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NBPOL Research Summary

Comparison of three types of pollination bag in an oil palm seed production setting

Summary

In commercial oil palm seed production, isolation of the inflorescence with a pollination bag is critical to ensure the production of high quality seed. Little systematic research has been undertaken to compare the impact of the type of pollination bag on both the genetic integrity and seed yield in this environment. Dami's Oil Palm Research Station (OPRS) undertook a controlled comparison, comparing the bags in three dimensions: presence of insects that might indicate contamination by unintended pollen, intactness of the bag (including any tendency to sag over the inflorescence), and the presence of water in or on the pollination bag.

Canvas bags performed least well in all three dimensions. They were found to sometimes contain insects; they became heavy and accumulated water after rain, and sagged onto the inflorescence. Tyvek-style bags did not show the presence of insects, but were found to sag. In wet weather they also had a tendency to accumulate water; when this happened, the average water accumulation measured as 4 litres. PBS International pollination bags were found to perform the best in all three dimensions, remaining insect-free, with no tendency to collapse onto the inflorescence, or collecting water.

Introduction

Anecdotally pollination bags made from different materials perform in different ways in the field. Little systematic controlled comparison has taken place; therefore this experiment is intended to evaluate the effectiveness of different pollination bags in oil palm seed production.

Effectiveness involves two characteristics – maintaining genetic integrity of the crosses and the impact that pollination bag choice has on the economics of the seed production process.

The genetic integrity is defined as seeds and seed bunches which have not been contaminated by unintended pollen. Oil palm is largely fertilized by the weevil Elaeidobius kamerunicus which is attracted to the scent of the inflorescence. Access by weevils or thrips to the inflorescence during its receptive period could cause such contamination. A secondary concern is air borne pollen grains penetrating the pollination bags in some way.

Economically the results of failure in this respect can be significant. Often seed producers will abandon the whole seed bunch, often worth close to USD $1000, if contamination is suspected. Alternatively, failing to reject a contaminated bunch may cause poor quality seed, which could negatively affect the reputation and trust in the seed producer.

In order to guard against these risks and maximize productivity, durability of the pollination bag is important. In oil palm seed production it has to withstand damage that may be caused by the plant's tough abrasive physiology, as well as the climatic demands including UV light, rain and wind.

Seed production units are also commercial enterprises, so maximising the number of germinated seeds per inflorescence is important to maximise revenue and productivity. Damage caused to the stem of the inflorescence, increased probability of disease, or reduced pollen dispersal (for instance as a result of dampness inside the bag) could all impact seed set. A pollination bag should maximise the chance of high seed set.

To compare three types of commonly used pollination bag, a study was carried out independently by Dami OPRS in New Britain, Papua New Guinea.

Methods

Three types of bag were chosen for comparison – Canvas, Tyvek-style nonwoven material and PBS International **dura**web® material. At the time of the experiment, PBS International were running field trials for a new production line to manufacture **dura**web® (in this experiment known as trial **dura**web®) so this material was included in the test as a fourth treatment.

Canvas

Tyvek style

Trial **dura**web®

duraweb®

320 palms were randomly selected from the seed garden and divided among four workers to ensure a fair test. Each isolator had a total of 80 bags, 20 bags of each type.

The standard isolation procedure used by Dami OPRS was carried out in this experiment. The field was surveyed on a daily basis to select female inflorescences before anthesis stage.

The selected palms are marked and the female inflorescences bagged 10 days before the receptive stage is reached. This involves cleaning to remove spathes and clearing the base for ease of applying the pollination bag. The exposed inflorescence is then sprayed with a 40% formalin solution to kill any foreign pollen, which, when combined with Mortein, acts as an insecticide.

The inflorescence is then isolated using a pollination bag, which is wedged in place using a chisel and tied for extra assurance that no foreign pollen can enter via the base. As a further security measure two cotton wool rolls with Furadan are placed at the base to deter insects. The strong scent will deter insects for 3-4 weeks.

Once isolated in this way, the bags were kept on the female inflorescence until the flower was receptive. At this stage, pollen was puffed into the bag and the resulting hole covered with tape. The bag stayed in place for a further 31 days after pollination, after which the bag was removed and the fruit allowed to mature normally. The observation and results were collected during these 31 days.

