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RESEARCH ARTICLE

IMPROVEMENT OF COWPEA (*Vigna unguiculata*) SEED GERMINATION BY TREMPING TECHNIQUES

***Ibrahima Mbodj[1], Mouhamadou Moussa DIANGAR[2] and Astou TINE[1]**

[1]Alioune DIOP University of Bambey, Higher Institute of Agricultural and Rural Training, BP 54 Bambey-Senegal
[2]Senegalese Agricultural Research Institute, Center of Bambey, Senegal

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****Corresponding author:***
Ibrahima Mbodj

ABSTRACT

Cowpea, Vigna unguiculata, has a prominent place in Senegal both for its nutritional benefits and for its suitability for adverse growing conditions. Studies were conducted on three cowpea genotypes with the objective of evaluating the effect of seed pretreatment with sodium hypochlorite (NaClO) and optimal water volume on cowpea germination rate. A completely randomized design with three replications was used with two factors: volume of water drenched, duration of soaking. The analysis of variance showed a great variability of the genotypes with respect to the different soaking times. The trait studied in the trial was germination speed. Significant differences were observed at the level of AxBxC, AxB and AxC interactions and then at the level of genotype, the main source of variability. The performance of each genotype was also observed in relation to the adapted soaking time. The application of the decontaminant sodium hypochlorite and the volume of irrigation water showed a clear improvement of the germination speed.

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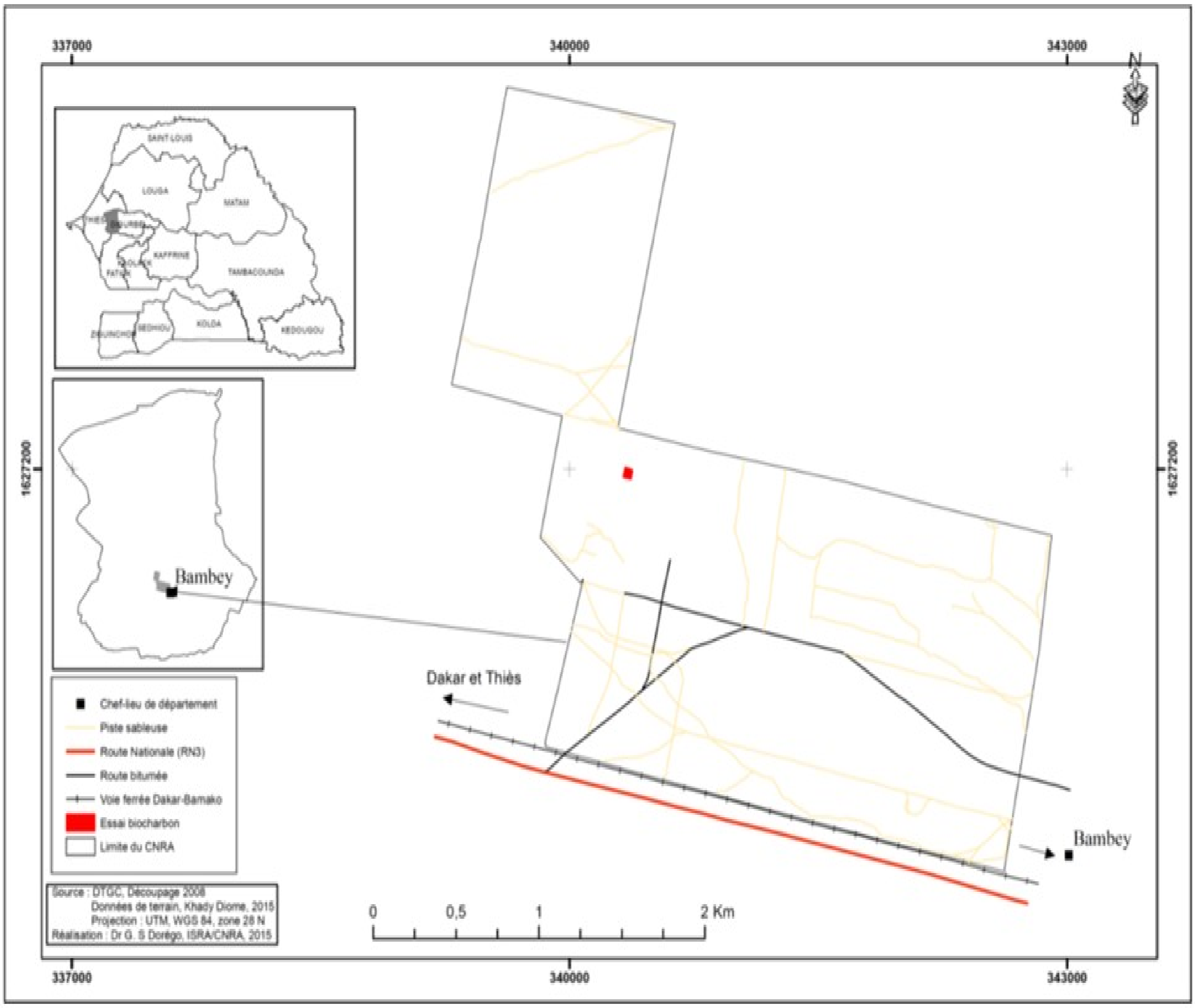
INTRODUCTION

