PEARL MILLET SEED PELLETING[1]

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ABSTRACT - The pearl millet seed is small and its size varies, making sowing more difficult. The pelleting technique increases and homogenizes seed size, but it is essential to determine the physical and physiological characteristics of pelleted seeds. The physiological analysis consisted of: first germination count, final germination, speed emergence index, and seedling emergence. Physical analysis consisted of determining the 1000-seed weight, 1000-seed volume and fragmentation. The control treatment did not receive any coating, and the other 36 treatments combined four binders: bentonite, polyvinyl acetate (PVA), polyvinylpyrrolidone (PVP) and methyl cellulose (Methocel®), and nine powder coating products: microcellulose, plaster, vermiculite, magnesium thermophosphate (Yoorin®), phytic acid, dicalcium phosphate, super simple phosphate (SS), monoamonic phosphate (MAP) and reactive phosphate. Among the materials used to form the pearl millet pellet, the most efficient binders were the polyvinyl acetate and the methyl cellulose, and as coaters, the vermiculite and the microcellulose.

Index terms: coating, *Pennisetum glaucum* (L.) R. BR, binders.

PELETIZAÇÃO DE SEMENTES DE MILHETO

RESUMO - As sementes de milheto são pequenas e têm tamanho variado, vindo a dificultar a semeadura. A técnica de peletização aumenta e uniformiza a forma das sementes. No entanto, é necessário determinar as características físicas e fisiológicas das sementes peletizadas. Logo, as análises fisiológicas consistiram do teste de germinação, primeira contagem de germinação, índice de velocidade de emergência e emergência final. As análises físicas consistiram do teste de peso de mil sementes, volume de mil sementes e fragmentação. A testemunha foi o tratamento de sementes sem peletização, os demais 36 tratamentos combinaram quatro adesivos: bentonita, acetato de polvinilina (PVA), polivinilpirrolidona (PVP) e metil celulose (Methocel®), e nove produtos de enchimento em pó: microcelulose, gesso, vermiculita, termofosfato magnesiano (Yoorin®), fitina, fosfato bicálcico, fosfato super simples (SS), fosfato monoamônico (MAP) e fosfato natural reativo. Dentre os materiais testados para formar a pelota de semente de milheto nesta pesquisa, os adesivos mais eficientes foram o acetato de polvinilina e a metil celulose. Já os materiais de enchimento em pó mais eficientes foram a vermiculita e a microcelulose.

Termos para indexação: recobrimento, *Pennisetum glaucum* (L.) R. BR, adesivos.

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INTRODUCTION

Pearl millet is cultivated in both summer and winter and is used for grazing or for forage, by cutting the plant and making hay. It can also serve for silage, grain production for human consumption and be cultivated to produce straw in a no-till system (Salton; Kichel, 1997).

Gardner e Vanderlip (1989) and Maiti et al. (1990) observed that the lack of uniformity in the development of the millet plant is a problem, which has its origin in the variation in seed size. This prejudices the formation of a suitable plant population for cultivation and an ideal inter-plant distance, and, consequently, potential crop productivity, since natural resources, such as water and sunlight may not be properly used.

Pelleting, which is the technique for coating seeds, is a potential alternative for improving sowing efficiency, since it allows the seeds not only to gain both weight and volume but also standardizes seed size in terms of length, width and thickness. Furthermore, the pellet's external surface is smooth and not deformed, facilitating its planting by seed drills (Silva, 1998).

However, pelleting is mainly used for seeds which have a high market value, such as tobacco, eucalyptus, some vegetables and ornamental plants, but is uncommon for smaller seeds, such as grasses, which have a lower market value,.

The materials used for coating seeds are classified into two groups: binder materials and bulking or coating materials (Gimenez – Sampaio; Sampaio, 1994).

The binders that are commonly used to inoculate vegetable seeds usually originate from polymers and, therefore, have a high molecular weight; included among these are Gum Arabic, methyl cellulose, polyvinylpyrrolidone (PVP) and polyvinyl acetate (PVA). According to Silva & Nakagawa (1998a), the "Cascorez Extra®" PVA adhesive was the one which showed the best physiological performance for coating cucumber, lettuce and tomato seeds.

