Germinación de semillas de Pinus patula en residuos de cáscara de nuez (Juglans regia L.) en vivero

Seed germination of Pinus patula in waste Nutshell (Juglans regia L.) in nursery

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RESUMEN

El presente trabajo evaluó la capacidad germinativa de *Pinus patula* Schl. *et* Cham en vivero, utilizando composta de cáscara de nuez de castilla y sustituyendo paulatinamente el Peat Moss. Se utilizó un diseño experimental completamente al azar con 100 repeticiones por tratamiento, donde se estudiaron cuatro mezclas de sustratos a base de cáscara de nuez, más agrolita y vermiculita en proporciones que variaron desde 33 % hasta 80 % de cáscara de nuez y la mezcla de sustratos comerciales.

Palabras clave: sustrato, cáscara de nuez, capacidad germinativa, Peat Moss.

Abstract

This paper evaluates the germination capacity of Pinus patula Schl. et Cham nursery, using compost shell walnuts and gradually replacing the Peat Moss. A pilot randomized design with 100 replications per treatment, where four mixtures of substrates were studied based Nutshell, more agrolita and vermiculite in proportions ranging from 33% to 80% walnut shell and mix commercial substrates.

Key Words: substrate, Nutshell, germination capacity, Peat Moss.

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Introduction

Chemistry based substrate nutshell presents macronutrients nitrogen, phosphorus, potassium and micronutrients such as Cu, Zn, Mn, Ca, Mg and Fe, of great importance for the development of seedlings, and the composition of matter organic. After 30 days of germination, the seedlings were grown in the control treatment (Peat Moss vermiculite 33% + 33% + 33% perlite) and treatment 3 (Nutshell vermiculite 50% + 25% + 25% perlite) had significantly higher percentages of germination compared to the other treatments ($p < 0.05$), which between them showed no statistically significant differences. The substrate based nutshell vermiculite 50% + 25% + 25% perlite enables a high germination rate, reducing production costs and contributing to forest productive sector.

Forests are disappearing rapidly and continue the current rate of deforestation, forest areas will end in this century (Greenpeace Mexico, 2009). According to figures from the Secretariat of Environment and Natural Resources (SEMARNAT, 2010), 45% of the country has some type of degradation, mainly due to the change of use of land for agricultural activities. Mexico currently ranks fifth in the world in deforestation (World Resource Institute, 2012).

Given the current need to restore missing vegetation cover through reforestation programs, especially with native species and diverse forest products (wood, wood, pulp, resins and edible seeds, etc.), as well as ecological services uptake water, oxygen, carbon capture and recreation that contribute to balance the environment (Wightman and Santiago, 2003). The nurseries have gained an important role as supplier of plants, especially now that its importance for the conservation of biodiversity (Benitez et al., 2002) is recognized.

Mexico is the country with the largest number of species of pine (Greenpeace Mexico, 2009), they have great ecological, economic and social importance (García and Gonzales, 2003; Ramirez et al., 2005). Pinus patula Schl. . et Cham, commonly known as pitch pine, red pine, pine slouch, is a species of great economic and ecological importance; due to its productive potential and ability to adapt to different soil and climatic conditions, it is widely used for projects of reforestation and commercial forest plantations, which are aimed at producing good quality wood for low resin content, free of knots and straight shank (Velazquez et al., 2004).

There are approximately 4,230 ha planted with P. patula in Mexico. The state of Puebla, in the program of PROARBOL obtained in 2010 the sixth nation in reforestation, below states like Veracruz, Chiapas, Coahuila, Jalisco and San Luis Potosi. The total area planted during the end of 2010 amounts to 2427.00 ha, for which an amount exceeding 16 million pesos in various regions of the state erogó.

P. patula production depends on such factors as: the appropriate selection of substrates for the preparation of growth media as a suitable mixture should have physical and chemical properties that allow the timely availability of nutrients and water (1997 Bures Matthew 2002, Bobby and Valdivia 2005, Martinez et al., 2009).

