One year old seeds showed 45.9% while freshly harvested seeds recorded 33.4% higher SVI II when treated with MF of 100 mT over control. Pre sowing seed priming competently improve germination and growth of seedlings under in situ condition and resulted in superior development in comparison to untreated seeds.

**Impact of pre sowing seed treatment on biochemical seedling vigour activities**

Biochemical seeding vigour activities like electrical conductivity (EC) of seed leachates, activity of dehydrogenase, α amylase and protease enzymes of chickpea seeds were also analysed after the exposure from magnetic field and hydro-priming. Results indicated that EC of seed leachates significantly reduces in case of treated seeds in both the year seed lot over control. Lowest value in old and fresh seeds was recorded in MF 100 mT technique (0.097 & 0.098 dSm/m/g respectively) which was 59.8% and 42.8% lower than untreated seeds. Untreated seeds showed highest electrical conductivity in both the years. This estimation of EC shows membrane permeability and integrity of plasma membrane. Pre sowing seed priming techniques successfully enhance quality of seeds through keeping cell membrane intact. Similar kind of trend was detected in the activity of dehydrogenase enzyme which is an indicator of aliveness of embryo in seeds. Activity of this particular enzyme determined by tetrazolium test and highest value was observed in seeds treated with MF of 100 mT in old (0.248 OD/10 seeds) as well as in fresh seeds (0.267 OD/10 seeds). Every seed priming technique performed superbly and significantly higher than control. Fresh seeds resulted in more dehydrogenase activity over old seeds due to high vigour and less aging. Hydroprimed seeds also showed 37.9% & 22.2% more dehydrogenase activity than control in old and new seeds respectively.

Results indicated that α amylase activity of old and fresh seeds notably influenced by both the intensities of MF and hydro-priming. The highest activity was recorded in seeds treated with MF of 100 mT in old (18.37 mg of starch hydrolysed /g of seed) and fresh seeds (19.0 mg of starch hydrolysed /g of seed) while lowest activity was found in old untreated seeds (9.85 mg of starch hydrolysed /g of seed). All the exposure priming techniques performed significantly higher than control. Magnetic field exposer of 200mT reduced amylase activity which suggested that optimization of magnetic field strength for every crop is necessary for better results. Same trend of increment was recorded in protease activity of chickpea seeds. Highest value of activity was recorded in old seeds treated with MF of 100 mT (12.38mg of protein hydrolysed/g of seed) while old untreated seeds (8.23 mg of protein hydrolysed/g of seed) resulted in lowest activity. Freshly harvested magnetically treated chickpea seeds showed increment over untreated seeds. Greater enzyme activity was reflected during germination of seeds. With the higher activity of these hydrolytic enzymes in hydroprimed seeds, took lesser time to germinate over untreated seeds.

**Discussions**

**Magnetic field and Hydro-priming impact on physiological seedling vigour activities**

Seed germination and seedling growth are multifaceted process. It gets affected by many factors and it can also influenced through magnetic field as well as hydro-priming in numerous ways: by altering seed surface structure, enhancing water uptake rate, breakdown of endosperm's food through higher hydrolytic enzyme activity, oxidative stress during priming process which accelerate overall development of seedling. The results obtained from this laboratory experiment showed that both the priming treatments (magnetic field treatment of 100 and 200 mT, hydro-priming) have positive impact on germination and growth of chickpea. In case of germination activity, recorded observations indicate that the exposure of seeds to magnetic field 100 mT considerably enhanced final germination count in comparison to untreated seed. It was reported that magnetic field of 16 Hz and 50 Hz had no effect on germination on spring wheat and spring triticale at 20 $^0$C temperature while at 5 $^0$C seeds of both the crops treated with 16 Hz and 50 Hz resulted in significantly higher germination over control [14]. The inner energy of the seeds responds positively when there is an appropriate combination of treatment strength and exposure time [15]. Germination was counted daily till 8 days and magnetically treated seeds germinated rapidly in comparison to control. These results are lined with the observations of Florez *et al.*, in case of maize in which seeds treated with magnetic field emerged quickly than untreated seeds [16]. Higher and quicker germination in magnetically treated seeds was associated with altered hydrolytic enzymes activity inside the seed which leads to uniform germination [17]. Quick germination was also noticed under hydroprimed seeds which took almost 15.0% less time than control. Increased germination rate in hydroprimed seeds have been attributed due to quick metabolic repair during imbibition through seed and build-up of germination – enhancing metabolites [18].

