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# Effect of Seed Priming of *Toria (Brassica napus* L Var. Napus L.) on Drought Tolerance and its Yield Performance

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**ABSTRACT:** A field experiment was conducted during the *rabi* seasons of 2010, 2011 and 2012 at the experimental farm of All India Coordinated Research Project for Dryland Agriculture at Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali to find out suitable pre-sowing treatment for drought tolerance and its effect on growth and yield of *toria.* Treatments consisted of 8 soaking medium viz. Water soaked ($S_1$), 0.1% KOH ($S_2$), Vermiwash ($S_3$), 1% KCl ($S_4$), 1% $KH_2PO_4$ ($S_5$), 1% NaCl ($S_6$), Diathane M-45 ($S_7$) and Dry seed ($S_8$) as control in a randomized block design (RBD) with 3 replications. Required quantities of seeds were soaked in respective chemical solutions for 10 hours followed by drying in shade to almost its original weight. From the pooled data of three years, it was found that growth and yield attributes showed significant differences due to various priming treatments. The highest grain yield of 9.10 q/ha was obtained with 1% $KH_2PO_4$ treated seed which was 27.84% higher over dry sowing. This was closely followed by 8.72 q/ha with 0.1% KOH and 8.48 q/ha with 1% NaCl. It was also observed that the growth and yield attributes *viz.,* plant population, plant height and number of siliqua/plant differed significantly highest being in 1% $KH_2PO_4$. The pooled data recorded the highest test weight (2.92g) and rain water use efficiency (59.52 kg/ha/mm) under 1% $KH_2PO_4$ treated seed. The highest net return and B:C ratio were also recorded in 1% $KH_2PO_4$ with the values ₹ 8067/ha and 1.58, respectively.

**Key words:** Pre-sowing seed treatment, *Toria,* water, chemical solutions, vermin wash, RWUE, drought tolerance

Toria, (*Brassica napus* L., var, *napus* L. sensu stricto: *syn B.campestris* L. var *toria)*, is the most popular oilseed crop grown during *rabi* season under rainfed upland situation of Assam. Moisture stress at the time of sowing and also during its crop growth periods, light textured soils with low water retention capacity and low fertility status are some of the common problems encountered by farmers resulting in low and unstable yield (Srinivasarao *et al.* 2013). Optimum plant stand establishment and subsequent maintenance of its growth and development are the key factors for getting assured yield under these conditions. Seed priming is known for decreasing the time necessary for seed germination, subsequent emergence and improving stand uniformity under moisture stress conditions (Ana and Kent, 1992: Sedghi *et al*. 2010., Harris *et al.* 2001).

Several investigations confirmed that seed priming has many benefits including early and rapid emergence, stand establishment, higher water use efficiency, deeper roots, increasing in root growth, uniformity in emergence, germination in wide range of temperature, break of seed dormancy, initiation of reproductive organs, better competition with weed, early flowering and maturity, resistance to environmental stresses like drought and salinity. It is the most important physiological seed enhancement method. Seed priming helped in increasing hydration level within the seeds which is required for germination and metabolic activity but radical emergence is prevented. The most important priming treatments are halo priming and hydro priming. Halo priming is a pre-sowing soaking of seeds in salt solutions, which enhances germination and seedling emergence uniformly under adverse environmental conditions. Hydro priming involved soaking of seed in water before sowing. Seed priming is a traditional practice in agriculture to improve plant establishment for centuries. Researchers have also showed that priming of seeds with different salts is one of the methods for inducing drought tolerance in crop plants (Chinoy *et al*. 1970). Harris *et al*. 1999 reported that seed priming increases yield of chickpea and other rainfed crops. Under limited soil moisture, better results in terms of germination, vigour and drought tolerance were obtained by treating the seeds of Indian mustard (Ghosh *et al*. 1986), *toria* (Paul *et al.* 1995), sesamum (Chatterjee *et al,* 1985) and lentil var. Khajura-2 (Neupane *et al*. 2002) before sowing. Therefore, keeping these in view, an experiment was carried out at the experimental field of All India Coordinated Research Project for Dryland Agriculture (AICRPDA), Biswanath College of Agriculture, Assam Agricultural University, Biswanath to find out suitable seed priming agent for increasing drought tolerance and its effect on growth and yield of *toria* under rainfed condition of Assam and also to determine the rain water use efficiency (RWUE).

