



PHYSIOLOGY OF RECALCITRANT SEEDS

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INTRODUCTION

SEED LONGEVITY:

SHORT-LIVED SEEDS AND LONG-LIVED SEEDS

- EVOLUTION OF SEED PHYSIOLOGY KNOWLEDGE:

desiccation tolerance

Orthodox and Recalcitrant Seeds

- RECALCITRANT SEEDS: do not undergo maturation drying, are shed at relatively high water content and are susceptible to desiccation injury (Roberts, 1973)

- TOLERANCE TO LOW TEMPERATURES



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GENERAL CHARACTERISTICS OF RECALCITRANT SEEDS

- HABITAT

- WATER CONTENT

- **EXAMPLES:** mango, avocado, cocoa, coconut, rubber tree, guarana, Brazil nut, oak, loquat, inga, etc.



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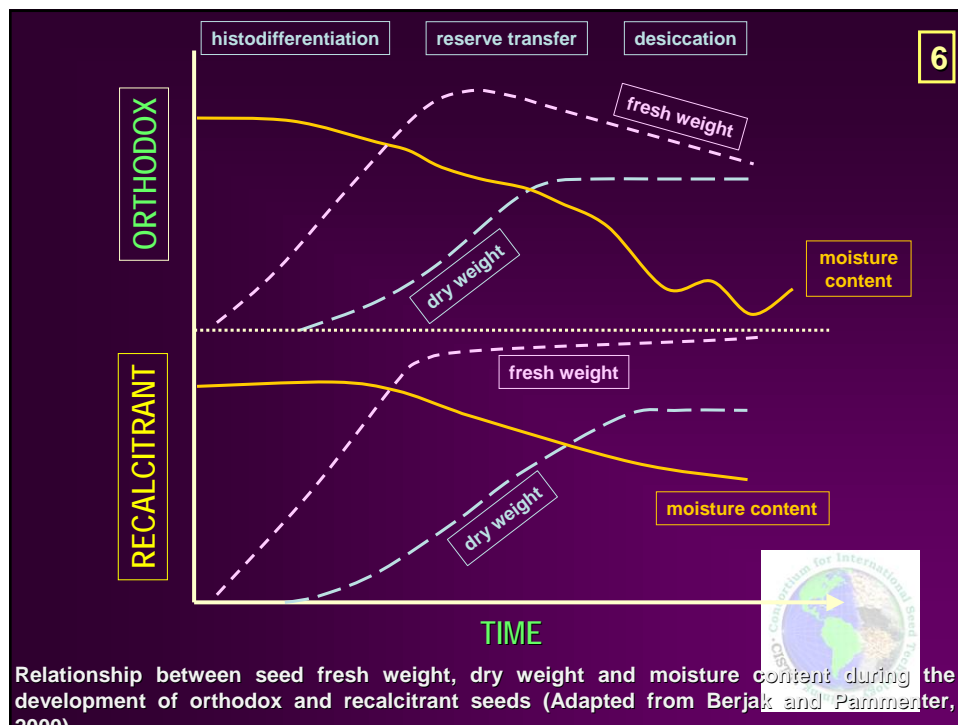
GENERAL CHARACTERISTICS OF RECALCITRANT SEEDS

- SEED MORPHOLOGY:
size, embryo axis x reserve tissue, seed coat

- SEED DEVELOPMENT AND MATURATION



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GENERAL CHARACTERISTICS OF RECALCITRANT SEEDS

- SEED DEVELOPMENT AND MATURATION

DECREASES IN WATER CONTENT

INCREASES IN DRY WEIGHT

PHYSIOLOGICAL MATURITY

MATURATION DRYING

- SEED GERMINATION



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GENERAL CHARACTERISTICS OF RECALCITRANT SEEDS


- CATEGORIES OF RECALCITRANT SEEDS



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TYPES OF RECALCITRANCE		
MINIMUM	MODERATE	HIGH
Fair amount of water loss tolerated	Moderate amount of water loss tolerated	Little water loss tolerated
Germination slow in absence of additional water	Moderate germination rate in the absence of additional water	Fast germination in absence of additional water
Lower temperature tolerated	Most species are temperature sensitive	Most species are temperature sensitive
Temperate / tropical distribution Ex.: <i>Quercus</i> , <i>Araucaria</i>	Tropical distribution Ex.: <i>Theobroma</i> , <i>Hevea</i>	Tropical forests and wetlands Ex.: <i>Avicennia marina</i>

The continuum to account for varying degrees of recalcitrance (Farrant et al., 1988)



