SEED INVIGORATION TREATMENTS FOR IMPROVED GERMINABILITY AND FIELD PERFORMANCE OF GRAM (CICER ARIETINUM L.)

N. Layek, B.K. De, S.K. Mishra and A.K. Mandal*

Department of Seed Science and Technology, Institute of Agricultural Science, 35 Ballygunge Circular Road, Kolkata 700 019, India

ABSTRACT

Pre-storage dry seed invigoration treatments of freshly harvested gram (Cicer arietinum L.) with chemicals (common bleaching powder at 2 g/kg of seed; calcium carbonate at 3 g/kg of seed and iodinated calcium carbonate at 3 g/kg of seed), pharmaceutical formulation (aspirin at 50 mg/kg of seed) and crude plant materials (finely powered dry red chilli fruit, at 1 g/kg of seed) showed significantly improved post-storage germinability as well as field performance of the resultant crop over untreated control. Among the dry treatments, bleaching powder, aspirin and red chilli powder has shown better results in improving storability and field performance of gram seeds. But pre-storage wet treatments did not show any improvement on germinability and field performance over control, probably due to soaking injury in harvest fresh (high-vigour) seed. On the basis of the result, dry treatments in high-vigour gram seeds with bleaching powder @2 g/kg of seed, aspirin @50 mg/kg of seed and red chilli powder @1 g/kg of seed are suggested for improved storability and field performance of gram.

INTRODUCTION

Availability of good quality seed is the key of successful agriculture and their use is an important factor in the production of higher yield. Unfortunately seeds used in Indian agriculture are not up to the mark in respect of physiological standpoint. According to Banerjee (1984), less than 15% of our fields are covered by quality seeds and the remaining areas are covered by seeds which do not have any form of quality control.

Maintenance of vigour and viability of gram (Cicer arietinum L.) seeds are a serious problem in the hot and humid climate in many parts of our country, particularly, in eastern India. Thorough sun drying followed by storage in sealed containers in controlled storage conditions have been recommended for the preservation of orthodox crop seeds. Usually small and marginal farmers store their seeds in gunny bags or cloth bags. During monsoon months these seeds absorb a lot of moisture from the surrounding atmosphere which coupled with high temperature and harden the ageing process of the seed and as a result the vigour and viability of stored seeds reduce significantly and finally reflected on yield. Besides, high moisture seeds are susceptible to fungal attack and storage microflora (Grewal and Kapoor, 1966).

Mid-storage hydration-dehydration treatments are very much effective in slowing down seed deterioration during subsequent storage (Basu, 1994; Kundu and Basu, 1981; Mandal and Basu, 1983). In leguminous seeds, soaking-drying treatment is not advocated because of soaking injury. But modified hydration-dehydration treatments such as moisture-equilibration soaking-drying or moist-sand conditioning-drying or moist-sand conditioning-soaking-drying would overcome the problem of soaking injury in leguminous seeds (Saha and Basu, 1984; Saha et al., 1990). Moreover, there is a problem of drying back the bulk quantities of seeds to its safe limits of moisture contents under sun during monsoon months and non availability of costly artificial drying facilities.

In order to overcome the same, dry-dressing treatment of high-vigour or high-
medium-vigour seeds of leguminous and non-leguminous crops with halogenated compounds like bleaching powder, iodinated calcium carbonate have been attempted by earlier researchers in the present laboratory (Mandal and Basu, 1986; Mandal et al., 2000). Besides, a number of crude plant materials (neem leaf powder, red chilli powder, turmeric rhizome powder, Vinca leaf powder, Trigonella seed powder etc.) and pharmaceutical formulations (aspirin, celin, ibucon) have been found very effective for the maintenance of vigour, viability and productivity of wheat, black gram, soybean and okra seeds (De et al., 1998; 2003; Mandal et al., 1999; 2000 and Kapri et al., 2003).

Therefore standardization of suitable inexpensive pre-storage dry seed invigoration treatments will be more useful to our farmers and seed growers to improve the germinability and field performance of gram seeds.

**MATERIAL AND METHODS**

Harvest-fresh seeds of Bengal gram (cv. Mahamaya-1) were cleaned and thoroughly dried under the sun to a moisture content of 8.8% were used for this study.

Pre-storage treatments were given to one-month-old (high-vigour) seed with finely powered aspirin @ 50 mg/kg of seed, bleaching powder @ 2 g/kg of seed, iodinated calcium carbonate @ 3 g/kg of seed, calcium carbonate @ 3 g/kg of seed and red chilli powder @ 1 g/kg of seed following the method of Mandal and Basu (1986) and Mandal et al. (1999; 2000). Treated and untreated seeds were kept in rubber stoppered glass bottle at room temperature and the bottles were shaken once in a day up to 7 days for thorough mixing of chemicals, pharmaceuticals and crude plant materials with the seeds.