Howieson et al. (1987) found that the use of PVP is appropriate for coating seeds that will be submitted to impact and abrasion during sowing or those which will be mixed with fertilizers.

The methyl celluloses, such as Methofas®, Cellofas® and Methocel®, are non-ionic cellulose ethers, soluble in water, which are recommended because they are semi-synthetic polymers that are economic due to their low use concentrations (Scott, 1989).

Silva at al. (2002) also studied bentonite as a binder for pelleting lettuce seeds. Evaluating different combinations of bentonite and PVA, they found that bentonite aggregates the coating particles and that a 100% use of bentonite, after drying at 36 ^{o}C, improved seed quality.

There has been a variety of promising products used for coating seeds, including microcrystalline cellulose (microcellulose), which is a thin, white, odorless, crystalline powder, originating from partial acid hydrolysis that causes depolymerization of the cellulose chains. These particles are not fibrous and they aggregate to form tablets that rapidly disintegrate in contact with water (Almeida, 2004).

However, other products are being tested as a coating for pelleting seeds, but their viability will depend on their compatibility with the binders and other materials on the seeds.

The objective of this study was to determine the physical characteristics of the pellet and the physiological quality of the seeds used in the pelleting of Pearl millet seeds submitted to different binders and coaters.

MATERIAL AND METHODS

The pelleting process was done at the IPEF, a research institute of the University of São Paulo (USP). All the physical and physiological analyses were made at the Seed Science Laboratory of ESALQ/USP in Piracicaba-SP.

The seeds used in this study came from a BRS 1501 seed lot, previously hand-classified using several sieves, and choosing those seeds which remained in the 3.5 mm oblong hole sieve.

The machine used in the pelleting process is composed of a convex stainless steel chamber, which has an adjustable and automated rotation speed. The coating product was added manually with the help of an ordinary sieve. The binders, diluted in water, were added with a plastic sprayer capable of spraying 10 mL of binder at every 40 sprays. The binders, in the form of a powder, were mixed to the products along with water sprays during the pelleting process.

The pelleting technique consisted of placing 15 g of seeds in the rotating chamber, followed by 5 mL of binder, intercalated with 3 g of coating, which were added until the pellets achieved the required diameter to be classified by a 4.5 mm round hole sieve. Those seeds that did not reach the minimum required size were returned to the machine to complete the pelleting process; the procedure was repeated until all the pellets reached the minimum established width of 4.5 mm.

There were 37 treatments; the control seeds received no coating and the other 36 treatments combined four binders: bentonite, polyvinyl acetate (PVA), polyvinylpyrrolidone (PVP) and methyl cellulose (Methocel®) and nine coating products as powders: microcrystalline cellulose, plaster, vermiculite, magnesium thermophosphate (Yoorin®), phytic acid, dicalcium phosphate, super simple phosphate (SS), monoamonic phosphate (MAP) and reactive phosphate.

In order to give the pellet physical resistance to the individual coating compounds, 20% (vol./vol.) of microcrystalline cellulose (proportion 4:1) was added to each coating compound in each treatment and these treatments were then compared with those which did not have microcrystalline cellulose added (Table 1).

TABLE 1. Combination and proportion of adhesive and powder coating products used in the pearl millet (Cultivar BRS 1501) pelleting process.

Binders	Coating powders							
Bentonite Methocel PVA PVP	Microcel.	Magnes. Thermoph.	Bicalc. Phosph.	Phytic acid	SS	MAP	Plaster	Vermiculite
Bentonite Methocel PVA PVP	Microcel.	Magnes. Thermoph.+ Microcel. (4:1)	Bicalc. Phosph.+ Microcel. (4:1)	Phytic acid + Microcel. (4:1)	SS + Microcel. (4:1)	MAP + Microcel. (4:1)	Plaster + Microcel. (4:1)	Vermiculite + Microcel. (4:1)

The treatments that did not receive the microcrystalline cellulose to the coating product were evaluated for fragmentation, which is a physical characteristic of the pellet. However, those treatments which had the microcrystalline cellulose added to the coating powder were evaluated for physical and physiological characteristics.

