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Effect of priming with trichoderma and rhizobium on germination, vigor and viability of maize (Zia mays L) seeds

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Abstract
In order to evaluate the effects of seed priming with bio fertilizers on germination percentages, vigour and viability of maize (*Zea mays* L.) seeds in CRD having four replications in post-graduation department Laboratory of Genetics and Plant Breeding department, Sam Higginbottom Institute of Agriculture, Technology & Sciences, Allahabad, during 2015-2016 to assess the effects of bio fertilizers in three durations on maize and identify the best durations of priming on maize seeds with bio priming treatments T_1 (unsoaked seeds with (control), T_2 [soaked seeds with *Trichoderma* (1% solution for 14 hours)], T_3 [soaked seeds with *Trichoderma* (1% solution for 18 hours)] and T_4 [soaked seeds with *Trichoderma* (1% solution for 22 hours)], T_5 [soaked seeds with *Rhizobium* (1% solution for 22 hours)], T_6 [soaked seeds with *Rhizobium* (1% solution for 22 hours)], T_7 [soaked seeds with *Rhizobium* (1% solution for 22 hours)] on seed germination and vigour of maize. All treatments significantly affected on germination percentage, vigor index, seedling dry weight and seedling length of maize seeds. It is concluded that, *Rhizobium* (1% solution for 14 hours) shown the excelsior result on all observed characters of maize.

Keywords: seed priming, durations, seedling parameters, maize

1. Introduction
Cereals such as rice, wheat and maize are members of the grass family and they are particularly important to humans because of their role as staple food crops in many areas of the world. Cereals are also used to produce animal feed, oils, starch, flour, sugar, syrup, processed foods, malt, alcoholic beverages, gluten and renewable energy (Pomeranz and Munck, 1981) [21]. Approximately 50% of the world's calories are provided by rice, wheat and maize, but in many parts of Africa and Asia, people rely mainly on grains such as sorghum or millet. Maize, sorghum and barley are important sources of livestock feed and barley and rice are used in the brewing industry (Chopra and Prakash, 2002) [11].

Maize is an important cereal crop that provides staple food to large number of human population in the world. It occupies third position in production next to wheat and rice in the world (Farnia 2014) [12]. It is food crop in Sub-Saharan Africa and Latin America, and is a key Asian crop. In Sub-Saharan Africa, maize is consumed by 50 percent of the population and is the preferred food for one-third of all malnourished children and 900 million poor people worldwide. It is food grains of the world and the most popular and palatable feed for all kinds of livestock and poultry birds all over the world (Hossain and Shahjahan, 2007) [16].

Maize can be produced successfully by priming seed at low moisture content of soil after harvesting transplant of rice. Priming decreases the time span between the emergence of the first and the last seedlings. Priming also increases the rate of emergence so the stand establishes itself faster. Priming is controlling the hydration level within seeds to allow seedlings to emerge more quickly and to help them all emerge at the same time. It is reported that seed priming is one of the most important developments to help rapid and uniform germination and emergence of seeds and to increase seed tolerance to adverse environmental conditions (Harris *et al*., 1999) [15]. Special priming treatments such as osmopriming, hydropriming, matricopriming and hormonalpriming have been tested (Basra *et al*. 2004) [5]. Seed priming is the imbibition of seeds in water sufficient for pregerminative metabolic activity to occur while preventing radical emergence (Basra at al. 2004) [5]. The seeds are then dried and will generally exhibit more rapid rates of radical emergence upon subsequent imbibition which lead to acceleration of seed germination and seedling establishment under both normal and stressful environments (Ashraf and Foolad 2005) [3].

One of the most important effective factors in increasing of corn yield is seed inoculation or priming with Plant Growth Promoting Rhizobacteria (PGPR). PGPR are a group of bacteria that actively colonize plant roots and promote growth and yield when added to seeds, roots or tubers (Kloepper *et al*., 1980 and Wu *et al*., 2005) [19, 27]. The mechanisms by which PGPR promote plant growth are not fully understood, suggested mechanisms include phytohormone production, enhancing stress resistance, stimulation of nutrient uptake and biocontrol of pathogenic micro-organisms (Rodríguez *et al*., 1999 and Sindhu *et al*., 1999) [22, 25], increasing the supply or availability of primary nutrients to the host plant (Wu *et al*., 2005) [27] or the synthesis of antibiotics, enzymes and fungicidal compounds**.** (Kloepper and Beauchamp, 1992) [18] showed that wheat yield increased up to 30% with Azotobacter inoculation and up to 43% with Bacillus inoculation. (Bashan *et al*., 2004) [4]. (Cakmak, 2005) [9] have reported that PGPR can increase yield and leaf area index, shoot and root weight and delay leaf senescence. Trials with PGPR indicated that yield and dry matter accumulation increased in maize (Pal, 1998) [20]. The objectives of this study

were to assess the effect of biopriming with Trichoderma and Rhizobium and identify the best durations of bio priming treatments on maize (*Zea mays* L.).