Wet treatments were given to gram seeds following the method of Basu (1976) and Saha and Basu (1984). It was given by three different ways.

i) **Soaking-drying (S-D):** Gram seeds (250 g) were soaked in double volume of distilled water for 2 hours at room temperature (29±1°C) with occasional stirring. After decanting off the excess water, the seeds were first surface dried with blotting papers and then dried in a drying cabinet over a current of dehumified air at 35±1°C for about 72 hours to get back the original moisture content (Mandal and Basu, 1983).

ii) **Moist-sand conditioning-drying (MSC-D):** Seeds were preconditioned by a slow and progressive rise in the moisture content which were achieved by keeping the seeds (250 g) in moist sand (sand : seed :: 3 : 1). For this purpose sand was sterilized with concentrated sulphuric acid to kill the microbes and then washed thoroughly and finally dried. Air-dry sand was moistened with water @ 7% (750 g sand + 52.5 ml water) at room temperature. Seeds were then thoroughly mixed with the moist sand and kept covered for 24 h at room temperature (29±1°C). After the stipulated period, seeds were sieved to remove the sand followed by drying in the cabinet over a current of dehumified at 35±1°C for about 72 hours.

iii) **Moist-sand conditioning followed by soaking-drying (MSC-S-D):** Seeds (250 g) were pre-conditioned with moist sand for 24 hours following the above noted method and then soaked in water for 2 h at room temperature (29±1°C) followed by drying to its original moisture content (Saha et al., 1990). After 15 days of treatment, all the treated and untreated seeds were subjected to natural ageing under ambient conditions (average relative humidity 92±3.2 % and temperature 30±1.6°C) for 70 days. For the purpose, treated and untreated seeds were stored in perforated paper packets (each packet with equal number of holes and containing equal amount of seeds) and then put into the cloth bag and kept in the laboratory self for natural ageing.

Germination test of the treated and
untreated seeds (minimum 400 seeds for each treatment as specified by ISTA, 1976) were carried out immediately after treatment (before ageing) and after 70 days natural ageing following the method of Punjabi and Basu (1982). Data on germination percentage and seedling length were recorded after germination for 7 days at 20±1°C temperature.

The field experiment was conducted in two consecutive seasons (2003-2004, 2004-2005). The treated and untreated gram seeds were sown in the field at Calcutta University Agricultural Experimental Farm at Baruipur, 24 Parganas (S), West Bengal using randomized block design with 3 replications for each treatment. After final land preparation, field was divided into 3 blocks and each containing 9 subplots measuring 10m² (4 m x 2.5m) in size. A fertilizer dose of N : P : K was given @ 20 : 50 : 20 kg/ha respectively. During final land preparation whole amount of nitrogen, phosphate and potassium were added as basal dose. Seeds were sown @ 55 kg/ha giving a spacing of 30 cm between the row and 10 cm between plants. The crop received a total of three irrigations; one at the same date of sowing, one at flowering stage and another at early pod filling stage and necessary cultural practices were done throughout the cropping period.

Data on field emergence percentage was recorded after 15 days of sowing. Plant height, yield per unit area and other yield attributes data viz., number of pods per plant, pod weight per plant, number of seed per pod, and 1000 seed weight were recorded replication wise for each treatment. The data obtained from laboratory germination test and field experiments were analysed statistically following the method of analysis of variance (Fisher, 1948). Data on germination percentage were transformed to their respective arc-sin angle prior to statistical analysis and seedling length data were analysed as such.

RESULTS AND DISCUSSIONS

Germination test carried out immediately after treatment, did not show any significant difference on vigour and viability between treated and untreated seeds (Table 1). Among the treatments, iodinated calcium carbonate, bleaching powder etc. showed marginal improvement on seedling length and vigour index over control. But after 70 days of natural ageing under ambient conditions, all the dry treatments significantly improved germination percentage and seedling length over control (Table 1). Among the treatments, bleaching powder, red chilli powder and iodinated calcium carbonate have shown better results in extending germinability over control. Seedling vigour as measured by root and shoot length of seedling as well as vigour index were also improved by all the dry treatments, especially with bleaching powder and iodinated calcium carbonate (Table 1). Pre-storage wet treatments viz., soaking-drying, moist-sand conditioning-drying, moist-sand conditioning-soaking-drying treatments did not show any significant improvement on germinability and seedling length over control (Table 1).

Field emergence percentage, grain yield per unit area and other yield attributes such as number of pods per plant, number of seeds per plant, pod weight per plant and 1000-seed weight were significantly increased by most of the dry treatments over control (Table 2). Among the dry treatments, bleaching powder and aspirin showed better result in improving yield and other yield attributes over control (Table 2). But pre-storage wet treatments (viz., soaking-drying, moist-sand conditioning-drying and moist-sand conditioning-soaking-drying) did not show any improvement on field performance and productivity of over control (Table 2), probably due to soaking injury in harvest fresh seed.