The binders were applied as follows: 80 g of bentonite were diluted in 1 L of water; PVA was diluted in water in the proportion of 20% (vol./vol.); methyl cellulose was mixed with the coating powder at a proportion of 10% (vol./vol.); and PVP was diluted in water at a proportion of 10% (vol./vol.).

After the pelleting process, the seeds were dried by artificial aeration at 30 ºC for 30 minutes. Random seed samples were collected to check the water content of most treatments with binder diluted in water and ensuring that the moisture content was not above 11%.

The physical analysis consisted of determining the 1000-seed weight, 1000-seed volume and fragmentation. The weight was determined according to the "Rules for Testing Seeds" (Brasil, 1992), using 8 replications of 100 seeds. The 1000-seed volume was obtained from the average value of 2 measurements of the volume occupied by an established mass of seeds dropped (free fall) into a graduated beaker.

The fragmentation test consisted of manually shaking a plastic bag with 50 seeds for one minute. Four replications of 50 seeds for each treatment were tested. The fragmentation was evaluated visually and the total number of cracked or broken pellets was counted with the help of a 10x hand lens. The results were expressed as the total number of fragmented seeds (Mendonça et al., 2007).

The physiological analysis consisted of: first germination count (FGC), final germination at day 7 (G), seedling speed emergence index (SEI), and final emergence at day 7 (FE) (Bahry et al., 2007).

The experiment used a completely randomized design, with four replications. The experimental design was a factorial of 4 x 9 (binders x coatings) plus the control, with a total of 148 experimental units. Statistical analysis included analysis of variance and a comparison of means using the Dunnett and Tukey test ($p \leq 0.05$).

RESULTS AND DISCUSSION

The fragmentation analysis of the pelleted material (Table 2) showed that the microcrystalline cellulose significantly affected the integrity of the pelleted seeds, by increasing pellet resistance in most treatments.

Reactive phosphate, phytic acid and plaster were the coating products which fragmented most when associated with bentonite and PVP without the addition of microcrystalline cellulose. However, the number of fragmented seeds decreased when microcrystalline cellulose and PVP were added to the other products.

TABLE 2. Mean percentage of the pearl millet seed pelleting combinations (cultivar BRS 1501) submitted to the fragmentation test.

	Bentonite	Methocel	PVA	PVP	MEAN
Fragmentation (0% of microcellulose addition)					
Microcellulose	0Aa	0Aa	0Aa	0Aa	0
Magn. Thermophosphate	32Cc	0Aa	2Aa	22Bb	14,2
Reactive Phosphate	39Cc	0Aa	5Aa	31Bc	18,8
Phytic acid	36Cc	0Aa	19Bbc	31Cc	21,7
SS	0Aa	0Aa	0Aa	0Aa	0
MAP	0Aa	0Aa	0Aa	0Aa	0
Dicalcium Phosphate	23Bb	0Aa	24Bc	37Cc	20,8
Plaster	35Cc	2Aa	13Bb	32Cc	20,5
Vermiculite	5Aa	0Aa	0Aa	0Aa	1,2
MEAN	19	0,2	6	17	
CV%		28,8			
Fragmentation (20% of microcellulose addition)					
Microcellulose	0Aa	0Aa	0Aa	0Aa	0
Magn. Thermophosphate	20Bc	0Aa	0Aa	1Aa	5,2
Reactive Phosphate	28Cde	0Aa	0Aa	10Bb	9,7
Phytic acid	23Bcd	0Aa	0Aa	4Aa	7,0
SS	0Aa	0Aa	0Aa	0Aa	0
MAP	0Aa	0Aa	0Aa	0Aa	0
Dicalcium Phosphate	12Bb	0Aa	0Aa	3Aa	3,8
Plaster	31Ce	0Aa	5Aa	20Bc	14
Vermiculite	0a	0a	0a	0a	0
MEAN	12,8	0	0,5	4,3	
CV%		31,2			

* The means within each column and followed by the same letter, as well as the means within each line and followed by the same capital letter do not differ among themselves, according to the Tukey statistical test, on a 5% level of probability

Among the seeds pelleted with 20% microcrystalline cellulose added to the coating powder, the highest fragmentation level was observed in the mixture of plaster with bentonite, which was the binder that gave the lowest resistance to the pellet, followed by PVP. On the other hand, methyl cellulose and PVA were the most efficient binders for maintaining the integrity of the pearl millet seed pellets.

