International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Impact of Seed-Priming Technique on Seed Germination of Three Rice Varieties

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***Abstract*— *Seeds quality, essential factor for a good germination and a harmonious development of the embryos / seedlings constitutes a real constraint in agricultural environment. In fact, many farmers suffer enormous financial losses each year because of the poor quality of the seeds they use. Very often this results in low germination rates (60 to 75 p.c.). The investigations carried out have shown that, in fact, the germination capacity of seeds depends on many parameters grouped into intrinsic factors (dormancy, permeability of the integument to water and oxygen, seed quality, etc.) and environmental (water, oxygen, temperature, light). Influences of these factors on germination differ from each other on the one hand, and differ from one variety to another. Thus, if the action of some parameters is irreversible, other such as the dormancy or ability of the seed to sprout when conditions are favorable, can be lifted, thereby improving the germination rate.*

A series of experiments conducted for this purpose on three varieties of rice, consisting of a soaking of seeds in simple water (seed-priming) and in water containing phosphorus (P) provided in the form of TSP a allowed to effectively improve germination rates from 70 p.c. to 97 p.c.. These experiments have also shown that the soaking time of seeds used which causes a maximum and significant increase in germination rates depends of the rice variety. Beyond this period considered optimal, the rate drops.

Finally, these experiments have also shown to us through the high germination rates derived from nutripriming (soaking in P solution) the possibility of enriching the nutritional potential of rice seeds, thus increasing the nutritional autonomy of seedlings in environments difficult.

Keywords *— Seedpriming, nutripriming, rice, seed, germination, phosphorus.*

I. INTRODUCTION

Having quality seeds is a major challenge for good agricultural production. Seeds are unfortunately at the center of many problems because of this quality. Among the most frequently encountered problems are the low seed germination rates which result in heavy loads on farmers forced to use one to two times the amount needed per superficial unit. The poor quality of the seeds at the origin of the low germination rates come mainly from the physical deterioration of the grains in a general way and in particular from the death of the embryo or the seedling in the seed. This does not, however, negate certain factors, such as the physiological dormancy which, affects in average15 to 40 percent of the seed usually available to farmers.

If the degradation of certain organs, including the embryo, the seedling, etc. irreversibly leads to that of the seed, some treatments prior to the use of seeds could reduce the losses due to dormancy.

For this purpose, the technique of seed - priming which consists in pre - germinating the seed physiologically by simply soaking in water has proved very often effective. Beyond soaking, nutrient intake of certain nutrients could increase its nutrient potential (Farooq, 2012) and, as a result, a degree of autonomy that may prove useful in some difficult ecosystems. Thus, increasing the phosphorus potential in a seed while allowing a harmonious development of the root system facilitates the seedlings access to minerals in acid soils.

The present work aims to improve germination rates of rice seeds by seed - priming techniques on three varieties of rice. Specifically, the aim is to evaluate the influence of seed - priming and nutripriming techniques on germination rates of rice seeds. To achieve this, a series of experiments were conducted and consisted in determining the optimal soaking time which produced the highest germination rates; ii / determine the rice variety (s) with the highest germination rates; iii / determine the influence of phosphorus (P) inputs in dipping solutions on germination rates.

II. MATERIAL AND METHODS

2.1 Field of Study

Various experiments of the present study were carried out in the laboratory of the University Jean Lorougnon Guédé located in the region of Haut-Sassandra at Daloa in the west - center of Côte d’Ivoire (6 ° 53 N and 6 ° 27 W).

2.2 Material

- Plant material

It consists of the seeds of three short cycle rice varieties (Figure 1), all from a rice plot of Zépréguié, small locality of Daloa. Explicitly, it is:

- V1 or IR 2042-178-1 x CT 19 commonly known as WITA 9 of the species Oryza Sativa;
- V2 or WAS63-22-5-1-7-7, also called V10;
- V3 or IR64 often called C35.

Fig. 1. Seeds of the different varieties of rice.

- Fertilizer

Triple superphosphate (TSP) was used as a source of phosphorus (P) in some experiments.

Kotchi Valère, Tonessia D. Charlotte, and Soko D. Faustin, “Impact of seed priming technique on seed germination of three varieties of rice,” *International Research Journal of Advanced Engineering and Science*, Volume 3, Issue 4, pp. 262-265, 2018.

