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Effect of hydro-priming duration on germination and seedling vigour of rice [*Oryza sativa* L.] cv. Prasad

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ABSTRACT

Poor seedling establishment is the major problem in direct seeded as well as in transplanted rice that affects the vigours crop stand and final yield. To obtain elite seedling alongwith better crop stand through seed priming may be an attractive economical and an eco-friendly approach. An investigation was carried out to find out the effect of hydro-priming duration on seed germination and seedling viogur in rice (Oryza sativa L.) For hydro-priming, seeds were soaked for 8, 16, 24, 32, 40, 48, 56, 64 and 72 h each treatment of 8 h interval in aerated tap water followed by drying to initial moisture content under shade and packaged in polythene bag for further use. All the seed treatments resulted in greater seed germination and seedling vigour as indicated by lower value of time to 50 percent germination (T_{50}) and mean germination time (MGT) while higher value of speed of germination, germination energy (GE), germination value (GV), peak value (PV), mean daily germination (MDG), germination index (GI) and relative growth index (RGI) for rice except seeds hydro-primed for 64 and 72 h. The seed germination and seedling vigour were increased as the hydro-priming duration increased up to 48 h and maximum vigour enhancement as depicted by lower T_{50} and MGT as well as higher GE, GV, PV, MDG, GI and RGI were noted in seeds hydro-primed for 48 h, which was followed by that of 40 h in all the parameters studied.

Key words: Duration, germination, hydro-priming, rice, vigour

Rice is one of the three most important food sources for more than one third of world's population. It is the grain that shaped the cultures, diets, and economies of billions of people in the world because its highest cultivation area and amount of production amongst crops and being mean source of calories for people, rice (*Oryza sativa* L.) is the most important staple food. For them, life without rice is simply unthinkable. It is arguably one of the most important cereals in the world feeding well in excess of 4 billion people and occupies a conspicuous position in the agro-based economy of India. Transplanting is the major method of rice cultivation in the world, in which nursery seedlings are raised and then transplanted into main fields. For decades, farmers in India have been using traditionally pre-germinated seeds for rice nursery sowing resulting in poor and delayed germination. Farmers generally transplant seedlings when it is 40 – 45 days old because of delayed emergence and slow growth rate. While, 30-day-old seedlings are considered ideal for transplanting as older seedling results in lower tillering capacity thus reducing the final yield. Sub-optimum plant population and uneven crop stand resulting from poor nursery seedlings are among the most important yield limiting factors in the traditional rice production system (Reddy, 2004).

Water uptake pattern is generally tri phasic with an initial rapid uptake known as imbibitions (phase I) followed by lag phase (phase II) and then the second rapid increase in water uptake resulting in radical emergence (phase III) (Bewley and Black, 1982). Seed priming is a process in which seeds are imbibed either in water or osmotic solution or a combination of solid matrix and water in specific proportions followed by drying before radical emergence. Hydro-priming is a special type of seed priming in which seeds are soaked in water and dried before sowing to accomplish seed hydration (Soon *et al.*, 2000). Soaking by submerging seeds in water can be performed with or without aeration (Thornton and Powell, 1992). Since water is not limited, seeds germinate if they are viable and non-dormant, so it also depending on the availability of oxygen and a suitable temperature. Therefore, the process must be arrested at a specific time in non controlled water uptake system to prevent the onset of phase III of germination. Seed vigour enhancement through priming treatments have proven to be very effective to achieve rapid and uniform seed germination of several vegetable species (Taylor *et al.*, 1998) and field crops including rice (Lee *et al.*, 1998). Hydro-priming is a very special, simple, economical and eco-friendly priming technique because only plain water is used. In an earlier study, hydro-priming in wheat for 24 h resulted in increased grain yield (Kahlon *et al.*, 1992). Hydro-priming increased the speed of seedling emergence along with field stand and plant growth in *Phaseolus vulgaris* (Kazem *et al.*, 2010). However, in contrast hydro-priming failed to improve germination in Common Kentucky blue grass seeds (Pill and Necker, 2001) but Basra *et al.*, (2002) found that wheat seeds responded to different pre-sowing seed treatments with hydro-priming for 48 h showing the maximum invigoration followed by 24 hrs.