Cowpea (Vigna unguiculata) is a seed legume known for its nutritional qualities. It plays a key role in the world's agricultural production system. Thanks to its high protein content, cowpea has been recognized as one of the best and least expensive solutions to the challenge of malnutrition in poor countries, particularly in Africa, earning it the nickname "meat of the poor". As a result of this trend, demand for cowpea is growing exponentially, while annual production is unable to meet demand. In fact, according to (1), the annual area sown worldwide amounts to over 12.5 million ha. West Africa, the largest cowpea production and consumption area, encompasses the 9.8 million ha cultivated and 64% of the world's annual production, which reaches 3.1 to 3.3 million tonnes of dry seeds. It is grown mainly in the north and central north of Senegal, notably in the Diourbel, Thiès and Louga regions, which are also Senegal's main arid and semi-arid zones. Cowpea is highly adaptable to unfavorable growing conditions. But its production is often hampered by irregular rainfall, declining soil fertility and attacks by various pests. All these factors lead to poor seed germination. Germination is an essential stage in the plant development process; good agricultural production depends in part on germination, so improving germination performance is becoming a crucial issue for all researchers. For good germination to occur, seeds must be placed in optimal germination conditions. Various factors can hinder seed germination, notably the impermeability of some seeds, which have hard seed coats that don't allow water or oxygen to pass through them, essential parameters in seed germination. To remedy this situation, researchers and breeders have been working to improve the germinative capacity of cowpeas, especially in the Sahelian zone of Africa, and particularly in Senegal. The technique of pre-treating cowpea seeds under different conditions could be an effective alternative to poor germination. Based on the fact that tests have been carried out in Morocco, Benin and Niger by various research organizations on other types of seed other than cowpea, a very satisfactory success rate of up to 95% was observed for pre-treatment techniques. The aim of this study was therefore to help increase cowpea yield by improving germination performance using a sodium hypochlorite (NaClO) pre-treatment technique, and to evaluate its effect on cowpea germination speed.

The aim is to identify the optimum soaking time for cowpea seeds with sodium hypochlorite and the best water volume for improving germination speed.

MATERIALS AND METHODS

Experimental site: The experiment was carried out at the Centre National de Recherches Agronomiques (CNRA) in Bambey. The CNRA is located in the heart of the groundnut basin in the department of Bambey, Diourbel region, Senegal. Its geographical coordinates are: 14°42' north latitude, 16°28' west longitude, and the center is 120 km from Dakar (Figure 1).



Source [2]

Figure 1. Geo-administrative situation of the study area

Plant material: Three cowpea lines were studied, including two ISRA varieties, Yacine and Thieye. The third line, L-P-check-1, is a minicore accession from the University of California Riverside. Yacine is a large-seeded, kidney-shaped variety with a brown seed coat. Thieye is also a large-seeded white variety, and L-P-check-1 is a small-seeded white variety.