2. Material and Methods

The laboratory experiment for present investigation entitled "Effect of hydropriming in different durations on germination, vigour and viability of maize (Zea mays L.) Seeds" The research was conducted at the post-graduation Laboratory of Genetic and plant breeding department Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India, during the period from February to April in 2016 to find out the effect of bio priming methods on germination percentages, vigour and viability of maize seeds. In this cases the seeds will soak in bio fertilizer solutions then will surface dry for two hours before placing the seeds on papers. In each papers, 50 seeds will be manage on germination papers.

Experimental details

Table 1: List of treatment in three durations

S. No.	Treatments	Descriptions
1	T_1	Control (unsoaked)
2	T_2	*Trichoderma* (1% Solution 14 hours)
3	T_3	*Trichoderma* (1% Solution 18 hours)
4	T_4	*Trichoderma* (1% Solution 22 hours)
5	T_5	*Rhizobium* (1% Solution 14 hours)
6	T_6	*Rhizobium* (1% Solution 18 hours)
7	T_7	*Rhizobium* (1% Solution 22 hours)

Maize seeds primed with above treatments were subjected to germination and vigour studies in laboratory and, Germination percentage (%), Germination mean time (day), Seed vigor index mass, Seed vigour index length, Seedling dry weight (g), Seedling length (cm) were recorded.

Lab experiment

Germination (%): Germination percentage (%): germination test has been conducted using four replicates of 100 seeds each in the paper (between papers) medium in the walk in germination room as per ISTA, (2010) [17].

$$\text{Germination percentages} = \frac{\text{Total number of seed germinated}}{\text{Total number of seed planted}} x\ 100$$

Mean germination time: The mean germination time (days) was calculated according to the following formula (Scott *et al*., 1984):

$$MGT = \frac{\sum T1N1}{S}$$

Where,
Ti = Number of days after beginning of experiment
Ni = Number of seeds germination on day i
S = Total number of seeds germination.

Seed vigour index: Vigour index is computed by adopting the following formula as suggested by (Abdul Baki and Anderson 1974) [1] and expressed in number.
Vigor index mass: SVI-M=Germination% x seedling dry weight on the final count.
Vigor index length: SVI-L= Germination (%) x seedling length (cm)
Seedling dry weight (g): Seedling fresh weight has been measured in grams after final count in the standard germination test. Ten seedling s selected randomly from each replicate in be cut free from their cotyledons and placed envelopes and dried in the oven at 80 1c for 24 hours. The dried seedling has been weighted to the nearest grams and average dry weight has been calculated as per ISTA (2010) [17].
Seedling length (cm): Ten normal seedlings used for root length and shoot length measurement has been used for the measurement of seedling length. The seedling length has been measured from the tip of the primary root to the base of the primary leaf.

3. Results and Discussions

The present investigation was carried out to assess the effect of different priming and durations and identify the suitable priming treatments of maize The experimental results are presented under the following headings, germination %, mean of germination time, seed vigor index mass, seedling dry weight length shown high significant, vigor index length and seedling.

In (Table 2.) analysis of variance for seed germination, germination mean time, seed vigor index mass, seedling dry weight length shown high significant** (1%) but two characters such as seed vigor index length and seedling length shown the low significant* (5%).

Table 2: Analysis of variance for different characters in maize (*Zea mays* L.) seeds

Mean Sum of Square	Observations recorded					
	GP (%)	GMT (day)	VIM	VIL	SDW (g)	SL (cm)
Treatments (df=6)	45.36**	0.511**	38.39**	576837.9*	0.375**	62.156*
Error (df=21)	9.84	0.062	1.48	218631.2	0.036	10.179

In this table, Germination percentage shown with (GP), Germination mean time with (GMT), Vigour index mass with (VIM), Vigour index length with (VIL), Seedling dry weight with (SDW), Seedling length with (SL).

Significant differences in seed germination, vigour and seedling growth parameters were observed due to seed priming in maize (Table 3.).