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Although, a lot of works have been conducted on hydro-priming, results on the benefits associated with hydro-priming duration are missing and no comprehensive study has been made, although farmers have been adopted traditional soaking (8 to 72 h) before sowing the rice in nursery since decades. Therefore, the present investigation was executed to effect of hydro-priming duration on seedling vigour of rice (*Oryza sativa* L.) cv. Prasad.

MATERIALS AND METHODS

The study was carried out in the seed research laboratory of the Department of Seed Science and Technology, GBPUA&T, Hill Campus, Ranichauri, Tehri Garhwal, Uttarakhand, India. The seeds of rice cultivar Prasad were used for present investigation to know the effect of hydro-priming duration on rice (*Oryza sativa* L.) seed germination and seedling vigour. The initial seed moisture content was 9.5 (dry weight basis) per cent, determined by high temperature oven method at 139± 2^0C for 4 h (ISTA, 2003). For hydro-priming 250g weighed quantity of seeds was soaked in aerated tap water at 25 ± 2 °C for 8, 16, 24, 32, 40, 48, 56, 64 and 72 h followed by drying to initial moisture under shade. Dried primed seeds were packaged in polythene bag at room temperature 25 ± 2 °C for further use.

The experiment was laid out in Completely Radomized Design with four replications of each treatment. Hundred seeds of each replication of each treatment were placed separately in pre-sterilized Petri-dishes with two fold filter paper at the bottom. The Petri dishes were placed in an incubator at 25 °C. The germination was counted daily for 14th days. Standard germination per cent were recorded on 14th day as produced normal seedlings (ISTA, 1985). Speed of germination after the seed began to germinate they were checked daily at approximately the same time each day. Normal seedlings were removed from the test when they reached a predetermined size. This procedure was continued until all seed that were capable of producing a normal seedling had germinated. An index was computed for each treatment by dividing the number of normal seedling removed each day by the corresponding day of counting (Devagiri, 1998).

The time to 50% germination (T_{50}) was calculated according to the following formula of Coolbear *et al.*; (1984) modified by Farooq *et al.* (2005) as under:

$$(T_{50}) = ti + \frac{\left(\frac{N}{2}\right) - ni\,(tj - ti)}{nj - ni}$$

Where, N is the final number of germination and ni, nj cumulative number of seeds germinated by adjacent counts at time ti and tj when ni < n/2<nj.

Mean germination time (MGT) was calculated to the equation of Yousheng and Sziklai (1985) as under:

$$MGT = \frac{Dn}{n}$$

Where, n is the number of seeds which were germinated on a day D, and D is the number of days counted from the beginning of germination.

Germinative energy was calculated using the Paul (1972) method.

$$\text{Germinative energy} = \frac{\text{Germination before peak period including peak period}}{\text{Total number of seeds taken}}$$

Germinative value was calculated according the Djavanshir and Pourberk (1976) formula:

Germination value= Peak value x Mean daily germination

Peak value was calculated according to following formula:

$$\text{Peak value} = \frac{\text{Final germination}}{\text{No. of days to reach maximum germination}}$$

Greater germination in a shortest time is sign of vigour potential of any seed or seed lot that favors the higher mean daily germination (MDG) and was calculated according to following formula:

$$MDG = \frac{\text{Final germination percentage}}{\text{Total number of days}}$$

Brown and Mayer (1986) suggested total germination at two separate times i.e. at the end of experiment (final count) and at some other relevant time such as the first count to be more informative to compare the vigour differences among the varieties in rice. However, it is necessary to have a single index to compare the treatments and variety with respect to seedling vigour, proposed the following formula to estimate the relative growth index (RGI).

