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EFFECT OF CHEMICAL AND BIOLOGICAL SEED TREATMENTS ON GERMINATION PERFORMANCE OF GCH-7 HYBRID CASTOR (*RICINUS COMMUNIS* L.)

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ABSTRACT
In order to study chemical and biological seed treatments on germination performance of GCH-7 hybrid castor (Ricinus communis L.) an experiment was carried out during 2013 and 2014 in the laboratory facilities of Department of Seed Science and Technology, University of Agricultural Sciences Dharwad, Karnataka, India. Statistical analysis indicated seed priming with 2 per cent $CaCl_2$ solution significantly reduced mean germination time (5.16 and 5.17). Whereas, daily germination index (16.63 and 15.96), coefficient of velocity of germination (0.180 and 0.173), seed germination (94.14 and 94.33 %), seedling root length (16.00 and 16.98 cm), shoot length (13.36 and 14.17 cm), Seedling Vigour Index-I (2764 and 2938), seedling dry weight (174.7 and 176.7 mg) and Seedling Vigour Index -II (16448 and 16668) were significantly improved during both 2013 and 2014 years of experiment respectively, compared to the untreated seeds (7.31 and 7.32, 14.52 and 13.94, 0.137 and 0.132, 87.56 and 87.29 %, 14.58 and 15.71 cm, 11.48 and 12.28 cm, 2282 and 2443, 150.9 and 150.2 cm, 13282 and 13250 respectively), such improved seed germination performance is due to efficient repair of deteriorated seed parts in presence of Ca+ ion.

INTRODUCTION

The slow and irregular germination of castor (Ricinus communis L.) seeds is a seed technological problem, as it poses several disadvantages like reduced germination, attack of pathogenic microorganisms when seed absorbs moisture and sufficiently hydrated they becomes most sensitive to pathogenic microbes, weed competition at initial seedling growth is very serious problem due to slow seedling establishment and vulnerability to drought conditions, since castor seedlings show sluggish development after field emergence, particularly up to 20 to 30 days after sowing it is very sensitive period for healthy plant stand with appropriate plant population per unit area which is very essential for castor hybrid seed production.

This problem could be resolved by using those seed treatments which will enhance the physiological activity involved in seed germination, promote seedling development processes and protect the germinated seeds and seedlings from pathogenic micro organisms during critical growth period. Seed priming as one of the most important development to help rapid and uniform germination and emergence of seeds and to increase seed tolerance to adverse environmental conditions (Harries *et al.,* 1999). Seed priming is now a widely used commercial process that accelerates the germination rate and improves seedling uniformity in many corps (Halmer, 2003; Taylor and Harman, 1990)

Trichoderma species are effective in the control of soil/seed borne fungal diseases in several crop plants (Kubicek *et al.*, 2001, Selosse *et al.*, 2004 and Preston, 2004). Seed treated with Trichoderma spp. check the growth of fungal diseases and improve the seedling development. Trichoderma spp. has evolved multiple mechanisms resulting in improvement in plants resistant to diseases, plant growth and productivity (Harman *et al.,* 2004; Vinale *et al.,* 2008). Possible explanation of this phenomenon include: control of minor population of pathogens leading to stronger root growth (Yedidia *et al.,* 2001) and increasing nutrient uptake by secretion of plant growth regulatory factors such as phytohormones (Das *et al.,* 2014) and release of soil nutrients and minerals by saprophytic activity in soil (Ousley *et al.,* 1994). The increased growth response induced by Trichoderma sp. has been reported for many crops such as beans, cucumber, pepper, carnation, maize and wheat (Lo and Lin, 2002) as well as in yield of sorghum (Ganesh *et al.,* 2012).

It has been also reported that seeds treated with Carbendazim and thiram recorded significantly high emergence in castor (Marroni *et al.,* 2012) and in soybean (Chavan *et al.,* 2014) Further, the use of seed treatment with chemicals (Ammara *et al.,* 2000) and biological agents is a well known practice to

get healthy and vigorous plants under field conditions (Rai and Basu, 2014). This will also facilitate in getting uniform maturity of seeds, harvesting and post harvest handling operations apart from getting increased seed yield in castor (Mendes *et al.,* 2009).