In case of growth parameters, length of radicle varied significantly among the all treatments but plumule length showed non-significant increment in fresh seed lot. Magnetically treated seeds showed 4-11% increase in radicle length in old seed lot while hydroprimed seeds resulted in 15% more length over control. In the same way magnetically treated seeds showed 27-12% enhancement in radicle length in new seeds while hydroprimed seeds resulted in 7.8% increment. The magnetic field enhances seedling growth parameters of wheat significantly than untreated seeds [19]. Increment in shoot lengths was also reported in wheat and rice crop [20-21]. In case of plumule length 50-57% improvement was observed than control. Improved growth of seedling may be due to the proper breakdown of reserve food material and translocation of energy to the growing parts of seeds. Magnetically treated seed with 100 mT and Hydro-priming resulted in significantly higher seedling dry weight, SVI I and II. Mridha and Nagarajan found out the positive impact of static magnetic field exposure on chickpea seed. They reported that magnetic field of 100 mT for one hour of duration enhanced seedling dry weight upto 46%, SVI I upto 48% and SVI II upto 58% over control [22]. In the same way pre sowing Hydro-priming effect on seedling vigour characteristics has been reported earlier in numerous crops [23-26].Robustness of seedling reflected higher dry mass of seedling and vigour index.

**Magnetic field and Hydro-priming impact on biochemical seedling vigour activities**

Electrical conductivity of seed leachates gives good indication of seed quality. Pre sowing seed treatments enhanced seed quality in terms of maintaining cell membrane integrity and less leakage of cell components. Seeds treated with hydro-priming and magnetic strength considerably reduced leakage through cell membrane while on the other hand untreated seeds showed higher leakage in old and new both seed lots. Reduced electrical conductivity of seed leachates in hydro primed cowpea seeds was reported in comparison to untreated seeds [27]. Low electrical conductivity may be due to a less loss of plasma membrane

integrity due to hydration in hydro-priming. Low electrical conductivity in hydro primed sunflower seeds was recorded due to increment in soluble proteins and protein binding in membranes enhances membrane firmness [28]. In case of other biochemical parameters *viz*. dehydrogenase, α amylase and protease enzyme highest activity was recorded in seeds treated with magneto-priming and also registered statistically higher enzymes activities over untreated seeds. Magnetically treated sunflower seeds with the strength of 50 to 250 mT resulted in 43%, 27% and 22% higher α-amylase, dehydrogenase and protease enzyme activity respectively than untreated seeds [3]. Results of increased hydrolytic and amylolytic enzyme activities due to pre sowing magnetic treatment were also reported in case of moong, maize and faba bean [29, 31]. It may be due to the modification in seed surface properties and quicker water uptake through magnetically treated seeds over control. The impact of increased enzyme activities reflects in rapid germination of treated seeds. Lower dose of magnetic treatment (100 mT) trigger greater activities, quick reduction in reserve food material and rapid germination of seed while high dose (200 mT) found inadequate to boost physiological and biochemical actions inside the chickpea seed.

Higher amylase activity was observed in hydro primed rice seeds in comparison to control which leads to significantly greater germination [32]. Similar results were also recorded in wheat and cowpea [33, 27].

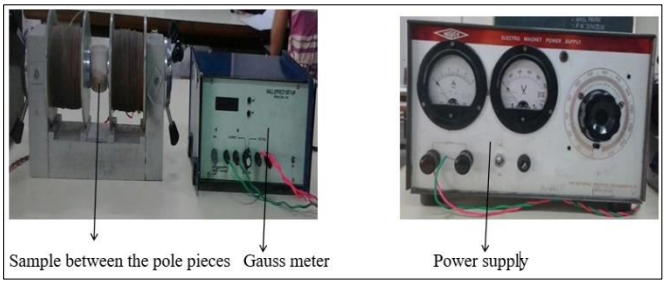


**Fig 1:** Experimental set up for creating static magnetic field.

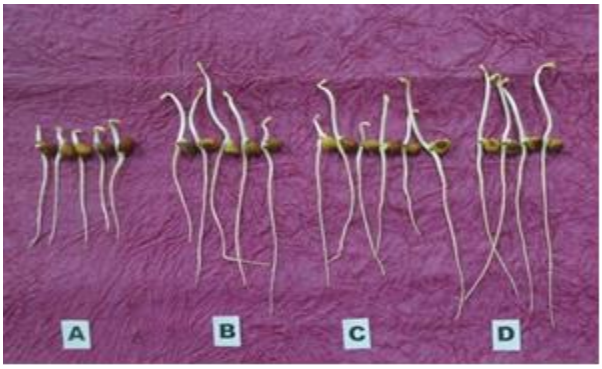


**Fig 2:** Impact of different seed priming (A) Untreated (B) Magnetic field 200 mT (C) 100 mT (D) Hydro-priming on seedling vigour of chickpea