Other Equipment: Petri dishes were used to grow cowpea seeds. Bleach was used to sterilize the plant material and other equipment, and distilled water was used for daily watering of the seeds, to ensure perfect hygiene and avoid contamination. Other materials, such as absorbent paper, adhesive tape and aluminum foil, were used to absorb excess water, mark codes and cover petri dishes to prevent light from entering methods.

Experimental design: A completely randomized block design was used. 4 factors were determined as follows in block design: 3 genotypes, 7 soaking times, 2 volumes of daily watering and 3 replicates. Petri dishes were labeled according to the system used. (Figure 2)

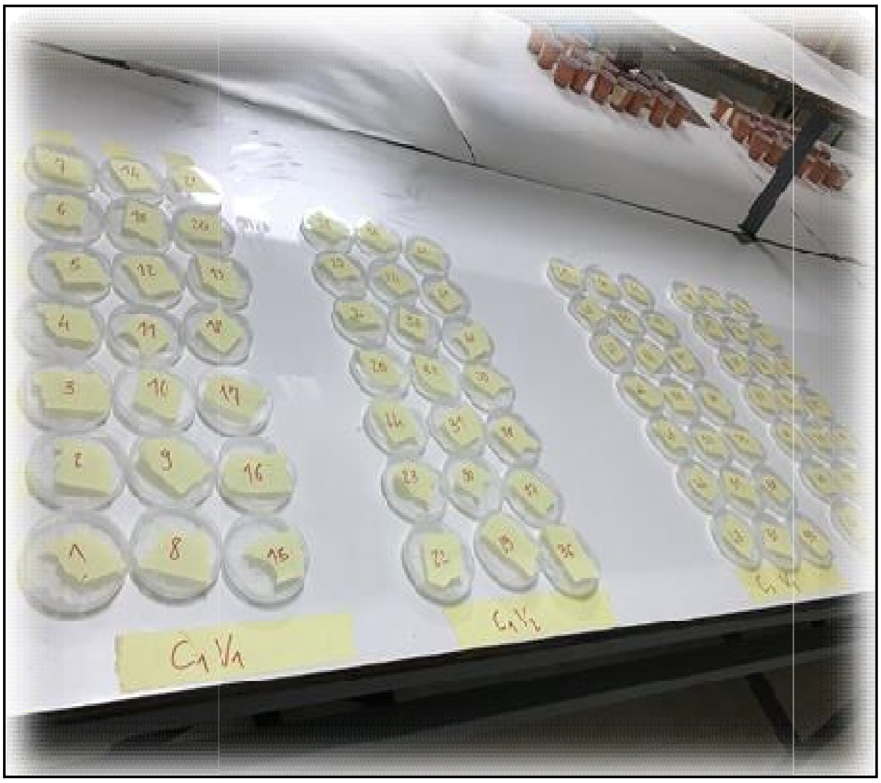


Figure 2. Experimental design of the study

Conducting the experiment: For this experiment, a pre-prepared 0.8% NaClO solution was used to weaken the resistance of the integuments. Petri dishes were then sterilized with the solution. The same cleaning solution was used to soak the seeds for 3 minutes. We used 30 cowpea seeds of each genotype, deposited in 140 ml capacity beakers. A 100 ml sodium hypochlorite solution was then poured into the cups at different soaking time intervals, followed by three successive rinses of the seeds. Sterilized absorbent paper was placed inside the petri dishes before the seeds were set out. The dishes were then covered with their labelled lids and finally wrapped in aluminium foil to prevent light penetration.

Observed parameters: Observations focused mainly on germination speed. This corresponds to the time taken for a batch of seeds to germinate, and was calculated in relation to the number of seeds germinated.