According to Silva and Nakagawa (1998a), pellet consistency is established by the resistance of the bind between the particles of the binder and the coating powder. Therefore, the higher the proportion of the binder, or the larger the surface of contact, considering both the size and the porosity of the particles of the product used as coating, the higher is the binding capacity of the pellet structures.

Considering the information above, the coating products used in this study that showed significantly greater pellet integrity, were microcellulose, super simple phosphate, monoamonic phosphate and vermiculite.

The results of this study for the combination of vermiculite with PVA, for pellet integrity, were similar to those reported by Mendonça et al. (2007), who demonstrated the superiority of this treatment for pellet integrity compared to the other treatments.

Table 3 shows that there was no significant difference between the treatments for 1000-seed weight compared to the control. However, the 1000-seed volume was significantly higher for all the treatments compared to the control

TABLE 3. Analysis of variance results for the 1000 seed weight, 1000 seed volume, germination at 7 days (G) , first germination count (FGC), seedling speed emergence index (SEI) and final emergence count (FE) of the pearl millet seeds cultivar BRS1501, which were pelleted with combinations of binders and powder coating materials containing 20% of microcellulose, compared to the non-pelleted seeds.

Treatment x Check	Coating powder	Adhesive	1000-seed weight	1000-seed vol.	FGC	G	SEI	FE
1	Microcellulose	Bentonite	ns	+	ns	ns	ns	ns
2	Microcellulose	Methocel	ns	+	ns	ns	ns	ns
3	Microcellulose	PVA	ns	+	ns	ns	ns	ns
4	Microcellulose	PVP	ns	+	ns	ns	ns	ns
5	Magnesium Thermo	Bentonite	ns	+	-	-	-	-
6	Yoorin	Methocel	ns	+	ns	ns	ns	ns
7	Yoorin	PVA	ns	+	ns	ns	ns	ns
8	Yoorin	PVP	ns	+	ns	ns	ns	ns
9	Reactive Phosphate	Bentonite	ns	+	-	-	-	-
10	Reactive Phosphate	Methocel	ns	+	-	-	-	-
11	Reactive Phosphate	PVA	ns	+	-	-	-	-
12	Reactive Phosphate	PVP	ns	+	-	-	-	-
13	Phytic acid	Bentonite	ns	+	ns	ns	ns	ns
14	Phytic acid	Methocel	ns	+	ns	ns	ns	ns
15	Phytic acid	PVA	ns	+	ns	ns	ns	ns
16	Phytic acid	PVP	ns	+	ns	ns	ns	ns
17	Dicalcium Phospate	Bentonite	ns	+	-	-	-	-
18	Dicalcium Phospate	Methocel	ns	+	-	-	-	-
19	Dicalcium Phospate	PVA	ns	+	ns	ns	ns	ns
20	Dicalcium Phospate	PVP	ns	+	ns	ns	ns	ns
21	SS	Bentonite	ns	+	-	-	-	-
22	SS	Methocel	ns	+	-	-	-	-
23	SS	PVA	ns	+	-	-	-	-
24	SS	PVP	ns	+	-	-	-	-
25	MAP	Bentonite	ns	+	-	-	-	-
26	MAP	Methocel	ns	+	-	-	-	-

Continua...

Continuação...

Treatment x Check	Coating powder	Adhesive	1000-seed weight	1000-seed vol.	FGC	G	SEI	FE
27	MAP	PVA	ns	+	-	-	-	-
28	MAP	PVP	ns	+	-	-	-	-
29	Plaster	Bentonite	ns	+	ns	ns	ns	ns
30	Plaster	Methocel	ns	+	ns	ns	ns	ns
31	Plaster	PVA	ns	+	ns	ns	ns	ns
32	Plaster	PVP	ns	+	ns	ns	ns	ns
33	Vermiculite	Bentonite	ns	+	ns	ns	ns	ns
34	Vermiculite	Methocel	ns	+	ns	ns	ns	ns
35	Vermiculite	PVA	ns	+	ns	ns	ns	ns
36	Vermiculite	PVP	ns	+	ns	ns	ns	ns