## Materials and Methods

The present study was conducted at the experimental farm of AICRPDA at Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali during *rabi* seasons of 2010, 2011 and 2012. The soil was sandy loam with organic carbon 0.53%, $P^H$ 5.05, available N, $P_2O_5$ and $K_2O$ were 385.7, 40.0 and 259 kg/ha, respectively. The experiment consisted of eight (soaking) treatments *viz.* Water soaked ($S_1$), 0.1% KOH ($S_2$), Vermiwash ($S_3$), 1% KCl ($S_4$), 1% $KH_2PO_4$ ($S_5$), 1% NaCl ($S_6$), Diathane M-45 ($S_7$), Dry seed ($S_8$). The experiment was laid out in a randomized block design with 3 replications. The *toria* 'TS-36' variety was sown at a row spacing of 30 cm on 26.10.2010, 01.11.2011 and 10.11.2012 during 2010, 2011 and

2012, respectively. The crops were fertilized uniformly with recommended dose of 40 kg N, 35 kg $P_2O_5$ and 15 kg $K_2O$/ha along with Borax 10 kg/ha. The cultural operations were carried out as and when required as per state's package of practices. Observations on growth and yield attributes (plant height, number of silique per plant, branches/plant and test weight), grain yields and benefit-cost ratio were recorded and analyzed statistically. The RWUE was calculated by dividing the grain yield (kg/ha) with cumulative rainfall (mm) from sowing to harvest and this indicates yield attained by a treatment per millimeter of rainwater received during the study period. Since there is no irrigation to the crop other than rain water, RWUE would also indicate the water productivity or water use efficiency of a treatment under rainfed condition (Sharma *et al.* 2013). The total rainfall received during the cropping periods of 2010, 2011 and 2012 were 68.4 mm, 66.6 mm and 5.6 mm, respectively and its weekly distribution pattern is presented in Table 1.

**Table 1 : Rainfall distribution(mm) pattern during cropping periods of *toria* in 2010, 2011 and 2012**

| Standard meteorological week | Rainfall (mm) | | |
|---|---|---|---|
| | 2010 | 2011 | 2012 |
| 40 | 8.6 | 0 | 0 |
| 41 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 |
| 43 | 0 | 16.6 | 0 |
| 44 | 0 | 0 | 0 |
| 45 | 24.8 | 5.6 | 0 |
| 46 | 4.4 | 14.8 | 0 |
| 47 | 1 | 0 | 0 |
| 48 | 0 | 0 | 0 |
| 49 | 0 | 0 | 0 |
| 50 | 0 | 0 | 0 |
| 51 | 0 | 0 | 5.6 |
| 52 | 0 | 0 | 0 |
| 1 | 29.6 | 2.8 | 0 |
| 2 | 0 | 19.8 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 0 | 7 | 0 |
| 5 | 0 | 0 | 0 |
| Total | 68.4 | 66.6 | 5.6 |

## Results and Discussion

### Effect on Growth and Yield Attributing Characters

Growth and yield attributes *viz.,* plant population/m$^2$, plant height, siliqua/plant and test weights were influenced by seed priming treatments in all the years of experimentation and also when pooled (Table 2). The pooled data indicated that the plant population and siliqua/plant was maximum in case of seed treated with $S_5$ i.e.1% $KH_2PO_4$ indicating better efficiency of the treatment over other treatments. Miraj *et al.* 2013 reported higher yield and yield attributes of maize due to seed priming with 1% $KH_2PO_4$. From the pooled data it was observed that plant height differed significantly amongst treatments and recorded maximum value in $S_3$ (vermiwash) 104 cm but, it was at par with 1% $KH_2PO_4$ (102 cm), 0.1% KOH (98 cm) and Diathane M-45 (94 cm). The siliqua/plant was differed statistically in all the years and on pooled, registering highest value in 1% $KH_2PO_4$ (119/plant) and significantly superior over rest of the treatments. Test weight (g) was found non significant in all the three years i.e., 2010, 2011 and 2012 of experimentation. This may be due to the fact that test weight cannot be changed easily by treatment within a short span of time. However, pooled data of three years

