EVALUATING POLYPROPYLENE BULK BAGS AS PINE CONE COLLECTION CONTAINERS AND COMPARING THEM TO WIRE BOUND WOODEN CRATES

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Abstract.--Slash pine (Pinus elliottii Engelm.) and loblolly pine (P. taeda L.) pine cones were harvested from seed orchards during September and October of 1988. All cones were placed in either 20 bushel wire bound wooden crates or 20 bushel polypropylene bulk bags and shipped to International Forest Seed Company for seed extraction and conditioning. Seed yields (pounds per bushel) and seed quality as expressed by speed of germination (PV), total percent germination and the percentage of fungus infection were evaluated for each container type. The costs and benefits of using each container in the seed orchard and seed plant are discussed.

Keywords: Pinus elliottii Engelm., Pinus taeda L., polypropylene bulk bags, wooden crates.

INTRODUCTION

Seed orchard managers are always looking for greater efficiency in their seed production. One of the most costly operations is cone harvesting. Those who continue to hand pick must confront the issue of the type of containers they use to hold cones before they are processed. It is logical to choose the container that provides a safe haven against seed degradation resulting in poor seed yield and seed quality. But, because they are managers they too must consider all the costs involved ranging from purchase price and depreciation to handling costs in the orchard and processing plant.

In the southeast the "one bushel" burlap bag and the twenty bushel wire bound wooden crates have been successfully used as containers for all the southern pines. Barnett, 1979b compared burlap bags and crates for storage of slash pine but neither container showed a consistent advantage. A study by F. T. Bonner, 1987 showed that neither container type had a significant affect on loblolly germination nor were they significantly different in yielding full clean seed.

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At International Forest Seed Company, we have been investigating the use of polypropylene bulk bags as a container to hold, transport, and store cones before processing.

Flexible intermediate bulk containers or "bulk bags" originated in Europe and Asia where they were developed over 20 years ago to hold agriculture seeds such as dried grain. They are now used extensively in the grain and flour industry in the U. S. as well as for bulk handling of industrial chemicals, fertilizers and cement.

Our interest in these bags as cone containers was enticed by the immediate recognition of their durability and ease of handling (at least when they were empty). The first use by IFSCO was a "square" bag (23 cubic feet) about the same size as a 20 bushel crate. Our initial comparison between a bulk bag and a crate revealed acceptable germination data (91% vs. 90%) using loblolly cones. We therefore proceeded to modify the bag for equipment handling and have since developed two models: A bottom discharge bag with straps attached to the top for lifting purposes and a solid bottom bag with side sleeves to enable the bag to be lifted and rotated 180° to empty. Each has their advantages and disadvantages and are discussed in a later section of this paper.

In a 1987 operational study at IFSCO of Slash pine, 760 bushels of cones in bulk bags were compared against 850 bushels in crates for percent germination and seed yield. The results were extremely promising showing 1.47 pounds per bushel and an average 96% germination for cones stored in bags and 1.43 pounds per bushel and an average and germination of 94% for those held in crates. A loblolly pine operational study of 1,000 bushels collected in 1987 resulted in a yield of 1.39 pounds per bushel and an average germination of 96%.

Based upon these operational results we felt confident that seed quality would not suffer if cones were stored in polypropylene bags and that they could be substituted for crates or burlap bags. However, we wanted to document the bulk bag's usefulness so we installed a replicated study comparing the uses of crates and bulk bags and the effects on seed yield and quality.

METHODS

Loblolly and slash pine bulk cone collections were made from grafted seed orchards during the weeks of October 10 and September 13, 1988, respectively. All cones were assumed to be mature (.88 specific gravity or less for loblolly, and .90 for slash) since each species were harvested well into their respective seasons. Enough cones were harvested from the loblolly orchard to fill 10 crates and 10 bags each with 20 bushels. Cones from the slash orchard were more scarce and only 185 bushels were included in the study, enough to fill 5 bags with 17 bushels each, and 5 crates with 20 bushels. For each species, all crates and bags were

uniquely identified so that individual containers were treated as separate lots through processing and seed testing. The tops of the bulk bags remained untied (except when in transit to our processing plant and excessive periods of rain) and allowed to "season" as do cones in crates. Barnett, 1979b showed that germination was faster in loblolly seeds from cones stored in the open: for slash there was no difference and in shortleaf (P. echinata mill.) increased both germination rate and total germination. All the bags were set on pallets to provide air circulation underneath each bag. Slash cones were placed in the kiln for 60 hours at 105°F, after 10 weeks from harvest. Two hundred bushels of loblolly cones (100 from crates and 100 from bags) were kiln dried at 105°F for 48 hours 10 weeks and 15 weeks from harvest. The drying, seed extraction and cleaning were done on an operational basis in an attempt to mimic as best as possible operational conditions. Seed yields for each container were recorded to the nearest hundredth of a pound.

