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EFFECT OF SEED PELLET MODIFICATION ON SPIRAL ROOT FORMATION OF TOBACCO SEEDLINGS

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INTRODUCTION

Tobacco seeds are often pelleted to facilitate precision seeding into float trays. Pelleting consists of the application of solid particles, such as clay, to seeds with a binder in a coating pan or tumbling drum to form spherically shaped dispersal units. One of the several advantages of pelleting is to provide seeds with a vastly enlarged bulk size to ensure proper placement of the seed at the surface of the growing medium.

The occurrence of aerial or "spiral roots" has adversely affected tobacco transplant production in the float system. Spiral roots have an altered geotropism and as a consequence, the roots fail to penetrate the growth medium. Tobacco seedlings with spiral roots may survive but lag behind development of other plants, and will not be usable at transplanting time (Pearce and Palmer, 1998).

The objective of this study was primarily to determine if chemical or physical factors were responsible for spiral roots formation. Seeds were sown on a synthetic growth medium and several treatments were applied to modify the pellet.

MATERIALS AND METHODS

Tobacco (*Nicotiana tabacum* L.) seeds were planted and seedlings were grown in a laboratory at the University of Kentucky, College of Agriculture, Lexington, KY. A lot of raw seed and a corresponding lot of pelleted seed was provided by F. W. Rickard Seeds for three commonly grown burley tobacco varieties (TN-90, KY-14xL8 and NCBH-129). In addition, one lot of pelleted TN-90 was provided by each Newtons Seed Inc. and Clays Seed. The growing medium was a non-nutrient containing agar (1% solution). Sterilization of medium was done with an autoclave for 15 minutes (250^{o} F at 22 lb/in^{2}). Approximately 50 ml of the sterile medium was poured into disposable petri dishes (3.4 x 0.5 inches) forming a stiff transparent gel medium (0.4 inch deep) after cooling.

Treatments applied to seeds and/or pellets were:

- Raw seed: unmodified raw seed from F. W. Rickard Seed was placed on the surface of the planting medium.
- Pelleted seed: unmodified pelleted seed from each company placed on surface of the planting medium.
- (-) Pellet: Seeds with the pellet removed. After softening pelleted seeds with distilled water, seeds were gently extracted from the interior and placed on surface of the planting medium.
- Softer Pellet: Pelleted seeds were moistened (saturated) with distilled water for 30 minutes before being placed on surface of the planting medium.
- Harder Pellet: Pelleted seeds were sequentially wetted and dried 3 times over a 24 hour period prior to placement on the surface of the planting medium.
- Raw Seed+Pellet: Raw seed (all provided by F. W. Rickard Seed) placed on the surface of the planting medium. Softened pellet material (previously removed with distilled water from pelleted seeds) was added to raw seeds on the planting medium.
- Buried Pelleted Seed: Pelleted seeds were placed on the surface of the planting medium and gently pushed into the medium until the top of pellet was flushed with the surface of the medium.

After placing the seeds on the gel medium, the dishes were sealed and kept at room temperature (70-75^{o} F) with 12 hours light for ten days after seeding. Experimental units consisted of a petri dish with 30 seeds. Each treatment x seed lot combination was replicated 4 times and arranged in a completely randomized design. A seed was counted as germinated at the first sign of radicle protrusion from the seed coat or pellet. The final germination count was performed 10 days after seeding. Roots that failed to penetrate the gel medium, and as a consequence showed a contorted pattern, were considered as spiral roots. Incidence of spiral roots was calculated based on the percentage of germinated seeds.

RESULTS AND DISCUSSION

The final percentage of germination for raw, pelleted seeds and modified pellet treatments was approximately 85% or above (Table 1). Removing the pellet material from seeds (-) Pellet) notably reduced germination in all tested varieties. The rates dropped to as low as 63 % on NCBH-129 and 41 % on KY-14xL8 (Table 1). Perhaps a reduced germination has been caused, in part, due to an inadvertent mechanical damage to the seed during the process of removing the pellet. Similar results have been reported on studies of clay-coated sweet pepper seeds (Sachs, et al., 1981). In this case, during the pellet extraction, some clay particles may remain firmly attached to the seed surface affecting a proper radicle protrusion and as a consequence reducing germination. Other pellet modification treatments did not consistently affect the final germination percentage.