Research investigations on effect of seed treatments with chemicals and biological agents on getting uniform germination and plant stand have not been carried out systematically in castor, since Castor (Ricinus communis L.) is one of the ancient and important oilseed crops of world wherein it occupies the fifth position after soybean, rapeseed mustard, ground nut and sunflower. Castor oil is distinguished from other vegetable oils due to its high specific gravity, thickness and hydroxyl value that makes it widely useful in the world as lubricant oil for locomotive bearings of heavy machineries (Wassell and Dittmer, 2006) and as a biodiesel (Hemant *et al.,* 2011) In view of its vast domestic and industrial applications, castor enjoys a tremendous demand in the domestic and world market. With this back ground a laboratory investigation was undertaken with an objective to evaluate the effect of chemical and biological seed treatments on germination performance of GCH-7 hybrid castor to study seed germination, speed of germination, seedling mortality rate, treatment effectiveness on disease incidences and field emergence.

MATERIALS AND METHODS

Effect of chemical and biological seed treatments on germination performance of GCH-7 hybrid castor (Ricinus communis L.) was studied during 2013 and 2014 in the laboratory facilities of department of Seed Science and Technology. University of Agricultural Sciences Dharwad, Karnataka, India with six seed treatments viz., T_1: Seed priming with 2.0 % $CaCl_2$ solution, T_2: Seed priming with 4.0 % $CaCl_2$ solution, T_3: Carbendazim @ 2 g/kg + Thiram @1.5 g/kg, T_4: Carbendazim @ 4.0 g/kg + Thiram @ 3.0 g/kg, T_5: Trichoderma Spp. @ 2.0 g/kg, T_6: Trichoderma Spp. @ 4.0 g/kg and a control (T_7: Untreated seeds) in the Completely Randomized Design (CRD) with four replications.

Seed priming with calcium chloride solution was carried out according to Malik *et al.* (2005) by overnight 12 hrs soaking of 1 kg seeds, using 2 and 4 per cent concentration of $CaCl_2$ solutions separately in two glass containers and then seed were dried back to original moisture content at room temperature.

For chemical seed treatment the method of Ganesh *et al.* (2012) was followed, one kilogram of seed sample was taken in a glass container and 2g Carbendazim + 1.5g Thiram was added, shaken manually to get a fine seed surface coating of chemicals. Similarly 4g Carbendazim + 3.0g Thiram was used for dry seed dressing.

Seed treatment with biocontrol agent Trichoderma harzianum was done with dry powder formulation of Trichoderma harzianum to follow the method of Nayakaa *et al.* (2008) and Shakshi *et al.* (2014), where about 1kg of seed sample was collected in two glass containers separately to which, Trichoderma harzianum the biocontrol agent was added @ 2 and 4gm per kg of seeds separately and mixed thoroughly to get seeds surface coated with biocontrol agent.

Hundred seeds in four replications were drawn at random from each treatments and the germination test was conducted by using between paper method as per the International Seed Testing Association (ISTA) procedure (Anon., 2011) in a laboratory germination cabinet maintained at 25 ± 1°C constant temperature and 95 per cent Relative Humidity. The number of germinated seeds were counted manually at the end of 14th day of seed germination test and expressed in percentage. The observations on root and shoot length was recorded from randomly selected ten normal seedlings after 14th day of germination test.

Mean time to germinate was calculated with the formula given by Ellis and Roberts, (1981)

$$MTG = \frac{\sum(nd)}{\sum n} (day^{-1})$$

Where 'n' in number of germinated seeds in day 'd'

$\sum n$ is total germinated seeds

'd' day of counting

Means daily germination was calculated by the formula given by Scott *et al.* (1984)

$$MDG = \frac{FGP}{D}$$

Table 1: Effect of seed priming, chemical and biological seed treatments on seed germination components of GCH-7 hybrid castor