Seed testing was completed in our laboratory according to official testing standards (Association of Official Seed Analysts, 1981). Twenty-eight day un-stratified germination tests were performed on all slash pine lots while for loblolly 28 day 35°F wet stratification germination tests were performed. Radiographs of each lot were examined for fungi infection. To compare the seed vigor of each lot the peak value was calculated according to Czabator, 1962 and Bonner, 1986. The percent germination data and the percent of fungus infection data was transformed using the arcsin transformation so ANOVA could be applied. A completely randomized design was used and an ANOVA applied to all four variables. The length of cone seasoning and container treatments were treated as fixed effects.

RESULTS

Slash pine seed yields were not significantly different ($P < 0.5$) for cones stored in crates (1.07 pounds per bushel) or bulk bags (0.99 pounds per bushel). However, differences in the seed quality evaluations for slash pine were significant (Table 1). Germination percent was an average 12% lower and the percent fungus infection was 8% higher from seed extracted from cones stored in bulk bags (Table 2). The Peak Value (PV) (the germination rate divided by the number of days at that count) was also lower for seed originating from bulk bags (PV = 5.04) and significantly different from seed originating from crates (PV = 6.2).

Table 1. Mean squares and F-values for seed yield, percent germination, percent fungus infection and germination rate (PV) for slash pine.

Source of Variation = Container Type[1]			
Variable	Df	MS	F
Yield	1	0.010	2.86 NS[2]
% Germination	1	436.890	19.80 *[3]
% Fungus infection	1	237.170	25.76 *
Germination Rate	1	4.10	19.60 *

[1] Container types are fixed effects.
[2] NS indicates no significant differences P > 0.05.
[3] *indicates significant differences P > 0.05.

Table 2. Average seeds per pound, percent germination, percent fungus infection, and peak value for slash pine and loblolly stored in crates or bulk bags.

	Seeds/Lb.		% Germination		% Fungus Infection		Peak Value	
	Crate	Bulk Bag	Crate	Bulk Bag	Crate	Bulk Bag	Crate	Bulk Bag
Slash	1.07	0.99	95	83	3	11	6	5
[1] Loblolly (10)	1.22	1.18	98	94	1	2	7	6
[1] Loblolly (15)	1.39	1.35	98	97	2	3	11	10

[1] Loblolly (10) and Loblolly (15) were held in crates or bulk bags for 10 or 15 weeks after harvest and before extraction.

For loblolly seed the results are a bit more promising in regards to the effects of the bulk bag on cone storage. Since we had twice as many bushels of loblolly than slash pine, we were able to process half the cones (100 bushels in 5 crates and 100 bushels in 5 bulk bags) after 10 weeks of seasoning and the same amount after 15 weeks (Table 3). Seed yields were not significantly different between container types within storage time. But, yields from the containers after 15 weeks of seasoning (1.39 pounds per bushel for crates and 1.35 pounds per bushel for bags) were significantly greater than those after 10 weeks (1.22 pounds per bushel for crates and 1.18 for bulk bags). Differences among the three seed quality characteristics measured are present in some situations. The average percent germination is high in both cases (Table 2) but was significantly lower from seed extracted from cones stored in bulk bags (94% after 10 weeks and 97% after 15 weeks) than those in crates (98% after 10 and 15 weeks). Also, germination was significantly greater after 15 weeks of storage (98% for crates and 96% for bulk bags). The average percent fungus infection was significantly greater in seed originating from cones stored in bulk bags (2.5% vs. 1.5%) but not significantly different within or between storage times. Like the percent germination the Peak Value was slightly greater from seed associated with crates but was not significant. PV was significant however after 15 weeks of storage time.