Currently the concern of the nursery lies in high production costs caused by the use of imported substrates. In Mexico it is used as main substrate for the production of plants in rigid containers, a mixture of peat (Peet Moss), perlite and vermiculite mainly in proportions of 6: 3: 1, it should explore options for replacing peat with other local products that contribute to reducing costs and ensuring the quality of the plant (Bastida 2002, Arteaga et al., 2003). Finding new viable alternative substrates for the production of nursery plants is necessary, peel walnuts (Juglans regia L.), which is a residue of nut production, which reaches a wide distribution and economic importance world, world production of walnut shell is about 1,100,000 ton (USDA, Foreign Agricultural Service, 2008); China and the US are the main producing countries, with about 45 and 30% of the world, respectively overall. Mexico ranked 13th on walnuts production worldwide in 2001, 2002 and 2003, with a production of 230 tons. Puebla ranks third nationally in production of walnuts, just below Tamaulipas and Jalisco. The walnuts are one of the main ingredients for the traditional dish "chile in walnut sauce," so it is a highly profitable crop in the state of Puebla (Puebla Produce Foundation, 2010).

The objective of this research was to chemically characterize compost shell walnuts (Juglans regia L.), as a substitute for peat (Peat Moss) for seed germination of P. patula in nursery conditions.

MATERIALS AND METHODS

This research was conducted in the forest nursery Xaltatempa belonging to the "Zempoaltekitini" association which in Nahuatl means "Twenty Men Working", located in the community of Xaltatempa Lucas, in the municipality of Tetela de Ocampo (Figure 1). The municipality of Tetela de Ocampo is located in the northern part of the state of Puebla, in temperate zones; as you move from south to north, the humidity increases, identifying climates ranging from temperate humid to semi, through the humid temperate primarily. The temperature of the coldest month is between -3 and 18 ° C, with an average annual rainfall of 750 mm, while the driest month is greater than 40 mm and the predominant vegetation is pine, mixed with some oak species (pine-oak) (INEGI, 2010).

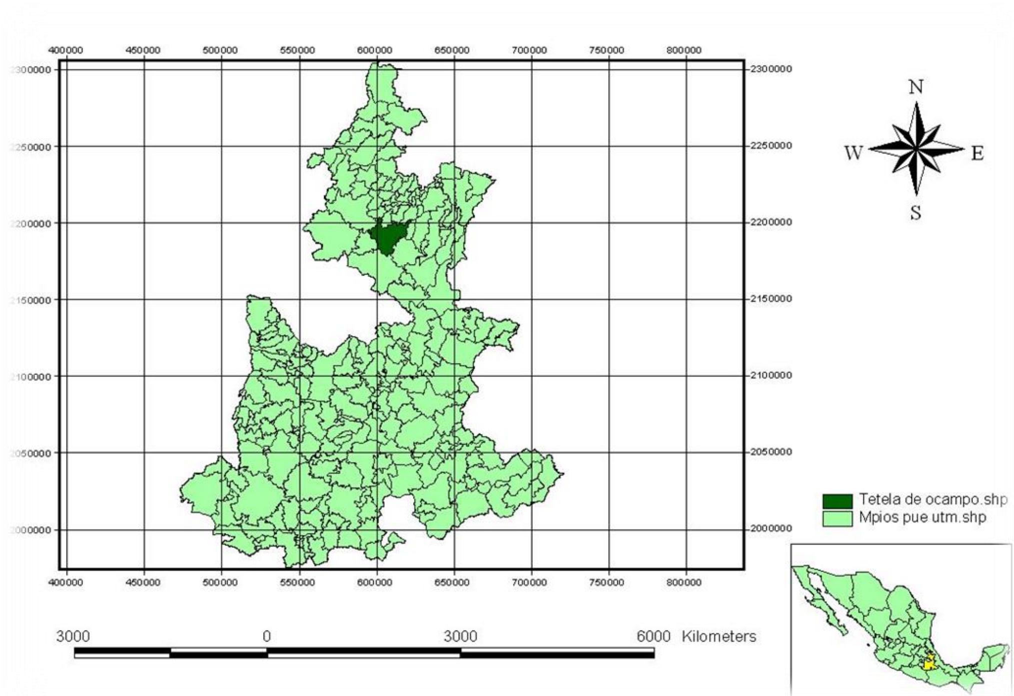

Figure 1. Location of the municipality of Tetela de Ocampo, Puebla.