**Table 1:** Effect of various pre sowing seed priming treatments on seedling vigour parameters of chickpea

| Treatments | Germination percentage (%) | | Time taken to 50% germination (days) | | Speed of emergence (seedlings/day) | | Radicle length (cm) | | Plumule length (cm) | | Seedling vigour index I | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Old | New | Old | New | Old | New | Old | New | Old | New | Old | New |
| Untreated | 85.5 | 90.0 | 3.7 | 3.4 | 10.7 | 12.2 | 7.3 | 6.6 | 1.4 | 1.8 | 767 | 776 |
| Hydro-priming | 89.0 | 95.5 | 3.3 | 3.2 | 12.3 | 15.0 | 8.1 | 7.1 | 2.5 | 2.4 | 842 | 852 |
| MF 100 mT (1 hour) | 97.0 | 95.5 | 3.2 | 2.5 | 12.6 | 15.9 | 8.1 | 8.4 | 2.2 | 2.3 | 882 | 890 |
| MF 200 mT (1 hour) | 90.5 | 92.0 | 3.2 | 2.9 | 11.6 | 13.2 | 7.6 | 7.4 | 2.1 | 2.3 | 829 | 844 |
| SEm± | 2.4 | 1.2 | 0.1 | 0.1 | 0.32 | 0.8 | 0.2 | 0.3 | 0.2 | 0.2 | 21 | 53 |
| CD at 5% | 7.7 | 3.9 | 0.3 | 0.4 | 1.0 | 2.6 | 0.6 | 0.9 | 0.7 | NS | 68 | NS |

**Table 2: Effect of various pre sowing seed priming treatments on physiological and seedling vigour parameters of chickpea**

| Treatments | Seedling vigour index II | | Electrical conductivity (dSm/m/g) | | Dehydrogenase activity (OD/10 seeds) | | α amylase activity (mg of starch hydrolysed /g of seed) | | Protease activity (mg of protein hydrolysed/g of seed) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Old | New | Old | New | Old | New | Old | New | Old | New |
| Untreated | 860 | 953 | 0.155 | 0.140 | 0.169 | 0.194 | 9.85 | 10.92 | 8.23 | 9.36 |
| Hydro-priming | 998 | 987 | 0.149 | 0.124 | 0.223 | 0.237 | 14.09 | 14.35 | 10.04 | 10.46 |
| MF 100 mT (1 hour) | 1255 | 1272 | 0.097 | 0.098 | 0.248 | 0.267 | 18.37 | 19.03 | 12.38 | 12.07 |
| MF 200 mT (1 hour) | 943 | 1191 | 0.117 | 0.121 | 0.230 | 0.246 | 17.47 | 17.15 | 10.27 | 10.07 |
| SEm± | 59 | 135 | 0.006 | 0.006 | 0.013 | 0.012 | 0.85 | 0.80 | 0.62 | 0.49 |
| CD at 5% | 185 | 43 | 0.019 | 0.019 | 0.042 | 0.038 | 2.83 | 2.67 | 2.07 | 1.63 |

## Conclusion

Hydro-priming is considered as one of the ancient priming technique while magneto priming is modernized technique to improve quality of seed. From the above findings it can be summarized that both the treatments are beneficial for enhancing germination, seedling vigour and enzyme activities of seed. In the present study Hydro-priming and magnetic treatment seems to improve seed quality parameters under laboratory condition. As hydro-priming is a low cost well established seed enhancement technology. Highly significant improvement in seed quality parameters was observed with hydro-primed seeds. Treating seeds with 100 mT for 1 hour was also found suitable for improving germination and seedling vigour parameters over untreated seeds. However, the strength and duration of magnetic treatment vary crop to crop and further investigation is required for standardization.

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