$$RGI = \frac{\text{No. of seed germinated at first count}}{\text{No. of seeds germinated at final count}} \times 100$$

Germination Index (GI) was calculated as described the formula by Association of Official Seed Analysts (1983) using the following formula:

$$GI = \frac{\text{No. of germinated seeds}}{\text{Days of first count}} + \frac{\text{No. of germinated seeds}}{\text{Days of final count}}$$

To determine the statistical difference between the treatments variance analysis and least significant difference (LSD= 0.05) were performed by following the method of Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

The analysis of variance of the laboratory data showed significant influence of hydro-priming duration on seedling vigour of rice except 72 hrs and 64 hrs. Speed of germination counted daily and the greater speed of germination index and standard germination per cent (22.62 and 87.77) was recorded for 48 hrs hydro-primed seeds followed by 40 hrs (21.56 and 86.75) respectively while, seeds subjected to the longer duration of hydro-priming showed negative effect on speed of germination index and standard germination, it is notices that lower value of speed of germination index and standard germination (8.55 and 49.25) was calculated for 72 hrs hydro-primed seeds (Fig. 1). The faster rate of germination index was obtained by soaking seeds in water, probably due to quick water uptake and earlier initiation of metabolic processes which determine radicle protrusion. Generally earlier germination might be due to higher synthesis of DNA, RNA and protein during priming. This result is conformity with the finding of Bray *et al.* (1989) in leek seeds. However, earlier germination indicated by lower value of T50 and MGT, the statistically lowest value of (3.60 and 4.42) days of T50 and MGT were found for 48 hrs hydro-primed seeds followed by 40 hrs (3.77 and 4.59) days respectively (Fig 2) while, control depicted more value of the T50 and MGT (4.79 and 5.87) days. However, greatest value (5.37 and 6.15) days of T50 and MGT were recorded when seeds subjected to longer duration of priming (72 hrs). Earlier and more uniform germination and emergence was observed in seed hydro-primed for 48 hrs followed by 40 h and it might be due to the attributed to increased metabolic activities in the hydro-primed seeds. These observations are lined with the observations of Basra *et al.* (2002).

Table 1: Effect of hydro-priming duration on seedling vigour of rice (*Oryza sativa* L.) cv. Prasad

Hydro-priming treatments	Speed of germination	Germination (%)	T_{50}	MGT	Germination energy	Germination value	Peak value	MDG	Germination index	RGI
8 hrs	14.47	73.00	4.71	5.82	0.41	76.09	14.60	5.21	12.46	56.22
16 hrs	15.33	74.50	4.52	5.66	0.45	85.06	16.01	5.31	12.91	60.43
24 hrs	16.71	77.25	4.33	5.27	0.42	95.83	17.37	5.51	13.89	65.37
32 hrs	18.75	81.75	4.13	4.92	0.43	113.34	19.30	5.83	14.93	69.72
40 hrs	21.56	86.75	3.77	4.59	0.49	134.33	21.68	6.19	16.14	72.91
48 hrs	22.62	87.75	3.60	4.42	0.53	137.40	21.93	6.26	16.46	75.52
56 hrs	14.06	69.00	4.53	5.51	0.43	67.93	13.80	4.92	12.16	63.03
64 hrs	10.77	55.00	4.71	5.73	0.31	43.75	11.00	3.92	09.51	57.73
72 hrs	08.55	49.25	5.37	6.15	0.20	34.64	9.85	3.51	08.17	42.23
Control	13.56	68.75	4.79	5.87	0.37	67.45	13.75	4.90	11.65	54.54
GM	**15.64**	**72.30**	**4.45**	**5.39**	**0.40**	**85.52**	**15.96**	**5.15**	**12.83**	**61.77**
LSD (0.05)	**0.37**	**2.03**	**0.12**	**0.14**	**0.63**	**9.55**	**1.58**	**0.14**	**0.29**	**3.10**
CV (%)	**1.67**	**1.94**	**1.93**	**1.82**	**10.74**	**7.73**	**6.88**	**1.95**	**1.60**	**3.47**