\+ Significant and superior to the check, by the Dunnett statistical test, on a 5% level of probability;
\- Significant and inferior to the check, by the Dunnett statistical test, on a 5% level of probability;
ns non-significant, by the Dunnett statistical test, on a 5% level of probability;

The physiological analysis showed that some treatments were significantly inferior to the control, including those that had the following coating products: the reactive phosphate, the super simple phosphate, the monoamonic phosphate, dicalcium phosphate (with bentonite and methyl cellulose) and magnesium thermophosphate associated with bentonite.

These physiological results support the conclusions reported by other authors with other species. When working with tomato seeds, Oliveira et al. (2003) concluded that seeds pelleted with combinations of microcellulose, sand and/or calcareous rock had a lower germination speed than the non-pelleted seeds (control).

Physical Analysis

With regard to the 1000-seed weight, the weight increase of the pelleted seeds varied among the powder products and, at a lesser degree among the binders.

Table 4 shows that the super simple phosphate, followed by magnesium thermophosphate, dicalcium phosphate and monoamonic phosphate, were the coating materials which gave a higher increase in seed weight. The degree of the seed weight increase is evident when comparing the mean value of the super simple phosphate, which provided an increment of 268% when compared to the mean seed weight vale of the vermiculite.

PVA and methyl cellulose were the binders that increased the 1000-seed weight the most and also aggregated the pellet with the lowest fragmentation index when associated with monoamonic phosphate, super simple phosphate, dicalcium phosphate, phytic acid and magnesium thermophosphate. Bentonite was the least efficient in increasing the 1000-seed weight.

Super simple phosphate, monoamonic phosphate and dicalcium phosphate were the materials that increased volume the most. However, vermiculite was the pelleted material that showed the lowest volume increase, although some authors have emphasized the efficiency of vermiculite as a coating material for pelleting seeds. Evaluating the changes in the physical conditions of carrot seeds that were pelleted in a prototype pelleting machine, Medeiros et al. (2004) used different combinations of vermiculite with polyvinyl acetate (PVA) and obtained significant results for the 1000-seed weight and final machine production.

The PVA and the methyl cellulose were the binders that increased the 1000-seed weight and 1000-seed volume the most.

Physiological Analysis

Tables 5 and 6 showed that the use of monoamonic phosphate and super simple phosphate damaged the pearl millet seeds, as they caused a reduction in both seed germination and seedling emergence. Similar results were obtained by Soratto et al. (2003), who observed a harmful effect on germination and vigor for the period during which the seeds remained mixed with phosphate fertilizers. Phosphate rock processing using sulphuric (SSP) and phosphoric (TSP) acids leaves residues which adversely affect seed germination and vigor when mixed with the fertilizers, and this effect increases with prolonged contact.

TABLE 4. Mean percentage of the pearl millet seed pelleting combinations (cultivar BRS 1501) submitted to the 1000-seed weight and volume tests.

	Bentonite	Methocel	PVA	PVP	MEAN
1000-seed weight (g)					
Microcellulose	19,3Acd	18,7Ade	19Ad	16,6Aef	18,4
Magn. Thermophosphate	23,1Cbc	36Bab	40Aa	22,2Ccd	30,3
Reactive Phosphate	11,4Df	22,3Bcd	26,6Ac	17,8Cdef	19,5
Phytic acid	16,8Ade	17,2Ae	18,7Ad	16,4Aef	17,3
SS	35,3Ba	39,1ABa	42,3Aa	38,8ABa	38,9
MAP	23,4Abc	26,4Ac	26,7Ac	23,8Ac	25,1
Dicalcium Phosphate	26,6Bb	31,5Ab	32,7Ab	28,8ABb	25,9
Plaster	16,3Bde	17,6ABde	18,8ABd	20,4Acde	18,3
Vermiculite	12,5Aef	15,5Ae	15,2Ad	14,7Af	14,5
MEAN	20,5	24,9	26,7	22,2	
Check			9,6		
CV%			8,9		
1000-seed volume (ml)					
Microcellulose	34,4Abc	31,2ABb	33,2Ad	27,3Bcd	31,5
Magn. Thermophosphate	27,1Cde	37,8Bb	45,6Abc	25,7Ccd	34
Reactive Phosphate	21,2Ce	37Ab	41,2Ac	30,5Bbc	32,5
Phytic acid	24,1Ade	23,8Ac	25,6Aef	23,3Ad	24,2
SS	42,9Ba	45,7Ba	55,2Aa	48,5Ba	48,1
MAP	40,8Aab	45,6Aa	45,5Abc	43,8Aa	43,9
Dicalcium Phosphate	42,3Ba	48ABa	49,2Aab	42,6Ba	45,5
Plaster	30,1Acd	32,8Ab	32,2Ade	35,3Ab	32,6
Vermiculite	20,6Ae	23,6Ac	24,5Af	23,3Ad	23
MEAN	31,5	36,2	39,1	33,4	
Check			12,8		
CV%			8,9		