The incidence of spiral roots was always higher with the original pelleted seeds compared with raw seed or any other treatment attempting to modify the original pellet (Fig. 1). Removing the pellet significantly reduced the number of spiral roots for TN-90, while on KY-14xL8 and NCBH-129 the differences due to pellet removal were not very pronounced.

Seeds that were moistened prior to placement on the planting medium had a softer pellet as expected. Those seeds showed a lower incidence of spiral roots in all tested varieties. In contrast, a much higher number of spiral roots was expected in hardened pellet seeds. Previously sequential wetting and drying had been shown to increase pellet hardness (personal communication, Larry Swetman).

Apparently, the wetting and drying process applied to the seed pellet was not sufficient to create a significantly harder pellet than the original pelleted seed. Instead, wetting to saturation followed by drying might have resulted in a less structured pellet thus reducing spiral root formation compared to the original pellet. Multiple wetting and drying cycles over a large period of time might be required to significantly harden the pellet.

Raw seeds in the presence of washed pellet material (Raw Seed+Pellet) gave a spiral root response equivalent to raw seeds. In addition, pelleted seed buried into the medium significantly reduced spiral root formation compared to the pelleted seeds placed on the surface. In this particular treatment, seed pellet surface was completely surrounded by the medium and therefore may have been able to absorb a larger amount of water creating a softer pellet for proper radicle penetration and development.

CONCLUSION

It is important to realize that some spiral roots were detected in raw seeds. Since the medium that was utilized in this experiment is free of any kind of chemicals, (such as fertilizer and wetting agents commonly used in peat-based growing medium) it is safe to conclude that spiral root formation observed in this experiment was due primarily to physical factors.

Overall the incidence of spiral root was much higher in this experiment than what is normally observed in the float system. This was probably due to the greater firmness of the gel medium surface as compared to the surface of a typical soilless medium. The fact that adding pellet material back to raw seed (Raw Seed+Pellet) had no effect on spiral root, and that softening the pellet (Softer Pellet) reduced spiral roots, suggested that the effect of the original (unmodified) pellet is due to physical factors.

Roots have the ability to displace particles creating their own pathway. However, in some cases, the seed pellet or the growing medium may be so resistant that the radicle tip becomes obstructed while the elongation zone (behind the root cap) continues to grow. This scenario may lead to a contorted (spiral) pattern, typical of the spiral rooting found in the float system trays.

The fact that a buried pellet reduced spiral root suggests that after placing seeds in the conventional float trays, a fine layer of growing medium could be applied on top of the trays to improve the water uptake by the pellets, therefore creating a more favorable environment for radicle protrusion. Recently, Smith et al. (2000) have reported that covering the float trays with a shallow layer of growing medium can be used to decrease spiral root incidence. However, more research is needed to define the optimum depth of covering, and to determine the margin of error that could be tolerated in covering the pelleted seed.

REFERENCES

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Sachs M., et al. 1981. Germination studies of clay-coated sweet pepper seeds. J. Amer. Soc. Hort. Sci. 106:385-389.

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Table 1: Effect of pellet modification on germination of seeds from different sources and varieties[a].

	Variety (Source)				
	NCBH-129 (Rickard)	KY-14xL8 (Rickard)	TN-90 (Rickard)	TN-90 (Newton)	TN-90 (Clay)
Treatments					
Raw Seeds[b]	85 ± 0.9[b]	91 ± 1.4	98 ± 0.3	___	___
Pelleted Seed	92 ± 0.3	98 ± 0.7	99 ± 0.3	98 ± 0.3	100 ± 0
(-) Pellet	63 ± 2.3	41 ± 3.5	75 ± 0.7	87 ± 1.0	81 ± 1.4
Softer Pellet	98 ± 0.3	94 ± 0.9	97 ± 0.6	91 ± 1.8	91 ± 0.9
Harder Pellet	93 ± 1.1	99 ± 0.3	94 ± 0.3	94 ± 1.2	93 ± 1.0
Raw Seed + Pellet	88 ± 1.2	93 ± 1.5	93 ± 1.5	100 ± 0[c]	100 ± 0[d]
Buried Pellet	90 ± 0.6	96 ± 0.7	94 ± 0.7	93 ± 1.0	97 ± 0.6