**Table 2 : Growth and yield attributes as influenced by seed priming treatments**

| Treatment | Plant population/ m$^2$ | | | | Plant height (cm) | | | | Siliqua/plant | | | | Test weight(g) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | Pooled | 2010 | 2011 | 2012 | Pooled | 2010 | 2011 | 2012 | Pooled | 2010 | 2011 | 2012 | Pooled |
| $S_1$ –Water Soaked | 68 | 74 | 71 | 71 | 98 | 87 | 85 | 90 | 103 | 79 | 78 | 87 | 2.69 | 2.01 | 2.04 | 2.25 |
| $S_2$- 0.1% KOH | 65 | 73 | 74 | 70 | 99 | 98 | 97 | 98 | 98 | 77 | 80 | 85 | 2.70 | 1.85 | 1.83 | 1.93 |
| $S_3$- Vermiwash | 69 | 68 | 64 | 67 | 99 | 107 | 105 | 104 | 108 | 109 | 107 | 108 | 2.75 | 2.04 | 2.05 | 2.28 |
| $S_4$- 1% KCl | 67 | 72 | 69 | 69 | 92 | 95 | 93 | 93 | 108 | 100 | 101 | 103 | 2.84 | 2.15 | 2.12 | 2.37 |
| $S_5$- 1% $KH_2PO_4$ | 71 | 79 | 73 | 74 | 91 | 109 | 107 | 102 | 118 | 118 | 120 | 119 | 2.95 | 2.89 | 2.91 | 2.92 |
| $S_6$-1% NaCl | 69 | 67 | 62 | 66 | 97 | 84 | 80 | 87 | 100 | 103 | 105 | 103 | 2.88 | 2.70 | 2.75 | 2.78 |
| $S_7$-Diathane M-45 | 63 | 70 | 68 | 67 | 99 | 91 | 89 | 94 | 112 | 98 | 102 | 104 | 2.78 | 2.81 | 2.83 | 2.81 |
| $S_8$- Dry seed | 64 | 74 | 69 | 69 | 94 | 83 | 79 | 85 | 107 | 111 | 109 | 109 | 2.70 | 2.35 | 2.45 | 2.50 |
| CD (P=0.05) | 2.0 | 3.2 | 2.9 | 5.1 | NS | 6.1 | 5.4 | 11 | 4.0 | 2.3 | 2.4 | 7.0 | NS | NS | NSNS | 0.31 |

recorded significant variations among treatments and the highest test weight of 2.92 g was found in 1% $KH_2PO_4$ and this was at par with $S_7$ (Diathane M 45) 2.81 g and $S_6$ (1% NaCl) 2.78 g. The higher values of growth and yield attributes due to seed priming with 1% $KH_2PO_4$ was also recorded in sesamun (Chatterjee *et al.,* 1985) and mustard (Ghosh *et al.,* 1986).

**Effect on grain yield**

Significant differences among the treatments were recorded during 2012 and also when pooled (Table 3 and Figure 1). The pooled data indicated that the 1% $KH_2PO_4$ treated seeds ($S_5$) recorded the highest grain yield of 9.10 q/ha which was significantly superior to rest of the treatments. The grain yields due to treatments during 2010 and 2011 were non-significant, which might be due to sufficient soil moisture for seed germination at the time of sowing and due to rainfall immediately after sowing leading to nullifying the effect of treatments. However, in contrast the grain yield during 2012 was significant due to treatments, which might be attributed due to limited soil moisture and very less amount of rainfall received during the period leading to significant treatmental effect. The percent increase in grain yield over dry seeding was significant in all the years and pooled data recorded highest increase of 27.84% in 1% $KH_2PO_4$ and lowest value in Diathane M-45 (4.57%) followed by 1% KCl soaked treatments (8.08%). The higher grain yield due to seed priming with treatments 1% $KH_2PO_4$ might be attributed to significantly greater values of yield attributing characters (plant population/m$^2$, siliqua/plant and test weight) and higher RWUE. Demir and Venter (1999) and Sallam (1999) found that priming of seeds with $KH_2PO_4$ and other inorganic salts resulted in advanced metabolic processes and higher germination percentage leading to more plant population, faster growth, ultimate crop yield for most crops.