DISCUSSION

Slash Pine

The apparent damaging influence the bulk bag had on the slash seeds was surprising. This is the first occurrence in which we have recorded lower values as compared to crates. The difference in seed quality was probably due to the difference in weather from year to year. The rainfall was noticeably higher in the fall months of 1988 (12.58 in.) than during 1987 (7.41 in.). The mean temperature of 53.5°F and 53.0°F were about normal. Wet weather when coupled with warm temperature is undesirable when harvesting and storing any crop.

We may expect to have a lower level of air circulation in the bulk bag because of the obvious construction and material differences but the polypropylene weave is breathable and patterned after a weave used to store grain. The fabric is a 9 ounce agritainer used by the agricultural industry. Standing water never occurs in the bag but the cones may remain wet longer than those in crates.

The factors that probably have the greatest influence in regard to the germability of pine seed are those related to dormancy. Slash pine does not enter a very "deep" dormancy state. Those biological/chemical factors which keep the seed active also influence the susceptibility of the gametophyte tissue to resist infection as well as the vigor to germinate. The most prevalent

diseases presently known to infect slash pine seed are Diplodia gossypina and Fusarium moniliforme var. subglutinans (T. Miller and D. L. Bramlet, 1978). It is obvious from these data fungus infection influence not only total germination but also the germination rate (PV).

These data point to the long standing belief that cone handling has a strong influence on seed quality (Bonner, 1987; Bonner, 1984, Barrett, 1976, 1979b; McLemore, 1975, and others). Harvesting, handling, and storage must be customized in regards to the weather particulars of each season no matter what storage system the orchard manager chooses. Bulk bag storage of slash cones requires different handling procedures than when crates are used. At this point the information available is inconclusive and we will continue testing the bulk bags. Those who continue to use bulk bags must at least set them on pallets, and tie the tops when it rains and open the tops when the sun is shining.

Loblolly

It appears from this study that length of storage seems to affect loblolly seed quality more so than the containers. Although yield differences were not significant for either effect the trend of higher germination after 15 weeks of storage is quite evident. The percent germination and germination rate (PV) were significantly better after 15 weeks of storage as compared to 10 weeks. This trend was found by F. T. Bonner, 1987 when loblolly cones were stored outdoors in crates or burlap bags. Apparently additional maturation is occurring in these seeds during cone storage. Bonner, 1987 described the effect as creating a physiological equivalent of seed storage. The percent fungus infection was not significantly different. This is important to know because during heavy crop years it is not uncommon for cones to sit in storage well into February or March.

The fungus infection was significantly greater in seeds extracted from cones stored in bags. I suppose one might expect the increase of fungus growth over time especially during warm and wet conditions.

The Lack of significant interactions is encouraging in that both containers perform consistently in regards to the variables studied in this experiment.

Cost Comparisons - Crates vs. Bulk Bags

Wire bound wooden crates have been a labor saver during harvest time for all of those who use them. It's the yearly naintenance and storage of these crates that has been the nemesis. 3ased upon the experiences we have encountered during the past 4 fears, it is in this area of seed orchard management that using Dulk bags as cone collection containers can make immediate improvements.

Bulk bags are easy to handle. They last a long time and require a fraction of the storage space of crates as well as the yearly maintenance (Table 4). For those who freight cones to our processing facility, full bags cost the same as full crates. But the returning empty bags requires a fraction of the cost that is necessary to return crates. We have loaded 150 empty bags (3,000 bushel capacity) into the back of a pick-up truck with room left over. The managers that are presently using bulk bags have had to modify only slightly their normal cone collection procedures to accommodate their differences. The most obvious difference between wooden crates and the bulk bags is their lack of rigidity. The bags should be held open until after the first 4 or 5 bushels provides enough "bulk" to hold them open on their own.

To move and load the sleeve type bulk bags a bobcat loader is probably necessary. They have the maneuverability to "spear" both sides at once. Tractor mounted forks work fine to move the bulk bags with loops attached to the top. It is possible to obtain a bag with both lifting devices. The sleeves lend the bags to 180° rotation when emptying the cones during processing.

The handling of the full bags in the orchard and the seed plant requires a lit more time to stage, lift and load (or empty). Like crates, two bags at a time can be loaded on to a flatbed truck for transporting but it requires a little extra time due to the care taken to "spear" the sleeves or loops. During extraction the average time to retrieve and empty a crate of cones tumble them, clean the system and prepare for another lot was 19 minutes, the same for a bulk bag with sleeves. But the bag with the bottom discharge requires more time and is not particularly liked by the processing crew; cleaning, folding and storage of the sleeve type bag is also much easier.