Treatments	Mean time to germinate per day			Mean daily germinationindex			Coefficient of velocity of germination seeds per day		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T_1: Seed priming with $CaCl_2$ (2.0 % solution)	5.16	5.16	5.16	16.63	15.96	16.30	0.180	0.173	0.177
T_2: Seed priming with $CaCl_2$ (4.0 % solution)	5.17	5.17	5.17	16.18	15.54	15.86	0.180	0.173	0.176
T_3: Chemical seed treatment with Carbendazim @ 2.0 g + Thiram @ 1.5 g	6.61	6.55	6.58	14.81	14.22	14.51	0.152	0.146	0.149
T_4: Chemical seed treatment with Carbendazim @ 4.0 g + Thiram @ 3.0 g	6.73	6.58	6.65	14.68	14.10	14.39	0.149	0.143	0.146
T_5: Seed treatment with Trichoderma spp.(2.0 g/kg)	6.68	6.68	6.68	14.52	13.94	14.23	0.149	0.143	0.146
T_6: Seed treatment with Trichoderma spp.(4.0 g/kg)	6.76	6.76	6.76	14.52	13.94	14.23	0.149	0.143	0.146
T_7: Control (Untreated seeds)	7.31	7.32	7.32	14.52	13.94	14.23	0.137	0.132	0.135
Mean	6.34	6.32	6.33	15.17	14.56	14.87	0.157	0.151	0.154
S. Em ±	0.10	0.14	0.11	0.31	0.30	0.31	0.002	0.006	0.003
C.D. at 1%	0.43	0.57	0.47	1.32	1.27	1.30	0.008	0.024	0.014

Table 2: Effect of chemical and biological seed treatments on seed germination (%) and seedling attributes of GCH-7 hybrid castor

Treatments	Seed germination (%)			Seedling root length (cm)			Seedling shoot length (cm)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T_1: Seed priming with $CaCl_2$ (2.0 % solution)	94.14	94.33	94.23	16.00	16.98	16.49	13.36	14.17	13.76
T_2: Seed priming with $CaCl_2$ (4.0 % solution)	94.05	94.25	94.15	15.99	16.96	16.48	13.36	14.17	13.76
T_3: Chemical seed treatment with Carbendazim @ 2.0 g + Thiram @ 1.5 g	89.61	89.70	89.65	15.23	16.15	15.69	12.77	13.47	13.12
T_4: Chemical seed treatment with Carbendazim @ 4.0 g + Thiram @ 3.0 g	89.66	89.75	89.70	15.24	16.15	15.70	12.73	13.49	13.11
T_5: Seed treatment with Trichoderma spp.(2.0 g/kg)	89.08	89.31	89.19	15.14	16.08	15.61	13.16	13.97	13.57
T_6: Seed treatment with Trichoderma spp.(4.0 g/kg)	88.56	88.81	88.69	15.06	15.99	15.52	13.03	13.83	13.43
T_7: Control (Untreated seeds)	87.56	87.29	87.42	14.58	15.71	15.15	11.48	12.28	11.88
Mean	90.08	90.20	90.14	15.25	16.23	15.74	12.78	13.60	13.19
S. Em ±	0.52	0.58	0.55	0.23	0.10	0.15	0.23	0.02	0.12
C.D. at 1%	2.20	2.44	2.31	0.98	0.44	0.64	0.99	0.09	0.51

Table 3: Effect of chemical and biological seed treatments on seedling vigour Indies of GCH-7 hybrid castor

Treatments	Seedling vigour index -I			Seedling dry weight (mg)			Seedling vigour index –II		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T_1: Seed priming with $CaCl_2$ (2.0 % solution)	2764	2938	2851	174.7	176.7	175.7	16448	16668	16558
T_2: Seed priming with $CaCl_2$ (4.0 % solution)	2760	2934	2847	174.5	175.9	175.2	16410	16582	16496
T_3: Chemical seed treatment with Carbendazim @ 2.0 g + Thiram @ 1.5 g	2510	2657	2583	158.5	159.0	158.8	14213	14270	14241
T_4: Chemical seed treatment with Carbendazim @ 4.0 g + Thiram @ 3.0 g	2508	2660	2584	158.6	161.2	159.9	14219	14465	14342
T_5: Seed treatment with Trichoderma sp.(2.0 g/kg)	2521	2683	2602	159.4	160.8	160.1	14197	14366	14282
T_6: Seed treatment with Trichoderma sp.(4.0 g/kg)	2488	2649	2568	157.3	158.3	157.8	13932	14068	14000
T_7: Control (Untreated seeds)	2282	2443	2362	150.9	150.2	150.6	13282	13250	13266
Mean	2527	2694	2611	143.9	146.7	145.3	12600	12811	12706
S. Em ±	44	28	34	159.7	161.1	160.4	14413	14560	14486
C.D. at 1%	186	120	145	10.41	7.54	7.66	1071	899	883