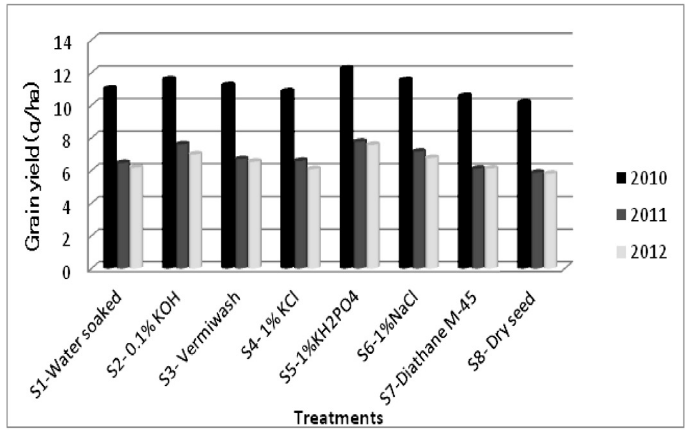


**Fig. 1 : Effect of different seed priming treatments on grain yield of toria, (TS-36)**

Potassium treated seed have higher K concentrations, and K is known to control water relation by impacting stomatal movement under water stress conditions. Optimum K nutrition in many rainfed crops through various means of its supply (seed priming, soil application and foliar sprays) showed positive impacts in mitigating mid-season droughts (Srinivasarao *et al.* 1999;1994). Further, 1% $KH_2PO_4$ might have produced the ability of drought tolerance to *toria* seed during the growing season which in turn, produced positive effects on yield and yield attributes. Harris *et al*. (1999) reported that seed priming with $KH_2PO_4$ attributed drought tolerance, reduce pest damage and increase crop yield. These might be due to more efficiency in utilization of available starch due to seed priming. These results are also in conformity with the findings of Paul *et al.* (1999) in rapeseed and mustard, Miraj *et al*. in maize (2013) and Arjunan and Srinivasan (1989) in groundnut.

**Table 3 : Yield and rainwater use efficiency (RWUE) as influenced by seed priming treatments**

| Treatment | Grain yield (q/ha) | | | | % Increase in yield (over dry sowing) | | | | RWUE (kg/ha/mm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | Pooled | 2010 | 2011 | 2012 | Pooled | 2010 | 2011 | 2012 | Pooled |
| $S_1$- Water Soaked | 11.00 | 6.45 | 6.16 | 7.78 | 8.35 | 10.25 | 6.40 | 8.38 | 18.2 | 19.4 | 109 | 48.87 |
| $S_2$- 0.1% KOH | 11.58 | 7.59 | 6.98 | 8.72 | 14.06 | 33.33 | 20.55 | 22.65 | 19.2 | 22.8 | 125 | 55.66 |
| $S_3$- Vermiwash | 11.22 | 6.69 | 6.53 | 8.15 | 10.52 | 14.35 | 12.78 | 12.55 | 18.6 | 20.1 | 116 | 51.56 |
| $S_4$- 1% KCl | 10.84 | 6.58 | 6.08 | 7.83 | 6.77 | 12.47 | 5.00 | 8.08 | 17.9 | 19.8 | 109 | 48.91 |
| $S_5$-1% $KH_2PO_4$ | 12.23 | 7.75 | 7.56 | 9.10 | 20.49 | 32.47 | 30.57 | 27.84 | 20.2 | 23.3 | 135 | 59.52 |
| $S_6$-1% NaCl | 11.52 | 7.15 | 6.76 | 8.48 | 13.47 | 22.22 | 16.75 | 17.48 | 19.1 | 19.8 | 121 | 53.00 |
| $S_7$-Diathane M-45 | 10.55 | 6.10 | 6.11 | 7.59 | 3.90 | 4.27 | 5.53 | 4.57 | 17.5 | 18.3 | 109 | 48.26 |
| $S_8$- Dry seed | 10.15 | 5.85 | 5.79 | 7.26 | _ | _ | _ | _ | 16.8 | 17.6 | 103 | 45.80 |
| CD (P=0.05) | NS | NS | 0.49 | 0.23 | 0.21 | 1.38 | 0.07 | 6.62 | 0.22 | 0.39 | 4.26 | 9.30 |