The composted shell Juglans regia L., used in this research comes from crops made by Community producers Zitlalcuautla population also located in the municipality of Tetela de Ocampo. For the soft husk (mesocarp of the fruit), debarking obtained manually separate the seed contained in the fruit peel and walnuts (Figure 2) was performed. The preparation of the compost was done in trenches 1 m deep, where it was deposited and 80% homogenized shell walnuts with 20% of forest soil; later, he covered with black plastic to increase the temperature at 75oC, during the first two weeks of composting. Composting shell walnuts takes six months, and during turns from green to black. 3 irrigations per day were made to keep the humidity to 60% through oscillatory movements performed every 2 weeks; at the end of the process, a mixture of black color and pleasant odor was obtained. Finally, it sieved to obtain a fine grit that would be used subsequently in the preparation of the treatments. A sample shell walnuts was obtained for analysis of fertility substrate and saturation extract at the National Laboratory of Soil Fertility and Plant Nutrition, National Institute of Forestry, Agriculture and Livestock (INIFAP) located in the Campo Experimental Bajio in Celaya, Guanajuato.

Figure 2. Obtaining shell walnuts (alternative substrate).

Seedling stage

1,600.00 seeds of P. patula, which were provided by the Forest Seed Bank nursery Pueblo Nuevo, located in the municipality of Chignauhaupan, Puebla were used. They distributed approximately at a spacing of 1 x 1 cm to facilitate determination of the total count and percentage of germination. As it was covered with a thin layer of mineral perlite commercial substrate, avoiding the formation of moss and compaction of the seed. A wooden base 40 * 40 mesh construction and was used in planting seedbed to retain the substrate and maintain drainage of seedlings in the initial development includes 16 divisions, allowing separate each treatment and their repetitions. Each division represents 100 cm2 per experimental unit. A plastic cover that allowed the entry of full sunlight to catch the ultraviolet rays and create a favorable microclimate for germination of seeds used, avoiding the incidence of wind and some pests that could harm the development of seedlings; Irrigation was done every third day in the morning for 30 days. For the seed to germinate easily and does not suffer dehydration in its initial development, the practices were developed according to the procedures the nursery staff performs daily.

Conventional substrates peat (Peat Moss), perlite and vermiculite were obtained in the City of Puebla. Mixtures of each treatment are shown in Table 1. Treatment was the one that was taken as a witness, as the mixture is normally used in the Xaltatempa nursery, where the research was conducted, while nutshell was used in increasing percentages, starting from 33% replacing the used amount of peat, to increase its concentration in 80% (Reyes et al., 2005 and Cobas et al., 2003).

Table 1. Proportions of the components to be tested using the nutshell as a substitute for Peat Moss, Tetela de Ocampo 2013.

		%			
Tratamientos	**Cáscara de nuez**	**Peat Moss**	**Agrolita**	**Vermiculita**	**Total**
T1*		33.3	33.3	33.3	
T2	80		10	10	
T3	50		25	25	100
T4	33.3		33.3	33.3	

T1* = Testigo, mezcla utilizada comúnmente en el vivero forestal de Xaltatempa

Evaluation of variables

The final germination capacity (CG), according to the methodology of Camacho-Morfin (1994), was used to determine differences between the tested treatments. The expression for the variable to be analyzed is:

$$Germination = (Ae \times 100/M)$$

Donde:

CG: Germination and final germination percentage
Ae: Accumulated germination to last assessment
M: Sample evaluated, corresponding to the total sown seeds

The obtained data were processed in the statistical package SPSS version 17 (Statistical Package for Social Sciences) for the analysis of variance (ANOVA) and then the multiple comparison test of Tukey ($p < 0.05$) was applied to determine significant differences between treatments.