Table 3: Effect of hydro priming methods on germination percentage of maize (*Zea mays* L.) seeds

S. N	Treatments	Observations recorded					
		GP (%)	GMT (day)	VIM	VIL	SDW (g)	SL (cm)
1	T1	80.00 g	4.065 a	10.955 g	1700.56 g	1.305 g	20.19 g
2	T2	96.00 a	3.345 d	18.075 c	2531.56 d	1.655 e	32.05 a
3	T3	92.00 b	3.955 b	17.215 d	2542.35 c	1.860 c	27.50 d
4	T4	92.00 c	3.445 c	14.495 f	2125.05 f	1.595 f	23.35 f
5	T5	90.00 d	3.140 g	20.425 a	2697.20 b	2.220 a	29.35 b
6	T6	90.00 e	3.275 f	18.605 b	2806.71 a	2.065 b	28.38 c
7	T7	84.00 f	3.315 e	16.345 e	2297.35 e	1.830 d	25.60 e
CD (5%)		4.618	0.369	1.795	7.70	0.284	4.696
CV (%)		3.467	7.174	7.353	19.592	10.692	11.973

Different levels shown by small letters in the above table. a= highest, b= higher, c=high, d= medium, e= low, f= lower and g= the lowest.

The treatments primed with bio fertilizer solution of T_2 [*Trichoderma* (1% Solution 14 hours)] (96%) shows the highest germination percentage while lowest seed germination was observed with T_1 [unsoaked (control) (80%). These findings may be due to the increased synthesis of hormones like gibberellins, which would have triggered the activity of specific enzymes that promoted early germination. Beside, significant increase in seedling vigour would have occurred by better synthesis of auxins. Similar results is in conformity by (Bharathi R *et al*, 2004) [6].

All treatments stress on germination mean time. Further, non-soaked seeds were significantly higher than primed seeds. The accelerated germination of primed seeds might be due to increased rate of cell division (Bose, *et al* 1992) [8] and stimulation of metabolic activities during early phases of seed germination. Similar research also reported reduction of mean germination time (Bocian, *et al*., 2008) [7], (Casenave, *et al*., 2007) [10] and (Sung, *et al*., 1995) [26].

The treatments primed with bio fertilizer solution of T_5 [*Rhizobium* (1% Solution 14 hours)] (20.425) finds out the superior result in seed vigor index mass. While lowest seed vigour index mass was observed with T_1 [unsoaked (control) (10.955). The treatment which is primed with biofertilizer increases due to increased supply on nutrition. These results of these experiment shows that, the seed vigour index mass increased by *Rhizobium* due to bacteria inoculation depending on the type of bacteria. This result is cerebrated with (Farnia *et al*., 2014) [14].

The seeds which has soaked with bio fertilize solution of T_6 [*Rhizobium* (1% Solution 18 hours)] (2806.71) shows the excelsior seed vigour index length. While lowest seed vigour index length was observed with T_1 [unsoaked (control) (1700.56). The probable reason for recording the highest vigour index length might be due to photosynthetic capacity of maize treated with bio fertilizers increases due to increased supply of nutrition. This result is in conformity with **(**farnia and shafie, 2014) [12].

Primed treatments with bio agent solution of T_5 [*Rhizobium* (1% Solution 14 hours)] (2.220) shows the preponderant result in seedling dry weight. While lowest seedling dry weight was observed with T_1 [unsoaked (control) (1.305). This result might be due to an increase of the synthesis of the hormone gibberellin, which Trigg the activity of α-amylase and other germination specific enzymes like protease and nuclease involved in hydrolysis and assimilation of the starch (Gholami, *et al.*, 2009) [13]. It might also be due to as a result of better activity of mitochondrial enzymes accompanied by an increase of the oxygen consumption. The similar result finding was observed by (Shaukat, *et al*., 2006) [24].

Soaked seeds with bio fertilizer solutions of T_2 [*Trichoderma* (1% Solution 14 hours)] (32.05) shows the superior result in seedling length. While lowest seedling length was observed with T_1 [unsoaked (control) (20.19). In this study application of *Trichoderma* increased either germination and emergence percentage and index which means that seeds germinated better, seedlings emerged stronger and whole period occurred faster. This might be due to higher production of growth stimulators that been reported in plant-*Trichoderma* interactions. This result is similar with (Gravel, 2006) [14].

4. Conclusion

It is concluded from the present study, the treatment which has soaked for 14 hours obtained the highest results while control which has called unprimed seeds was observed with the least primed affects.

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