Statistical processing of data: Data analysis was carried out using GENSTAT software. Analysis of variance (ANOVA) was used to determine the effect of different treatments on genotypes, and also to validate the best performances. An analysis of all interactions was first performed to assess the significance of the factors: A (soaking time), B (genotypes) and C (water volume).
Following this observation, the source of variability was determined, and finally the best seed pre-treatment time corresponding to each genotype.

RESULTS

Significance of sources of variation on germination speed (ANOVA): Analysis of variance showed significant differences between the AxBxC, AxB and AxC interactions. Most of the variability was observed in the AxB interaction (Table 1). The effect of genotype was the most significant, with a high mean square (0.00118190) distinct from volume and duration. This made it possible to complete this analysis by determining the best-performing genotype with the most suitable soaking time.

Table 1. Significance of sources of variation

Source of variation	d.l.	s.c.	c.m.	v.r.	F pr.	Codes
Répétition	2	0.00039116	0.00019558	13.54		
Durée_Tr_min	6	0.00035748	0.00005958	4.13	0.001	A
Génotypes	2	0.00236381	0.00118190	81.84	<.001	B
V_ml	1	0.00044245	0.00044245	30.64	<.001	C
Durée_Tr_min.Genotypes	12	0.00150494	0.00012541	8.68	<.001	AxB
Génotypes.V_ml	2	0.00002143	0.00001072	0.74	0.479	BxC
Durée_Tr_min.V_ml	6	0.00069888	0.00011648	8.07	<.001	AxC
Durée_Tr_min.Genotypes.V_m	12	0.00084662	0.00007055	4.89	<.001	AxBxC
Résiduel	82	0.00118420	0.00001444			
Total	125	0.00781097				

d.l: degree of freedom;s.c : sum of squares; c.m : medium square;v.r : variance;
F.pr :probability.

Tableau 1. **Comparing the performance of different genotypes in relation to volumes**

Average speed (Ng/jr)	L-P-check-1	Thieye	Yacine	Total général
2,5	0,039021164	0,027777778	0,03207672	0,032958554
5	0,041666667	0,031746032	0,036706349	0,036706349
Total	0,040343915	0,029761905	0,034391534	0,034832451

Comparison of the performance of the different genotypes in relation to duration: The results showed that Thieye performed best during a 12-minute soaking period, with an average rate of 0.037 Ng/dr (number of germinated seeds per day) compared with other soaking periods. As for Yacine, she preferred soaking for 7 minutes, with a performance far exceeding that of Thieye, at 0.042 Ng/dr. L-P-check-1 beats Yacine's and Thieye's record, as the observations revealed the flexibility of L-P-check-1 in relation to all durations: its performance varied very little. During only 1 minute of soaking, L-P-check-1 recorded a high performance with a velocity evaluated at 0.042 Ng/dr, and this performance was maintained even after 12 minutes of soaking. The genetic characteristics of L-P-check-1 proved to be very interesting in view of the performance recorded, and it can be deduced that this genotype is adaptable to different experimental conditions (figure 3).

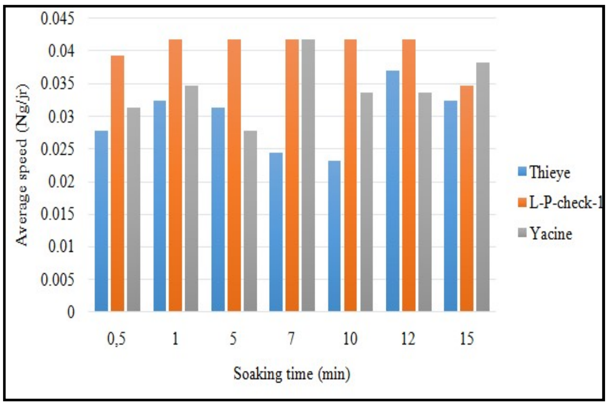


Figure 3. Performance of each genotype with the appropriate soaking time

Comparison of genotype performance in relation to water volumes: The results showed that the germination rate of L-P-check-1 increased significantly with a watering volume of 5ml. Indeed, with an average speed of 0.042 Ng/dr, it far exceeded the performance of Thieye and Yacine. The Yacine and Thieye genotypes also performed well with 5ml of water, their respective average speeds being 0.037 and 0.032 Ng/dr. Interestingly, even with 2.5ml of water, L-P-check-1 performed considerably better, with an average speed of 0.039 Ng/dr. With average velocities of 0.032 and 0.028 Ng/dr, Yacine and Thieye performed below L-P-check-(figure 4).