Regarding the mode of action of crude plant materials and pharmaceutical formulations,
Table 1. Effect of pre-storage seed invigoration treatments on vigour and viability of gram seeds before and after natural ageing under ambient conditions for 70 days (average 92±3.2 % RH and temperature 30±1.6°C)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Before ageing</th>
<th>Natural ageing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Germination (%)</td>
<td>Seedling length (mm)</td>
</tr>
<tr>
<td></td>
<td>Arc-sin value</td>
<td>Arc-sin value</td>
</tr>
<tr>
<td>Control</td>
<td>93</td>
<td>74.7</td>
</tr>
<tr>
<td>Aspirin</td>
<td>95</td>
<td>77.1</td>
</tr>
<tr>
<td>Bleaching powder</td>
<td>97</td>
<td>80.0</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>96</td>
<td>78.5</td>
</tr>
<tr>
<td>Iodinated calcium carbonate</td>
<td>97</td>
<td>80.0</td>
</tr>
<tr>
<td>Red chilli powder</td>
<td>97</td>
<td>80.0</td>
</tr>
<tr>
<td>S-D</td>
<td>91</td>
<td>72.5</td>
</tr>
<tr>
<td>MSC-D</td>
<td>95</td>
<td>77.1</td>
</tr>
<tr>
<td>MSC-S-D</td>
<td>91</td>
<td>72.5</td>
</tr>
<tr>
<td>L.S.D at 0.05P</td>
<td>-</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Vigour index = Germination % x Seedling length

Abbreviations:
S-D : Soaking-drying;
MSC-D : Moist-sand conditioning-drying;
MSC-S-D : Moist-sand conditioning-soaking-drying.

Table 2. Effect of pre-storage seed invigoration treatments on field performance and productivity of gram seed

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Field emergence (%)</th>
<th>Plant height (cm)</th>
<th>No. of pods/ plant</th>
<th>Pod weight/ plant</th>
<th>No. of seed/ plant</th>
<th>Grain yield (g/m²)</th>
<th>1000-grain weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>80</td>
<td>49.7</td>
<td>17</td>
<td>4.9</td>
<td>20</td>
<td>147</td>
<td>142.9</td>
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<tr>
<td>Aspirin</td>
<td>88</td>
<td>53.7</td>
<td>20</td>
<td>8.0</td>
<td>26</td>
<td>155</td>
<td>143.7</td>
</tr>
<tr>
<td>Bleaching powder</td>
<td>88</td>
<td>50.5</td>
<td>26</td>
<td>9.2</td>
<td>32</td>
<td>159</td>
<td>144.8</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>83</td>
<td>57.9</td>
<td>18</td>
<td>5.6</td>
<td>21</td>
<td>149</td>
<td>143.6</td>
</tr>
<tr>
<td>Iodinated calcium carbonate</td>
<td>85</td>
<td>54.7</td>
<td>20</td>
<td>6.2</td>
<td>21</td>
<td>153</td>
<td>142.9</td>
</tr>
<tr>
<td>Red chilli powder</td>
<td>87</td>
<td>49.6</td>
<td>22</td>
<td>7.6</td>
<td>23</td>
<td>154</td>
<td>143.2</td>
</tr>
<tr>
<td>S-D</td>
<td>80</td>
<td>49.9</td>
<td>17</td>
<td>4.3</td>
<td>17</td>
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<td>140.4</td>
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<td>55.2</td>
<td>18</td>
<td>4.9</td>
<td>20</td>
<td>145</td>
<td>142.7</td>
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<td>MSC-S-D</td>
<td>82</td>
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<td>18</td>
<td>5.0</td>
<td>19</td>
<td>146</td>
<td>142.4</td>
</tr>
<tr>
<td>L.S.D. at 0.05P</td>
<td>1.7</td>
<td>NS</td>
<td>1.1</td>
<td>1.3</td>
<td>1.6</td>
<td>3.0</td>
<td>1.1</td>
</tr>
</tbody>
</table>

we are still not in a position to elucidate the beneficial effects on the viability maintenance. Capsaicin an active ingredient of red chilli powder is an inhibitor of lipid peroxidation (Brand et al., 1990; Dey and Ghosh, 1993). So far studies have been made in the present laboratory, the effects of natural plant preparations have been basically physiological in nature because volatile aldehyde productions was lower in treated seeds (Pal and Basu, 1994; De et al., 1998; Mandal et al., 2000). They have also suggested that protein protective role of acetyl salicylic acid (aspirin) may also be operative in viability maintenance in the same fashion. Recently, Takaki and Rosim (2000) have reported that aspirin application to Raphanus sativus L. seed would increase the tolerance to high temperature and synchronized seed germination. Basu and Rudrapal (1980) suggested the role of iodine.
in the stabilization of double bonds of unsaturated fatty acid moieties and the lipoprotein membranes as a possible reason for viability extension, besides the possibility of iodine acting as a free radical controlling agent (Pryor and Lasswell, 1975). The role of chlorine (bleaching powder, a source of chlorine) would be more or less similar.

Whatever may be the exact mechanism of action of the pre-storage dry treatments on viability maintenance, bleaching powder @ 2 g/kg of seed, aspirin @ 50 mg/kg of seed and red chilli powder @ 1 g/kg of seed are suggested for the maintenance of germinability and field performance of high vigour gram (Cicer arietinum L) seeds.

ACKNOWLEDGEMENT

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REFERENCES