* The means within each column and followed by the same letter, as well as the means within each line and followed by the same capital letter do not differ among themselves, according to the Tukey statistical test, on a 5% level of probability

Phytic acid favored the germination of the pearl millet seeds but the other products gave results which were inferior to the ones shown by the control and by the phytic acid (Table 5). There was no significant difference in the germination of the seeds for the binders.

As observed in Table 6, the results of the seedling speed emergence index and the seedling final emergence demonstrated a significant difference between bentonite and the other binders. However, the PVA binder, “Cascorez Extra®”, was toxic to the emerged pearl millet seedling, causing leaf chlorosis for up to 21 days after seedling emergence but it did not influence the SEI average values and final seedling emergence. Similar results were observed by Silva & Nakagawa (1998a), when they observed that a binder based on polyvinyl acetate (PVA), "Grundi Extra®", was toxic to cucumber and tomato seeds for the final germination tests, germination speed, final emergence and seedling speed of emergence.

TABLE 5. Mean percentage of the pearl millet seed pelleting combinations (cultivar BRS 1501) submitted to the germination at 7 days (G) and first germination count (FGC), tests.

First germinating counting (%)					
	Bentonite	Methocel	PVA	PVP	MEAN
Microcellulose	69.5Ab	66.5Ab	70Aa	73Aa	69.7
Magn. Thermophosphate	69Ab	76Aab	71Aa	71.5Aa	71.8
Reactive Phosphate	64Ab	70Aab	66Aa	71Aa	67.7
Phytic acid	81Aa	78ABa	70.5Ba	73.5ABa	75.7
SS	0Ac	0Ac	0Ab	0Ab	0
MAP	0Ac	0Ac	0Ab	0Ab	0
Dicalcium Phosphate	66.5Ab	70Aab	72.5Aa	73.5Aa	70.6
Plaster	69.5Ab	66.5Ab	68.5Aa	69.5Aa	68.5
Vermiculite	69Ab	69Aab	69Aa	68.5Aa	68.8
MEAN	54.2	55.1	54.1	55.6	
Check			76.5		
CV%			8.7		
Germination at 7 days (%)					
Microcellulose	72.5Aab	70Aa	71.5Aa	76Aa	72.5
Magn. Thermophosphate	72.5Aab	77.5Aa	77.5Aa	74.5Aa	75.5
Reactive Phosphate	70.5Ab	72Aa	71Aa	75.5Aa	72.2
Phytic acid	82.5Aa	80Aa	75.5Aa	75Aa	78.2
SS	0Ac	0Ab	0Ab	0Ab	0
MAP	0Ac	0Ab	0Ab	0Ab	0
Dicalcium Phosphate	66.5Bb	72ABa	75Aa	78Aa	72.8
Plaster	72.5Aab	70Aa	72Aa	72.5Aa	71.7
Vermiculite	74Aab	76Aa	73.5Aa	74Aa	74.3
MEAN	56.7	57.5	57.3	58.3	
Check			78		
CV%			8		

* The means within each column and followed by the same letter, as well as the means within each line and followed by the same capital letter do not differ among themselves, according to the Tukey statistical test, on a 5% level of probability