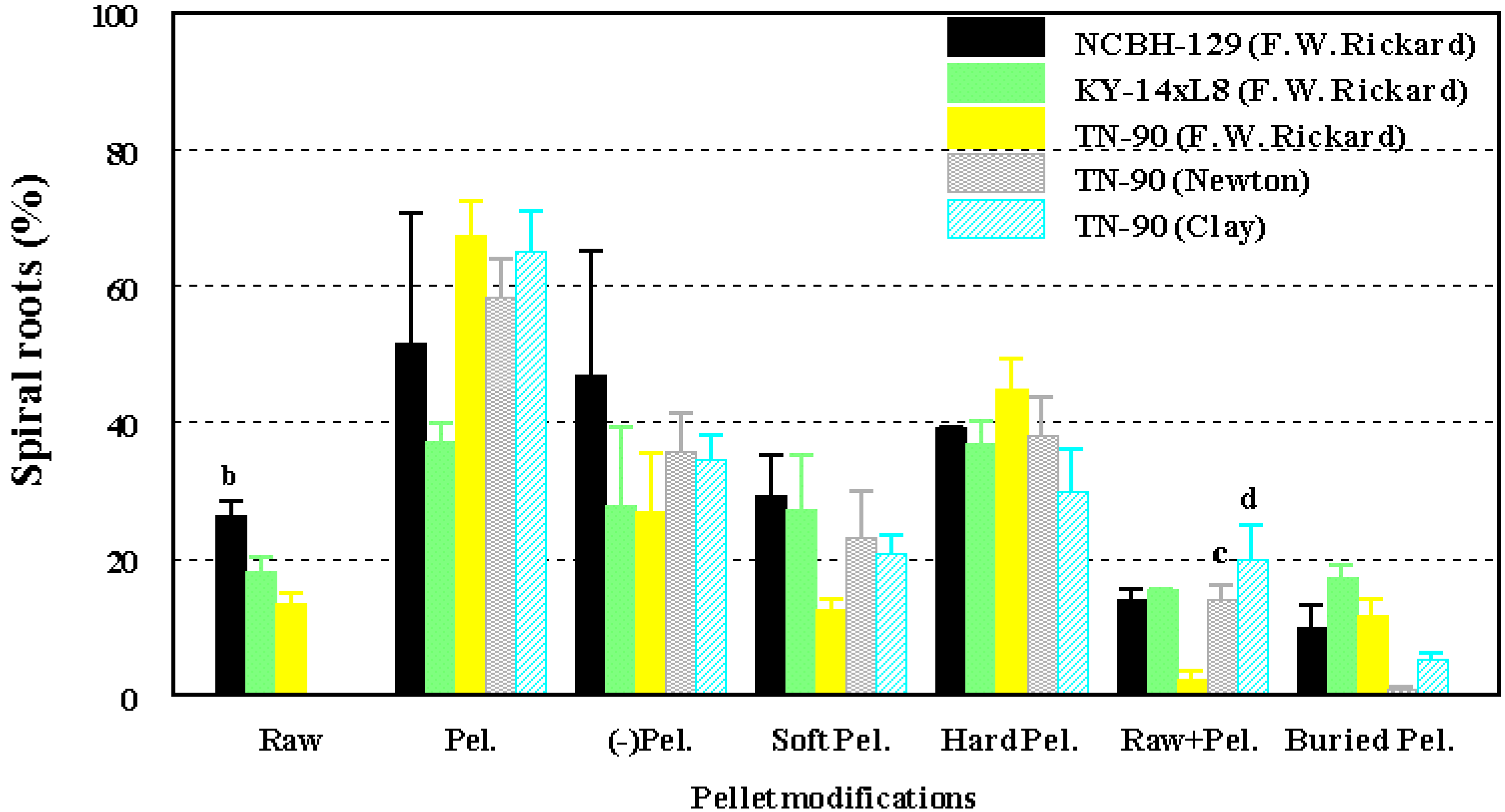
[a] A seed was counted as germinated at the first sign of radicle protrusion (10 days after seeding).

[b] Mean ± std. error of the four replications of each treatment.

[c] F. W. Rickard raw seed + Newtons seed pellet material.

[d] F. W. Rickard raw seed + Clays pellet material.

Fig. 1: Effect of different seed pellet modifications on spiral root formation[a]



[a] Spiral roots calculated based on the percentage of germinated seeds.
[b] Each bar represents the mean and std. error of four replications.
[c] F. W. Rickards raw seed + Newtons pellet material.
[d] F. W. Rickards raw seed + Clays pellet material.

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