Seed priming may help in dormancy breakdown possibly by embryo development and/or leaching of emergence inhibitors during priming as a result the increased germination energy. The maximum germination energy (0.53) was calculated for 48 hrs hydro-primed seeds (Fig 3) whereas, 0.49 value was calculated for 40 hrs hydro-primed seeds while, minimum germination energy (0.20) calculated while seed subjected to 72 hrs hydro-priming. Similar results were also reported by Farooq *et al.* (2005) in rice seed. However, significant effect has been shown of hydro-priming duration on germination value and peak value (Fig 4), highest germination and peak value (137.40 and 21.93) was found for 48 hrs hydro-primed seeds while similar results were obtained for seed hydro primed for 40 hrs. However, priming duration increased from 56 hrs to 72 hrs had negative effects on germination and peak value as compared to unprimed control and the lowest germination value as well as peak value (33.64 and 9.85) were recorded for 72 hrs of hydro-primed seeds while, 67.45 and 13.75 values respectively were observed in non primed seeds (control). Germination is an enzymatic reaction and is strongly correlated with enzymatic activities present in the seed. Hydro-priming might be increased the enzymatic activities during seed germination and enhance seedling vigour as indicated by grater value of germination and peck value.

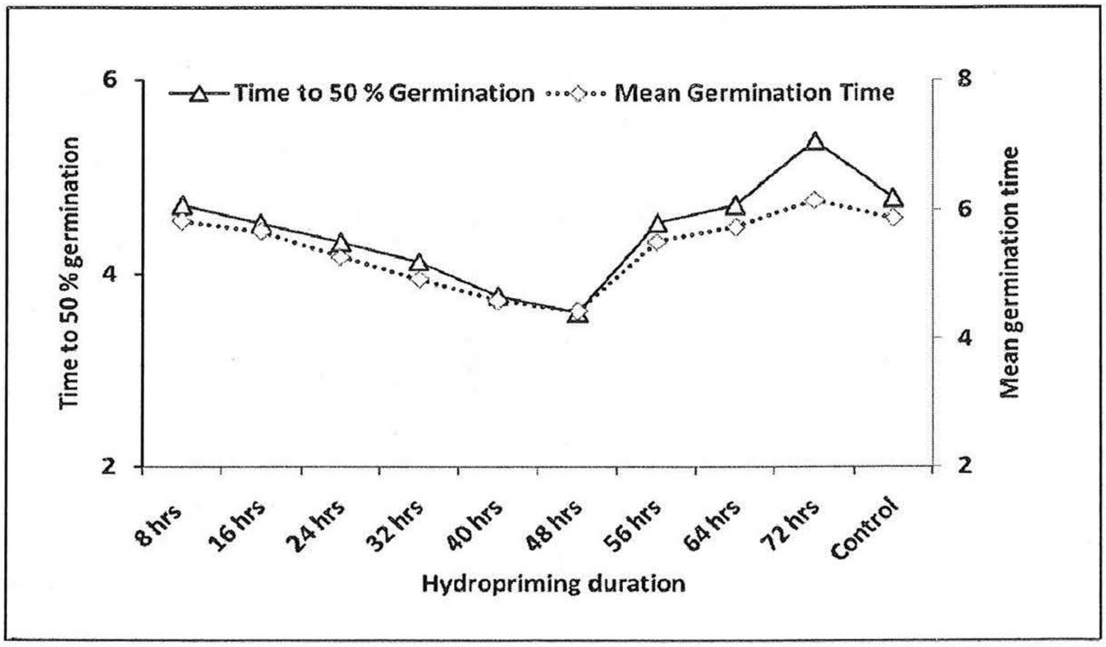

Fig. 1: Effect of hydro-priming duration on speed of germination and standard germination