- *Technical material*

It consists of boxes of kneaded and pots that were used for crops. The inside of each box is covered with blotting paper for moisture management depending on the amount of water absorbed.

In addition to this, a set of laboratory equipment including a precision electronic scale and pipettes for the various measures and the watering of the plants (germinated seeds), etc.

2.3 Method

It was based on two complementary experiments aimed at determining the impacts of soaking rice seeds in different media on germination rates.

2.3.1 Experimental devices

Experimentation 1. Optimal duration of soaking and germination rate

This experiment based on the technique of "seed priming", particularly of "hydropriming" has for main objective to determine the soaking duration of the seeds of the different varieties of rice in simple water which generate the most high germination rates.

For this, using a four-repetition factorial device, seed samples (25 grains / sample) of three rice varieties (factor 1) with three levels, in particular V1, V2 and V3, were dipped in the same volume of water (100 ml) at different times (factor 2) namely (T0 (0 min), T1 (1 min), T2 (30 min), T3 (1 hour), T4 (2 hours) and T5 (4 hours)). Once out of the water, the seeds are placed on the blotting papers in petri dishes.

Experiment 2. Influence of the P content in the soaking solution on the germination rate

This experiment, similar to the previous one but based on nutripriming, aims to determine the impact of P inputs on germination rates.

For this, similarly to the previous device with also four repetitions, the samples (25 grains / sample) of three rice varieties (factor 1) were soaked for the optimal duration of each previously determined variety in the same volume of four-concentration solution of P (factor 2), in particular (D0 (0 $g1^{-1}$), D1 (50 $gP1^{-1}$), D2 (100 $gP1^{-1}$) and D3 (150 $gP1^{-1}$)).

2.3.2 Observations, measurements and calculated parameter made

For an average of six (06) days, seed germination of rice varieties was observed (Figure 2a). The number of kernels sprouted per petri dish (Figure 2b) was determined for this purpose. The data obtained made it possible to calculate the germination rates according to the formula below:

$$\mathbf{GiT} = \frac{\mathbf{(GGN)i}}{\mathbf{TNGS}} \boldsymbol{X100}$$

With:
GTi: Germination rate of i treatment;
(GGN)i: Number of Germinated grains at treatment i level;
TNGS: Total Number of Grains Sown

Similarly, in order to illustrate the influence of soaking on germination, variation in varietal germination $(ß)_v$ rates due to soaking of seeds was determined by the formula below:

$$\mathbf{(ß)_i = MGRV_i - SGRV_i}$$

With:
(ß)i, variation in the germination rate of the variety i;
$MGRV_i$, the Maximum Germination Rate of the variety i;
$SGRV_i$, the Soaked Germination Rate of the variety i

2.3.3 Studies carried out

They consisted on the one hand in the determination of the optimal duration of soaking generating the germination rates significantly high, and on the other hand in the evaluation of the impact of the contributions of P on these....

2.3.4 Data processing and analysis

The statistical processing of the data was carried out from the software Statistix v.10. It consisted of an analysis of the variances of the germination rates. The tables and charts were made from the Microsoft Excel software on Windows 2010.

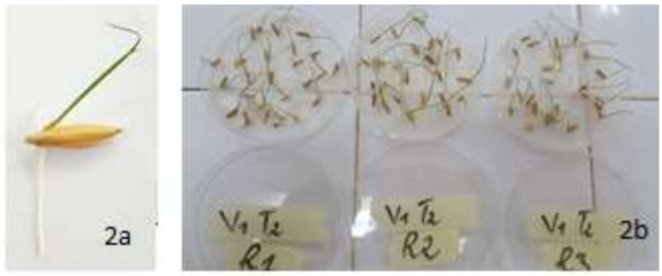

Fig. 2. Sprouted rice seeds.
2a: a grain of rice in full development
2b: seed of V1 in full germination in petri dishes.

III. Results

3.1 Soaking and Seed Germination Rate

3.1.1 Influence of soaking on seed germination rate

Without soaking the average germination rate is low, and is 70 p.c. (Table I). The analysis of the variances of these rates at the level of the three varieties of rice shows no significant difference. In other words, the seeds used are all similar in terms of germination.