Where,

'FGP' is final germination percent

'D' is day of maximum germination during experimented period

Coefficient of velocity of germination was calculated by the formula given by Maguire (1962)

$$CVG = \frac{G1 + G2 \cdots ..... + Gm}{(1XG1) + (2XG2) + ... + (nXGn)} (\text{seed day}^{-1})$$

Where 'G' is number of germinated seeds

Seedling vigour index-I and II

Seedling Vigour Index (SVI) was computed by adopting the following formula as suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

SVI-I = {Germination (%)} x {Shoot length (cm) + Root length (cm)}

SVI-II = Seed germination (%) x Seedling dry weight (mg)

RESULTS AND DISCUSSION

From the pooled data over two years, it is seen that seed primed with calcium chloride ($CaCl_2$) @ 2.0 per cent solution took significantly less mean germination time (5.16) but exhibited significantly higher daily germination index (16.30), coefficient of velocity of germination (0.177), seed germination (94.23 %) which was on par with seed priming with 4 per cent calcium chloride solution (5.16, 15.86, 0.176 and 94.15% respectively). Whereas, significant contrary values were observed with untreated seeds (7.32, 14.23, 0.135, 87.42 % respectively). Similar results were also recorded during the 2013 and 2014 experiments with significantly highest mean daily germination index (16.63 and 15.96 respectively), coefficient of velocity of germination (0.180 and 0.173 respectively), germination percentage (94.14 and 94.33 respectively) and less mean time to germinate (5.16 and 5.16 respectively) with seed priming with 2 per cent calcium chloride solution which was on par with 4 per cent calcium chloride seed priming.

The significantly increased daily germination parameters and germination percentage with reduced mean germination time noticed due to seed priming with 2 and 4 per cent calcium chloride solution might be attributed to the hydra-tion and dehydration of seeds during priming; it has accelerated the germination process besides (Airin and Khosro, 2013), seed priming also permits early DNA replication, increased RNA production and protein synthesis, increased enzyme activity, greater ATP availability (Mewael *et al.,* 2010), faster embryo growth and efficient repair of deteriorated seed parts. All these activities might have initiated quicker radical protrusion through seed coat and have accelerate the process of germination and other parameters by shortening the germination time (Elouaere and Hannachi, 2013) Similar results were also reported by the research workers like Jamadar and Deshpande (2014) in pigeonpea.

Pooled data indicated that significantly maximum the root length (16.49 cm), shoot length (13.76 cm), vigour index-I (2851), seedling dry weight (175.7 mg) and seedling vigour index-II (16558) were noticed in the 2 per cent calcium chloride seed priming which was on par with 4 per cent calcium chloride seed priming (16.48 cm, 13.79 cm, 2847, 175.2 mg, and 16496 respectively) as compared to the untreated control (15.15 cm, 11.88 cm, 2362, 150.06 mg and 13266 respectively). Similar results were also recorded during the 2013 and 2014 experiments with significantly long seedling root (16.00 and 16.98 cm, respectively) and shoot length (13.36 and 14.17 cm, respectively), increased seedling vigour index - I (2764 and 2938 respectively), seedling dry weight (174.7 and 176.7 mg, respectively) and seedling vigour index-II (16448 and 16668 respectively) due to seed priming with 2 per cent calcium chloride solution which was on par with 4 per cent calcium chloride seed priming.

The increased root and shoot length might be attributed to the increased enzymatic activity because of increased RNA and protein synthesis; this inturn enhanced cell division, cell elongation and metabolic activity of embryo that led to added growth and development of seedling structures (Kazem et al., 2012). Increased seedling vigour index directly proportional to root, shoot length and germination percentage. Significantly improved seedling dry weight might be attributed to the increased of metabolic activity of embryo, increased respiration due to hydration and dehydration of seeds due to priming (Berhanu and Gebremedh, 2013). According to Virupaksh Prabhu *et al.* (2006) the increased germination and seedling vigour noticed in calcium chloride seed priming was attributed to the effective control of peroxidation and free radical damage either by stabilizing the cellular membrane or by facilitating the recombination of free radicals into non-harmful products. Mewael *et al.* (2010) reported that seed priming with calcium chloride @ 2 per cent solution significantly improved all the seed quality parameters due to the positive effect of $CaCl_2.2H_2O$ (0.5%) and role of Ca++ ion in the membrane integrity.

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APPLICATION FORM

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