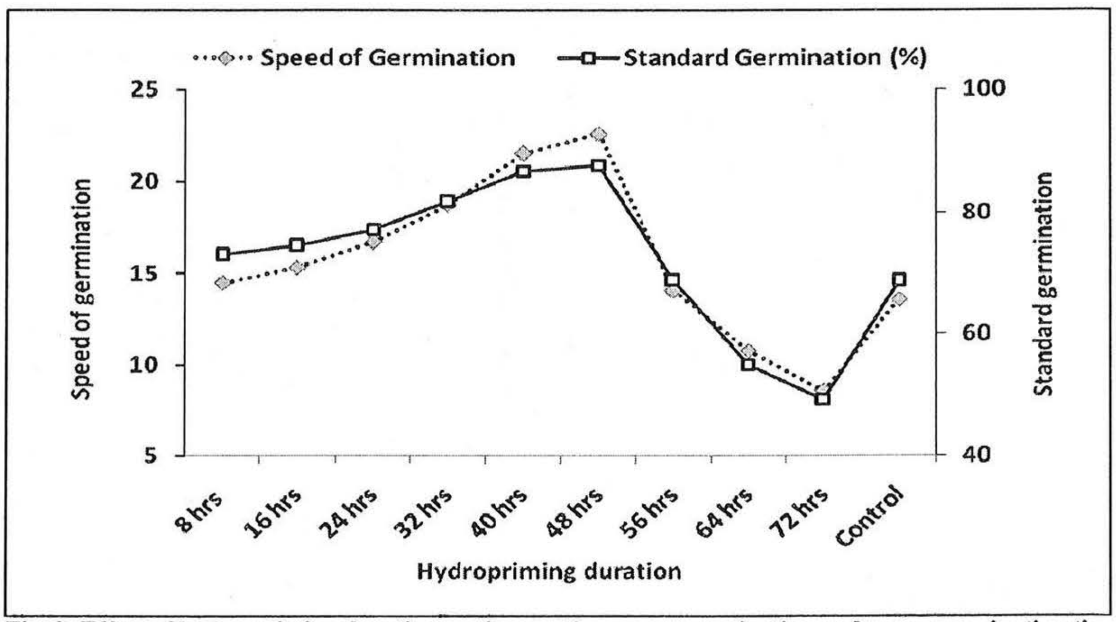

Fig. 2: Effect of hydro-priming duration on time to 50 per cent germination and mean germination time

Significant effect observed on mean daily germination (MDG), germination index (GI) and relative growth index (RGI) and it has been found that the maximum value (6.26, 16.46 and 75.52) of MDG, GI and RGI was calculated for seed hydro-primed for 48 hrs followed by 40 hrs primed seed (6.19, 16.14 and 72.91) respectively. Whereas, lowest value of MDG, GI and RGI (3.51, 8.17 and 43.23) were observed for unprimed seed i.e. control (Fig 5). Hydro-primed seeds have been shown beneficial effect on seedling vigour from 8 to 48 h and delayed and poor germination and higher germination time as indicated by highest value of T50 and MGT in seed subjecting to 56 to 72 hrs hydro-priming is probably due to over priming as a results decay were observed during investigation. Lee and Kim (2000) also reported that 60 hrs hydro-primed seeds showed delayed, poor germination and emergence of rice seeds.