Table 3. Mean squares and F-value for seed yield, percent germination, percent fungus infection and germination rate (PV) for loblolly pine.[1]

Source of variation	Df	MS	F
SEED YIELD			
Storage time	1	.133	3.89 NS[2]
Container type	1	.008	0.25 NS
ST x CT	1	.000	0.00 NS
Error	16	.034	0.00 NS
GERMINATION			
Storage tine	1	24.865	5.08 *[3]
Container type	1	71.821	14.67 *
ST x CT	1	4.901	1.00 NS
Error	16	4.895	
PERCENT FUNGUS INFECTION			
Storage time	1	4.141	1.14 NS
Container type	1	17.485	4.83 *
ST x CT	1	0.013	0.00 NS
Error	16	3.620	0.00 NS
GERMINATION RATE (PV)			
Storage time	1	63.013	13.97 *
Container type	1	2.381	0.53 NS
ST x CT	1	0.013	0.00 NS
Error	16	4.512	

[1] Storage tines and container types are fixed effects.
[2] NS indicates no significant differences at P > 0.05.
[3] * indicates significant differences at P > 0.05.

Table 4. Cost comparisons for using 20 bushel bulk bags and wire bound wooden crates as pine cone storage containers.

Item	Dollars	
	Bulk Bags	Crates
Annual Depreciation[1]	200	350
Storage and Repair[2]	141	814
Harvest Handling[3]	16	36
Freight[4]	261	422
Cost per Year/1,000 bushels	618	1,622

[1] Assume 50 bags @ $20.00 lasting five years and 50 crates @ 21.00 lasting three years.

[2] Assume $5.00 per square foot, bags occupying 25 square feet and crates 150 square feet; 4 man hours to maintain bags, 16 man hours to maintain crates @ $4.00 per hour.

[3] Assume 4 man hours of handling bags and 9 man hours to handle crates @ $4.00 per hour.

[4] Assume 380 mile distance empty bags occupying 25 square feet, crates 150, costs of $21.00 and $182.00; full bags or crates $240.00 per 1,000 bushels.

CONCLUSION

There are no significant differences between the pounds of seed extracted from loblolly or slash cones stored in crates or bulk bags. In each case the percent germination, percent fungus infection and germination rate was lower and in some cases significantly at the 5% level from seed that originated in bulk bags. This indicates as expected that cones in bags must be handled differently when in storage. Presently the bulk bag with sleeves and loops are preferred over the bottom discharge bag and costs are considerably lower for bulk bags as compared to crates. Future test are necessary to determine the proper seasoning methods when cones are stored in bags to ensure high yields as well as high quality seed.

LITERATURE CITED

Association of Official Seed Analysts. 1981. Rules for testing seeds. J. Seed Tech. 6(1): 1-126.

Barnett, J. P. 1976. Cone and seed maturation of southern pines. USDA For. Serv. Res. Pap. SO-122. 11p.

Barnett, *J.* P., 1979b. Southern pine cone maturation and storage. P. 11-20 in proc. seed collection workshop. May 16-19 16-19 1979. Macon, Georgia. USDA For. Serv., State and Private For. SA-TP-8.

Bonner, F. T., 1987. Effects of storage of loblolly and slash pine cones on seed quality. South J. Appl. For. 11(1): 59-63

Bonner, F. T., 1986. Measurement of seed vigor for loblolly and slash pines. Forest SCC. Vol. 32 No. 1 pp. 170-178.

Bonner, F. T., 1984. Effects of seed extraction on the quality of southern pine seeds. P. 111-120 in proc. 1984. South Nursery Conf. USDA For Serv. Southern Region

Bonner, F. T., 1987. Effect of storage of loblolly and slash pine cones on seed quality. Southern J. Appl. For. 11(1): 59-63.

Czabator, F. J., 1962. Germination Value: an index combining speed and completeness of pine seed germination. For Sci. 8:386-396.

Miller, T. and D. L. Bramlett. 1978. Proc. Flowering and seed development in trees. A Symposium USDA For. Serv., South For. Exp. Sta. New Orleans.

Mclemore, B. F., 1975. Collection date cone-storage period affect southern pine seed yields, viability. Tree Planters Notes 20(1): 24-26.