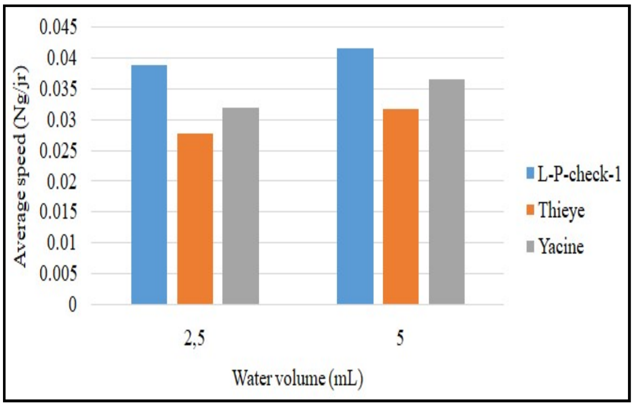


Figure 4. Performance of each genotype as a function of optimal volume

DISCUSSION

The performance of the different genotypes was remarkable after application of the decontaminant at various soaking times. Indeed, the dominant morphological characteristic which was a large seed took much longer to achieve its greatest performance and engorged more water. The small seed, on the other hand, performed considerably better after only 1 minute of soaking. According to (3), quoted by (4), differences in permeability can lead to variability in germination speed between seeds from the same population. The results of this study were in perfect agreement with the advances of these authors, as there were indeed significant differences in the germination capacity of the three genotypes after application of the decontaminant.

It was therefore deduced that the agro-morphological characteristics of cowpea seeds have an influence on germination speed. Results showed that sodium hypochlorite accelerated the germination rate of Vigna unguiculata seeds under favorable germination conditions. Seeds were found to have a higher germination speed than untreated seeds, with significant differences. Sodium hypochlorite is capable of weakening the resistance of the integuments, breaking the barrier of permeability to water and air, and thus causing the seed to blossom. The integument is the seat of the seed's inability to hydrate properly (5), so hypochlorite, by evenly softening the various superficial layers of the seed's envelope, allows water to enter the seed through its entire surface. Previous studies on several crop species such as wheat, barley, maize, chickpea, rice, watermelon, melon, tomato, amaranth, cucumber, soybean, onion, sorghum, and Chinese rye have shown that seed pre-treatment is effective for germination performance ((6); (7); (8); (9); (10); (11); (72); (13); (14); (15)). On the other hand, (16) do not agree with the results of the effect of sodium hypochlorite (NaClO) on seeds. Their study on Acacia Senegalensis shows that NaClO treatment leads to too rapid an entry of water into the embryo, which then develops pathologically.

CONCLUSION

Cowpeas occupy an important place in the world's agricultural production system. Unfortunately, its production often encounters constraints linked to rainfall irregularities, declining soil fertility and the attack of various pests leading to poor seed germination. The aim of this study was to evaluate the effect of seed pre-treatment with sodium hypochlorite (NaClO) and optimal water volume on cowpea germination speed. Analysis of variance showed a high degree of variability between genotypes with regard to different soaking times. Significant differences were observed at interaction level and then at genotype level, the main source of variability. The performance of each genotype in relation to the adapted soaking time was also observed. The application of the decontaminant sodium hypochlorite and the volume of irrigation water showed a clear improvement in germination speed. These results can be seen as a step forward in varietal improvement programs. It would therefore be of interest to all researchers to intensify research into seed pre-treatment for better adaptation of cowpea to saline soils where rainfall is deficient. This preliminary work has enabled us to establish an experimental protocol and identify controls for similar experiments involving the largest possible number of genotypes.

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