The germination rate of the quenched grains is much higher, averaging 77.6 p.c. (Table I). The analysis of the variances of the average seed germination rates shows a significant difference related to the soaking but not significant between the average rates of the seed soaked at the varietal level. Soaking effectively influences germination. The comparison of the variations of the germination rates of the different varieties shows that C35 is the most sensitive to soaking (26.7 p.c. followed by WITA 9 (25.4 p.c.) and finally V10 (24 p.c.) (Figure 3).

3.1.2 Soaking time and seed germination rate

Their evolution of germination rates according to the duration of soaking are similar from one variety to another, and are characterized by three phases:

- A growth phase during which the average germination rate increases with the duration of soaking;
- A decay phase during which the germination rate decreases contrary to the duration of soaking;
- A peak located between the two phases, which reflects the maximum germination at a given soaking time.

The analysis of the variances of the germination rates gives a significant difference in the duration of soaking. In other words, the soaking time effectively influences the germination rates. The application of LSD at the 5-point threshold at the

International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

different rates shows that the soaking times that give rise to maximum germination are reached at T1, T2 and T4 respectively for the V10, WITA 9 and C35 varieties.

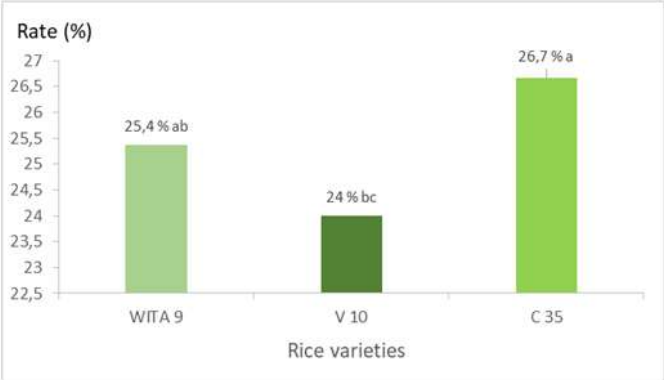

Fig. 3. Variation of germination rates by varieties (soaking in simple water)

TABLE I. Average germination (p.c.) of seeds after soaking in water

Varieties	Soaking duration						Mean
	T_0	T_1	T_2	T_3	T_4	T_5	
WITA 9	69,33^{cde}	78,67^{cde}	**94,67^{ab}**	80^{bcd}	76^{cde}	74,67^{cde}	78,89^{a}
V 10	70,67^{cde}	**94,67^{ab}**	80^{bcd}	73,33^{cde}	64^{e}	65,33^{de}	74,67^{a}
C 35	70,67^{cde}	70,67^{cde}	76^{cde}	80^{bcd}	**97,33^{a}**	81,33^{bc}	**79,33^{a}**
Mean	70,22^{c}	81,33^{ab}	**83,56^{a}**	77,78^{abc}	79,11^{ab}	73,78^{bc}	**77,63**

NB. Line averages (in columns, respectively) followed by different letters, differ significantly (P <0.05)

3.2 Influence of P Input on Seed Germination Rates

3.2.1 P intake and p germination rate

Average germination rates are high (87.61p.c.), and remain above those of non-soaked seeds, all varieties included, but below those of seeds soaked in simple water (Table II). The analysis of seed germination rate variances shows a significant difference in treatment (soaking in the P solution). In other words, soaking in the P solution significantly influences the germination of rice seeds. The application of LSD at the 5p.c. threshold shows that the D1 dose generates the highest germination rates (Table II). A low dose P intake significantly influences the germination of rice seeds with any variety included. Although it influences germination, the rates obtained from dipping in the low dose P solution (D1) do not differ significantly from the maxima obtained during dipping in simple water.

3.2.2 P intake and varietal germination rate

Germination rates are high at the different rice varieties (87, 61 p.c.) (Table II). These rates decrease, contrary to the doses of P in the solution. The analysis of the variances of the maximum average germination rates shows that there is no significant difference in rice varieties. In other words, the differences in germination rates obtained at the level of rice varieties are not the result of the contributions of P. The analysis of the variations of the germination rates of the different varieties shows no significant difference. (Figure 4).

TABLE II. Average Germination Rate (p.c.) of Rice Seeds after Soaking in P Solutions.