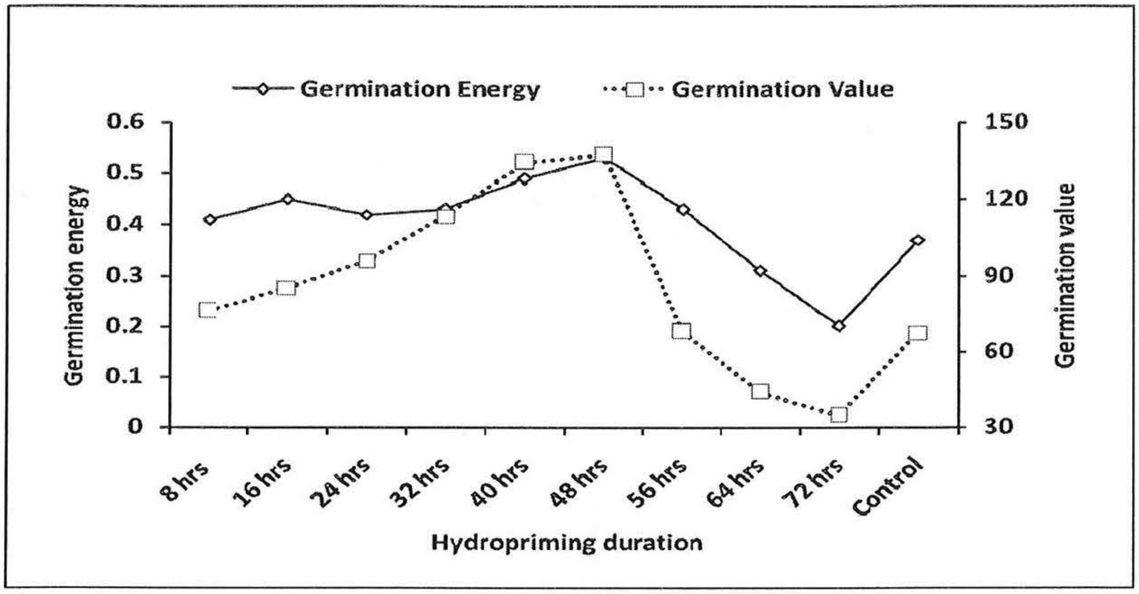

Fig. 3: Effect of hydro-priming duration on germination energy and germination value

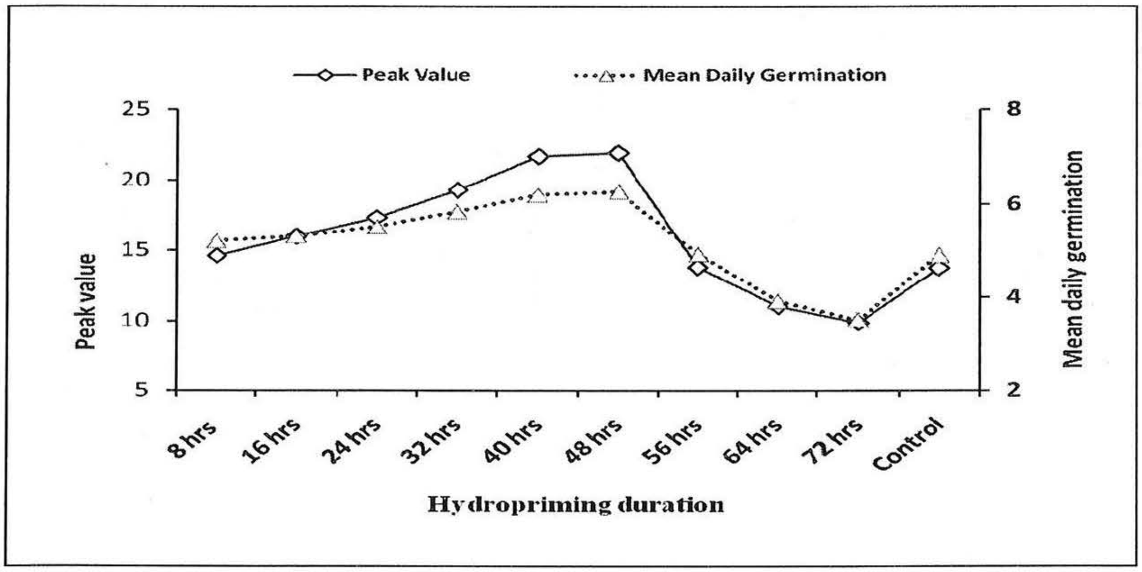

Fig. 4: Effect of hydro-priming duration on peak value and mean daily germination