Material	Photo	Details
Canvas		Rough texture ✓ Little sunlight penetration ✓ Inexpensive ✓ 1 window ✓
Tyvek-style		Smooth, slippery texture ✓ Fasteners attached ✓ 1 circular window ✓ Light weight ✓
Trial **dura**web®		New trial production line for the **dura**web® material ✓ 2 windows ✓ Designed to match standard product ✓
duraweb®		Made from **dura**web® ✓ 2 windows ✓ Used by Dami for commercial seed production ✓

Data collection

Three key measures were used to evaluate the performance of the bags

Intactness of the bag – a daily picture taken to record the condition of the bags. Scores were allocated between 1 and 3 (1 = best, 3 = worst):

1. fully intact
2. shrinking onto inflorescence
3. collapse stage

Insect count – a daily inspection for insects in the bag. Scores of 1 or 2 were used:

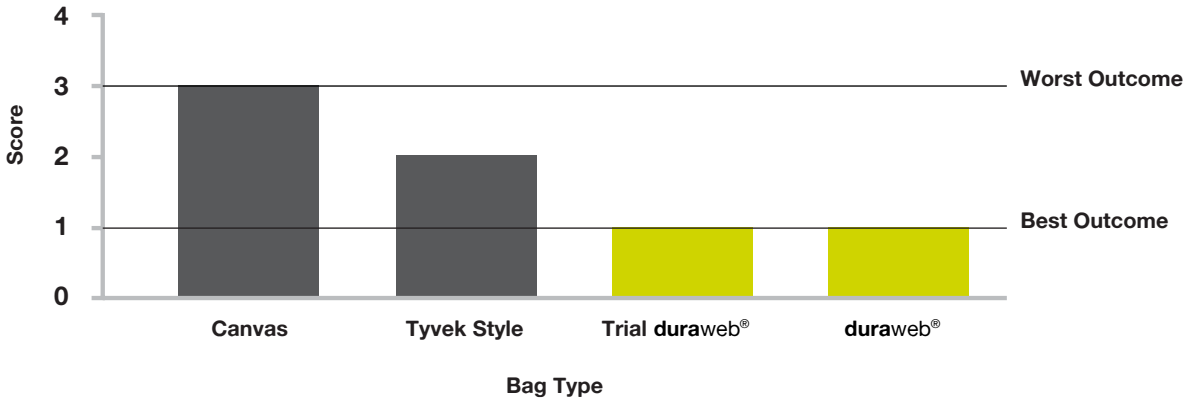
1. no insects found in the bag
2. insects found in the bag

Water Test – to measure water absorption or collection of water inside the bag. A daily inspection would result in removal of water, if found, using a 10ml syringe to puncture the bag. Any water was then captured in a 600ml container. Once the water was collected the hole was resealed using tape to avoid insects getting in. Scores were allocated on a 1-3 basis:

1. no moisture or water in the bags
2. moisture on the bags
3. water in the bags

Results

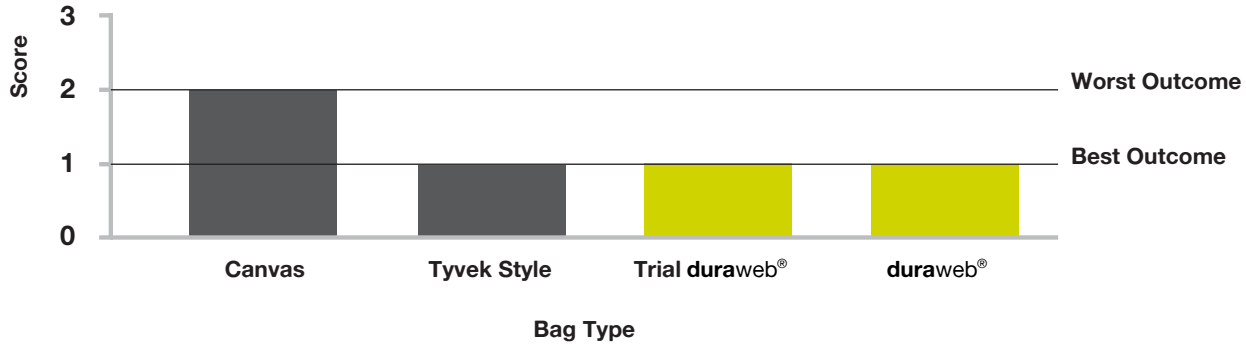
Intactness Results



Anova						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	4.1875	3	1.3958	9.5714	0.0017	3.4902
Within Groups	1.75	12	0.1458			
Total	5.9375	15				

The data indicates that canvas performed the worst, being prone to total "collapse" as the material absorbed water and gained weight. The Tyvek-style bag performed poorly, losing shape and shrinking. By contrast both the standard and trial **dura**web® material in the PBS International bags kept their shape. There is a significant difference in the intactness performance of bags with a P-value of 0.0017.