Varieties	Soaking duration						Mean
	T_0	T_1	T_2	T_3	T_4	T_5	
WITA 9	69,33^{cde}	78,67^{cde}	**94,67^{ab}**	80^{bcd}	76^{cde}	74,67^{cde}	78,89^{a}
V 10	70,67^{cde}	**94,67^{ab}**	80^{bcd}	73,33^{cde}	64^{e}	65,33^{de}	74,67^{a}
C 35	70,67^{cde}	70,67^{cde}	76^{cde}	80^{bcd}	**97,33^{a}**	81,33^{bc}	**79,33^{a}**
Mean	70,22^{c}	81,33^{ab}	**83,56^{a}**	77,78^{abc}	79,11^{ab}	73,78^{bc}	**77,63**

NB. Line averages (in columns, respectively) followed by different letters, differ significantly (P <0.05)

Fig. 4. Variation of germination rates following to varieties (soaking in P solution)

3.3 Synthesis

The techniques of seed priming used (hydropriming and nutripriming) effectively increase the germination rates of rice seeds. If simple soaking in water allows a significant increase in germination rates, the one performed in the P solutions does not significantly increase germination rates from the D1 dose. The comparison between seed germination rates at the three varieties of rice under different treatments does indeed illustrate this (Figure 5).

Fig. 5. Evolution of germination rates (TG) following treatments
SBT: Non-Soaked Seed
SS (water): Seed dipped in simple water
SS (P Solution): Seed Soaked in P solutions

IV. DISCUSSION

The effective contribution of seed priming techniques (hydropriming, nutripriming, etc.) to improve germination of agricultural seeds has been done by many authors, including Rahman et *al.* in 2011, Basra et *al*. in 2002, Omidi et *al*. in 2009, Kaya et *al*. in 2006, Goswami et *al.* in 2013, Posmyk et *al*. in 2007, on corn, wheat, canola, sunflower, rice, mung beans, etc., respectively.

Seed germination is in fact influenced by intrinsic factors (dormancy, permeability of the integument to water and oxygen, seed quality, etc.) and environmental factors (water, oxygen, temperature, light). The latter participate in the activation of hormones and enzymes essential for germination (Bove et *al*., 2001). If some components of these factors do not appear to be major constraints, inability or dormancy of the seed to germinate despite the favorable environment (Bewley, 1997; Finch-Savage and Leubner-Metzger, 2006) on it is of crucial importance and can significantly affect seed germination rates.

In fact, induction and dormancy are controlled by various mechanisms that include complex interactions between the environnent and two major phytohormones: abscisic acid (ABA), and Gibberellins such as gibberellic acid (GA). ABA by promoting the induction and maintenance of dormancy during embryonic maturation may inhibit germination, and its accumulation is correlated with the onset of dormancy (Hilhorst & koornneef, 2007, Finkelstein et *al*., 2008). Gibberellins, on the other hand, are known to promote the process of dormancy and germination (Finkelstein et *al*., 2008) in several species of plants including rice. This group of hormones stimulates germination by inducing hydrolytic enzymes that weaken tissue barriers such as endosperms or integuments, inducing mobilization of seed storage, and stimulating embryo expansion (Finch -Savage & Leubner-Metzger, 2006).

Also, one understands on the one hand the interest of this phase of imbibition which besides constitutes the first of the germinative process and which is translated by a water absorption by the seed.

On the other hand, the challenge is the nutripriming technique, whose seed germination rates, resulting from its implementation by the addition of certain TSP doses in the soaking water, do not differ significantly from those of the hydropriming, translates the possibility of enriching the nutritional potential of the embryo. The exploitation of this possibility constitutes a real alternative as to the search for solution for the exploitation of some difficult grounds, particularly acid soils as for the availability of P.

However, even if water (moisture) is an essential or limiting factor of germination, its excess or prolonged stay of grains in water could lead to a decrease in its capacity to germinate (embryo asphyxiation). This remains variable from one species / variety to another, and is a function of certain stages of development. Thus, an extended stay of the seed of more than four days in water during the germination process (swollen seed stage) is responsible for a drop of more than 50 p.c. in the germination rate in some varieties.

In all cases, the success of germination strongly depends on the quality of the seeds (physical, physiological and sanitary qualities).

To conclude, the different germination rates resulting from the experiments carried out highlight the positive or non-positive contribution of many parameters grouped into environmental and intrinsic factors.

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