Improved seed performance may be due to altered physiological condition of the embryo and it may be also due to libration of enzymes, thus rapidly increasing in the production of soluble food nutrients, the whole system is already in motion so that when the seeds are shown developmental processes go on more rapidly than in case of non primed seeds (Kattimani *et al.*, 1999). There are several indications that many physiological mechanisms are involved in seed priming, the repair of the age related cellular and sub cellular damage that could accumulated during seed development (Burgass and Powell, 1984) and an advancement of metabolic events the prolonged lag phase- II imbibition that repairs the radicle protrusion (Dell Aquilla and Beweley, 1989). Some morphological changes also occur in the primed seeds which are helpful in the later growth of embryo *e.g.* a portion of the seed endosperm is hydrolyzed during priming that permits faster embryo growth (Burgass and Powell, 1984).

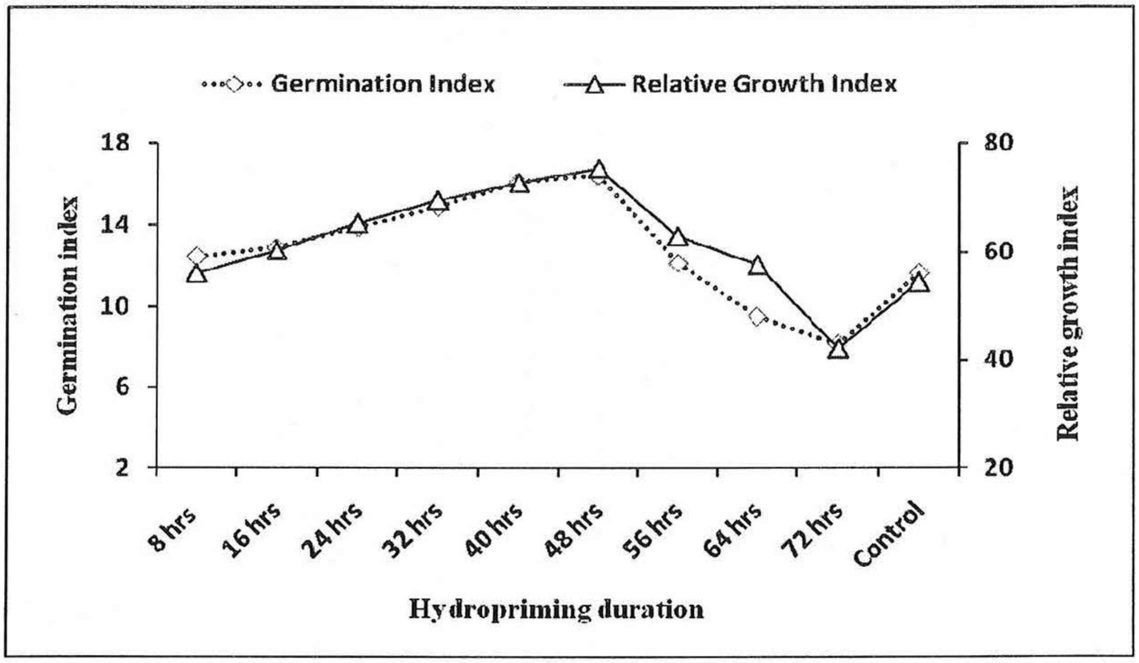

Fig. 5: Effect of hydro-priming duration on germination index and relative growth index

In conclusion, employing seed priming improved the seed germination and seedling growth. Hydro-priming in rice seed for 40 or 48 h was the most influencive duration for better seedling invigoration, while, 64 and 72 h hydro-priming exhibited for over priming.

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