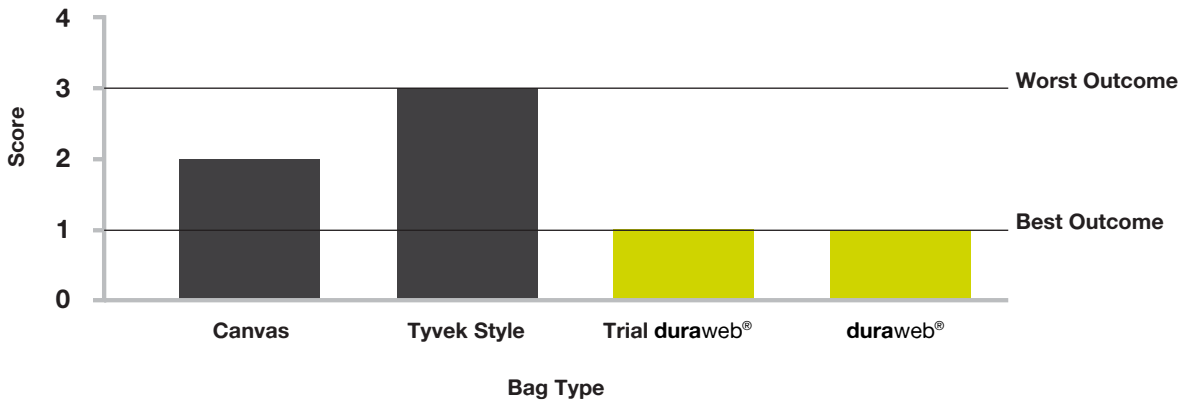
Presence of Insects Results



Anova						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.6875	3	0.5625	9	0.0021	3.4903
Within Groups	0.75	12	0.0625			
Total	2.4375	15				

Although made from strong woven material, the canvas bags were found to have been contaminated by weevils, gaining access through the side stitches. The Tyvek-style bag and both **dura**web® bags performed well, with no observed insect contamination. Analysis of variance shows a P-value of 0.0021, indicating the canvas bags perform ed significantly worse than the other types.

Water Results



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In the dimension of water retention, the Tyvek-style bag scored worst, retaining water within the bag. 6.25% of bags used for the experiment had accumulated water ranging from 0.11 litres to 12 litres per bag, and averaging 4 litres per bag extracted over the course of the 31 days. The researchers speculate that this might be due to holes created during the isolation process, believing it is unlikely to arise from result of inflorescence transpiration, because water was present in a few bags and only after rain. A P-value of 0.0021 shows a significant difference between the bag types in this respect.

Canvas proved partially effective, with some moisture on the bag, primarily on the lower part of the bags after rain. Both of the PBS International **dura**web® bags performed well with no water found inside the bags or accumulating on the material. Analysis of variance shows a significant difference between the bag types at the 5% level of significance with a P-Value of 0.0021.

Results Summary

Test/Bag	Canvas	Tyvek-Style	Trial **dura**web®	**dura**web®
Intactness	Fail	Fail	Pass	Pass
Presence of insects	Fail	Pass	Pass	Pass
Water Retention	Fail	Fail	Pass	Pass

Conclusion

The four types of pollination bag were evaluated side-by-side in order to compare their performance in field conditions, and how this might affect seed quality and seed yield.

Over the course of the trial, the canvas bag performed least well, failing on all three tests – being prone to collapse, permitting penetration by insects and retaining water. Dami's standard procedures insist on the rejection of all the seeds produced using these bags as a result of the potential for contamination by unintended pollen.

The Tyvek-style bag did not allow insects to gain entry, but it did show a tendency to sag onto the inflorescence. It also had a propensity to collect water.

The PBS International **dura**web® bags, both the standard **dura**web® material and the **dura**web® made on the new production line performed well on all three counts. Insects did not penetrate, the bags did not sag or collapse onto the inflorescence, and they did not absorb or retain water. In terms of preventing contamination by foreign pollen, the Tyvek-style bag and PBS International **dura**web® bags therefore performed equally.

However seed production units are also commercial enterprises, so the impact that the choice of pollination bag has on the seed set is important. Moisture inside the pollination bag is thought to have a negative impact on the dispersal of pollen, reducing the number of fertilised flowers per application. In addition the consequence of the bag collapsing or sagging onto the inflorescence, a persistently very humid environment around the inflorescence (significantly more humid than the ambient conditions), and in particular the identification of especially significant volumes of standing water, is highly likely to have a damaging effect on the rate of fungal disease, the number of flowers successfully fertilised, and the number of seeds produced.

Unfortunately because the water was drained from the Tyvek-style bags, this impact cannot be measured directly in the current evaluation. In practice applying additional labour to check for and drain standing water inside the bags may be a partial remedy, albeit increasing operational costs, but this may also increase the risk of contamination by foreign pollen.

The researchers therefore reject the null hypothesis that all pollination bag types are the same.

The researchers concluded that of the bags tested, the PBS International **dura**web® pollination bags offer the best conditions for the production of high quality oil palm seeds, and provide the best return on investment.

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