RESULTS AND DISCUSSION

The chemical composition of the substrate through compost made of shell walnuts is presented in Table 2, included as macronutrients (N, P, K) and micronutrients (Cu, Zn, Mn, Ca, Mg, Fe) of great importance for the development of seedlings as well as the composition of organic matter where a value was found 6.99% in the nutshell. This result can be compared with the results found by Arteaga (2003), ranging from 1.0 to 14.4%; components of such substrates were used: forest soil, agricultural land, river floor, each combined with oak leaf. According to Donahue et al., (1981), nitrogen is the most critical and essential for plant growth element, however, the composition of the compost based nutshell shows very low levels of this mineral element (N), like magnesium. Phosphorus (P) and potassium (K) are essential nutrients for the development of seedlings and very high levels in compost based nutshell. With regard to calcium (Ca), this is presented in a medium, nutrition studies of forest species show that calcium needs are very small, especially in the pines level. The proportion of copper (Cu) in the compost walnut shell has a moderate low value; manganese (Mn), moderately high; and zinc (Zn), very high. These three metals are essential to plant growth, although small amounts required by plants; agricultural soils typically contain one or more micronutrients such that its concentration in the tissues of plants falls below levels that allow optimal growth (Roca, 2007).

Table 2. Chemical composition of the shell walnuts (*J. regia* L.).

Determinación	Rango de fertilidad							
	Muy bajo	Bajo	Mod. bajo	Mediano	Mod. alto	Alto	Muy alto	Unidades
Materia orgánica (MO)							6.99	%
Nitrógeno (N)	2.82							Ppm
Fosforo (P)							219	Ppm
Potasio (K)							1761	Ppm
Calcio (Ca)				1978				Ppm
Magnesio (Mg)	27.8							Ppm
Sodio (Na)							905	Ppm
Fierro (Fe)							71.5	Ppm
Zinc (Zn)							10.3	Ppm
Manganeso (Mn)					13.8			Ppm
Cobre (Cu)			0.61					Ppm

*ppm= Partes por millón

The compost nutshell presented a pH of 7.95 for the analysis of fertility, while the analysis of saturation extract showed a pH of 8.09 both considered high according to the rules of general interpretation for chemical properties of substrates analyzed by Extract method Substrate Saturated (Warnecke and Kraus-Kopf, 1983). The pH was similar to those found by Villanueva et al. (1998) in perlite and tezontle latter zero% organic matter, however, Peat Moss found a low pH of 3.9, a concentration of organic matter of 50.9% and an electrical conductivity of 0.26, and a capacity cation exchange (CIC) of 60.40 meq / 100g. In the case of compost based nutshell, has a cation exchange capacity (CEC) of 18.6 and an electrical conductivity (EC) of 1.85 dS / m-1, considered within the ideal range (Warnecke and Kraus-kopf , 1983).

Salinity is of great importance in osmotic potential, although higher levels can cause problems for the processes of water absorption by the roots. In the substrate-based nutshell (Table 3), there are no risks since no high salinity levels (1.85 dS m-1). This result is similar to those reported by Martinez et al. (2009), ranging from 2.0 to 3.1 dS m-1 almond shell. Vargas et al. (2007) shown in chemical determination substrate coconut powder a range of 1.5 to 4.5 dS m-1, with a dry grinding process; however, this high salinity no risk for use as alternative substrate in controlled leaching tests coconut powder. Noguera et al., (2000) concluded that the excess of soluble salts is easily leached with irrigation. The soil saturation extract or substrate reports on the actual availability of nutrients for the plant in the case of the nutshell, but some are below optimal levels; eg meq / l Ca, Mg and Na cations. However, they exceed the ideal level for the K, similar to those reported by Vargas et al. (2007). According bar (1986), tree species, like other plants, need a series of chemical nutritional elements nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, boron, copper, zinc and molybdenum, which must be supplied by the substrate or through fertilization, in this sense, based substrate shell walnuts (Juglans regia L.) presents the micro and macro elements necessary for proper germination in nursery

Table 3. Determination of the saturation extract of the sample substrate shell walnuts (*Juglans regia* L).

Extracto de saturación		
Cationes meq/l	Resultados	Ideal
Ca ++	3.61	5 - 10
Mg ++	0.31	3 - 5
Na +	0.39	5 - 8
K +	15.0	2 - 3
Aniones meq/l	Resultados	Ideal
CO3	0.20	0 – 0.2
HCO3	2.35	2 - 4
Cl -	1.07	4 - 6
SO4	6.84	4 - 6
N – NO3	0	5 - 8
P – PO4	0	5 - 6
Relación nutrimental	Resultados	Ideal
NO3/K		4 - 6
K/Ca	4.16	0 – 0.2
K/Mg	48.4	4 - 6
Ca/Mg	11.6	2 - 4
Ca/Na	9.26	5 - 8

Determining the percentage of germination Pinus patula *Schl. et Cham.*

The results of the analysis of variance show that the percentage of germination, there are significant differences (P <0.05) among the treatments tested (Table 4).