### Effect on rain water use efficiency (kg/ha/mm)

The rain water use efficiency (RWUE) was significantly differed during all the years of experimentation and also on pooled analysis (Table 3). During 2012, the overall RWUE was more than 2010 and 2011 which was due to very less amount of rainfall indicating better efficiency of seed priming treatments. Comparatively lower RWUE during 2010 and 2011 was due to higher rainfall received during the seasons. From the pooled data, the highest RWUE (59.52 kg/ha/mm) was found in 1% $KH_2PO_4$ which was statistically superior over $S_1$, $S_4$, $S_7$ and $S_8$ and the lowest RWUE (45.80 kg/ha/mm) was recorded by dry sowing. As the soil K status was medium and with meagre amount of K application, seed priming with $KH_2PO_4$ affected the RWUE positively. Higher water use efficiency and grain yield due to seed priming over no priming was reported by Ali *et al.* (2013) on late sown wheat.

### Effect on Economics

The highest net return of ₹ 14,316/-, ₹ 5,174/- and ₹ 4,709/ha was recorded by 1% $KH_2PO_4$ ($S_5$) during 2010, 2011 and 2012, respectively, with a mean value of ₹ 8,067/ha but, the lowest was noticed in control i.e. dry seed (Table 4). On an average, the higher net returns during 2010 was due to the higher grain yields received during that period over 2011 and 2012. Similarly, seed priming with 1% $KH_2PO_4$ maintained higher values of benefit-cost ratios during all the years of experimentation being the highest mean of 1.58 and the lowest under dry seed (control). The economics of different seed priming treatments indicated that priming of seed is beneficial to get higher returns instead of dry sowing of seed. Higher net income and B: C ratio due to seed priming in maize was also recorded by Priya *et al.* (2011).

## Conclusion

From this study, it was inferred that seed priming with 1% $KH_2PO_4$ resulted highest grain yield (9.10 q/ha) of *toria* against the common dry sowing method yielding 7.26 q/ha. The study also indicated that primed seed with 1% $KH_2PO_4$ had better ability to thrive under drought situation.

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**Table 4 : Economics as influenced by seed priming treatments**

| Treatment | Total cost of cultivation (₹/ha) | Net returns (₹/ha) | | | | Benefit-cost ratio | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean (2010-12) | 2010 | 2011 | 2012 | Mean | 2010 | 2011 | 2012 | Mean |
| $S_1$-Water Soaked | 13638 | 11662 | 2164.5 | 1454 | 5094 | 1.85 | 1.15 | 1.11 | 1.37 |
| $S_2$-0.1% KOH | 13738 | 12896 | 4857.5 | 3363 | 7039 | 1.94 | 1.35 | 1.24 | 1.51 |
| $S_3$- Vermiwash | 14625 | 11181 | 1765.5 | 1374 | 4774 | 1.76 | 1.12 | 1.09 | 1.32 |
| $S_4$- 1% KCl | 13788 | 11144 | 2333.0 | 1108 | 4862 | 1.81 | 1.17 | 1.08 | 1.35 |
| $S_5$-1% $KH_2PO_4$ | 13813 | 14316 | 5174.5 | 4709 | 8067 | 2.04 | 1.37 | 1.34 | 1.58 |
| $S_6$-1% NaCl | 13720 | 12776 | 3797.5 | 2842 | 6472 | 1.93 | 1.28 | 1.21 | 1.47 |
| $S_7$-Diathane M-45 | 13763 | 10502 | 1182.00 | 1207 | 4297 | 1.76 | 1.08 | 1.09 | 1.31 |
| $S_8$- Dry seed | 13338 | 10007 | 994.50 | 852 | 3951 | 1.75 | 1.07 | 1.06 | 1.29 |

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