TABLE 6. Mean percentage of the pearl millet seed pelleting combinations (cultivar BRS 1501) submitted to the seedling speed emergence index (SEI) and final emergence count (FE) tests.

	seedling speed emergence index (%)				
	Bentonite	Methocel	PVA	PVP	MEAN
Microcellulose	13.4Bab	14.1Bbcd	14Bb	17.1Aa	14.7
Magn. Thermophosphate	12.2Ab	13.2Abcd	13.5Ab	14.5Aab	13.3
Reactive Phosphate	11.9ABb	12.1ABd	9.9Bc	12.6Ab	11.6
Phytic acid	13.5Bab	17.1Aa	15.2ABab	14.6Bab	15.1
SS	0Ac	0Ae	0Ad	0Ac	0
MAP	0Ac	0Ae	0Ad	0Ac	0
Dicalcium Phosphate	11.9Bb	12.5Bcd	15.7Aab	15.4Aab	13.9
Plaster	14.3Aab	15.3Aabc	15.7Aab	14.6Aab	15
Vermiculite	15.2Aa	15.5Aab	16.9Aa	15.7Aa	15.8
MEAN	10.2	11.1	11.2	11.6	
Check			15.5		
CV%			11.6		
	final emergence counting at 7 days(%)				
Microcellulose	63Ba	65.5ABabc	67.5ABa	75.2Aa	67.8
Magn. Thermophosphate	57.5Ba	66.5ABabc	68Aa	68Aab	65
Reactive Phosphate	55.5ABa	57Ac	47Bb	58.5Ab	54.5
Phytic acid	62Ba	76Aa	69.5ABa	67.5ABab	68.7
SS	0Ab	0Ad	0Ac	0Ac	0
MAP	0Ab	0Ad	0Ac	0Ac	0
Dicalcium Phosphate	56Ba	58Bbc	76.5Aa	69.5Aab	65
Plaster	66.5Aa	72Aa	71.5Aa	68Aab	69.5
Vermiculite	67Aa	69.5Aab	74.5Aa	70.5Aab	70.3
MEAN	47.5	51.6	52.7	53	
Check			72		
CV%			10,5		

* The means within each column and followed by the same letter, as well as the means within each line and followed by the same capital letter do not differ among themselves, according to the Tukey statistical test, on a 5% level of probability

Among the coaters, the results were homogeneous for both the seedling speed emergence index and seedling final emergence evaluations. Although there are exceptions, such as the reactive phosphate, which was significantly inferior when compared to the others, and also both the super simple phosphate and monoamonic phosphate, that inhibited seed germination.

As the percentage of germination and emergence were similar to the ones verified with the check (unpelleted seeds), the results obtained with vermiculite were similar to the ones obtained by Medeiros et al. (2006) for carrot seeds. They evaluated the physiological performance of pelleted carrot seeds using vermiculite as the coating material and polyvinyl acetate (PVA) as binder and found that using vermiculite as a coater, in a 3:1 proportion (vermiculite:seed) associated to the PVA as binder and the fungicides thiram + carbendazim, did not affect germination.

The physiological results obtained with the treatment that used magnesium thermophosphate on pearl millet seeds, did not differ significantly from the control and the other treatments, and contrast with the results obtained for other species. According to Silva and Nakagawa (1998b), the pelleting of lettuce seeds with thermophosphate (Yoorin®) adversely affected seedling emergence, germination and the seedling speed emergence index.

However, Magalhães et al. (1994), evaluating the effect of different fertilizer coatings on sorghum seeds, observed that the treatment with magnesium thermophosphate (Yoorin®) gave the best results for all the physiological analyses.

CONCLUSIONS

Among the materials used to form the pearl millet pellet, the most efficient coaters are the vermiculite and the microcrystalline cellulose.

The coating materials, microcrystalline cellulose, phytic acid, plaster, vermiculite and magnesium thermophsphate do not cause a significant difference in the physiological performance of the seeds. On the other hand, super simple phosphate (SS) and monoamonic phosphate cause significant damage to seed physiological performance.

The most efficient binders, both physically and physiologically, are the polyvinyl acetate (PVA) and the methyl cellulose, called “Methocel®”.

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