Table 4. The germination percentage variable presented statistical differences between the treatments tested.

	Variable determinada	
	Capacidad germinativa %	Proporciones de sustrato en %
T1*	84.50 a	33-33-33
T2	81.25 b	80-10-10
T3	84.25 a	50-25-25
T4	82.50 c	33-33-33

T1* testigo = Peat Moss, Vermiculita, Agrolita, T2 = Cáscara de nuez, Vermiculita, Agrolita, T3 = Cáscara de nuez, Vermiculita, Agrolita, T4= Cáscara de nuez, Vermiculita, Agrolita. Letras diferentes en la misma columna indican diferencias significativas con la prueba de rango múltiple de Turkey Kramer (p<0.05).

After obtaining the total number of seeds germinated in seedbeds (Figure 3), the germination or percentage of end geeminación capacity was determined according to the methodology of Camacho-Morfin (1994), which consisted of observing the accumulated germination to last assessment (Figure 4).

Figure 8. Seedlings developed by treatment.

the highest value (84.5%) was obtained for treatment 1 (control group) consisting of the control mixture (Peat moss vermiculite 33% + 33% + 33% perlite), followed by treatment 3 (84.25%), composed of 50% compost walnut shell in combination with 25% perlite and 25% vermiculite; treatment 4 to a value of (82.5%) of the tested treatments, while the lowest (81.25%) value was recorded in treatment 2 was obtained.

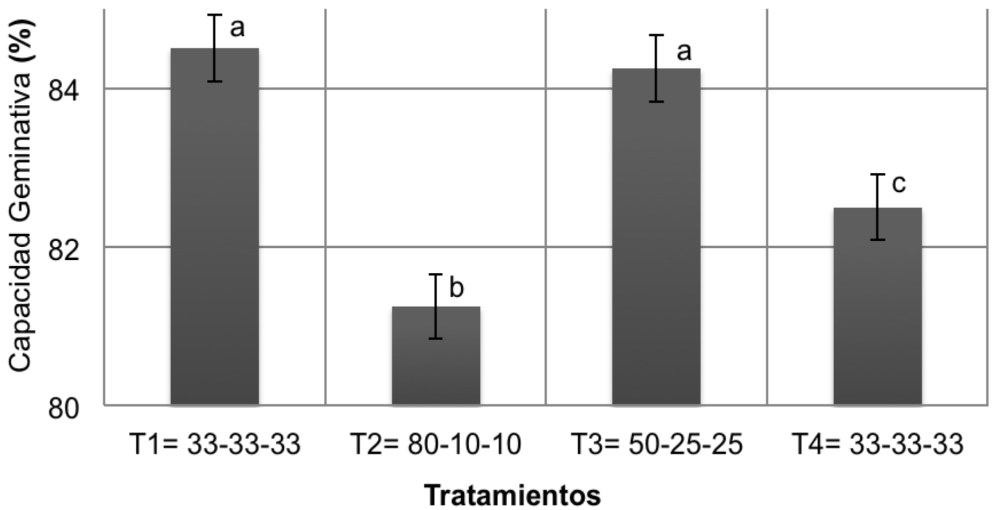

Figure 9. Representation of the percentage of germination

CONCLUSIONS

1. We can conclude that the analysis of fertility and saturation extract of compost based nutshell (Juglans regia L.) features important for the development of seedlings of P. patula elements, though some are below ideally without side effects on the development level.

2. According to the experiment, the compost residue nutshell (Juglans regia L.) can secure more than 80% germination of P. patula in the three inclusion levels (33%, 50% and 80%), replacing conventional substrates, the substrate prepared with T3 nutshell (50%), vermiculite (25%) and perlite (25%) no statistical difference to the control treatment.

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