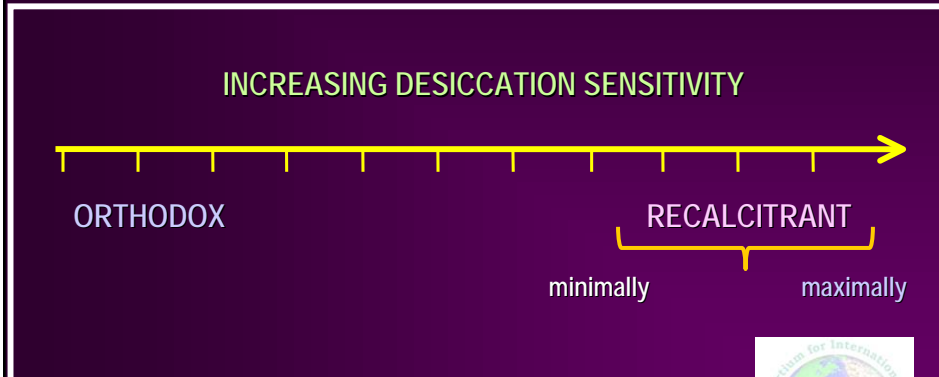
GENERAL CHARACTERISTICS OF RECALCITRANT SEEDS

- **DESICCATION TOLERANCE**
- **DEFINITION**
- **DROUGHT TOLERANCE**
- **MEMBRANE INTEGRITY**
- **MINIMUM HYDRATION LEVEL: water type 3**



GENERAL CHARACTERISTICS OF RECALCITRANT SEEDS

- DESICCATION TOLERANCE



The suggested continuum of categorizing seeds that might emerge from the most desiccation-tolerant orthodox to the most desiccation-sensitive recalcitrant species (Berjak and Pammenter, 2000)



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GENERAL CHARACTERISTICS OF RECALCITRANT SEEDS

- DESICCATION TOLERANCE

- INTERMEDIATE BEHAVIOR

- EFFECTS OF DRYING RATE

Seed size and excised embryos



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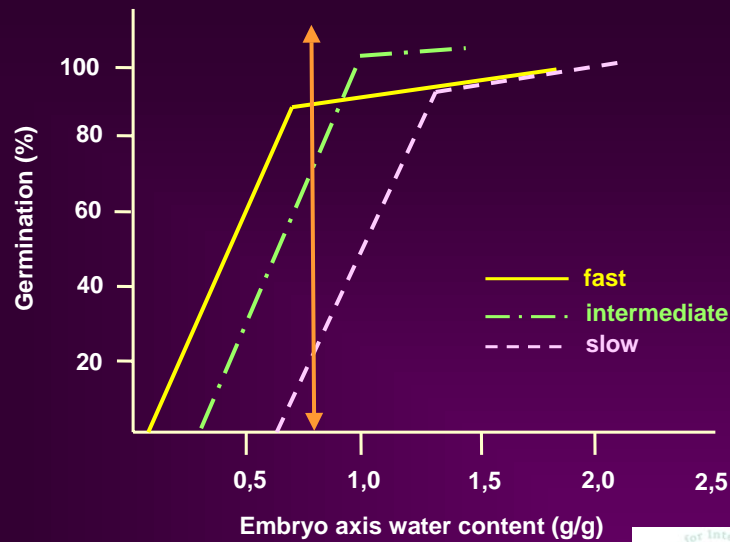
GENERAL CHARACTERISTICS OF RECALCITRANT SEEDS

- DESICCATION TOLERANCE

- CRITICAL AND LETHAL WATER CONTENTS ?



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Response of *Ekebergia capensis* seeds to rate of drying (Pammenter et al., 1998)



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ASSOCIATION WITH MICROORGANISMS

PROBLEMS CAUSED BY FUNGI

SPECIES INVOLVED: *Aspergillus* and *Penicillium*

VARIATION IN WATER CONTENT



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ASSOCIATION WITH MICROORGANISMS

Water Content (%)					Germination (%)				
0 ^(†)	15	30	45	60	0 ^(†)	15	30	45	60
57.3	58.5	61.4	60.6	60.4	99	67	0	1	0
51.4	52.1	53.8	53.7	53.8	100	97	71	69	43
45.9	46.5	46.5	46.8	47.5	95	92	56	23	7
38.6	39.6	39.8	39.2	39.9	89	62	12	1	0
32.4	33.1	34.3	32.3	39.1	68	8	0	0	0
28.0	28.7	29.1	31.9	30.1	0	0	0	0	0

Seed water content and germination percentage of *Inga urugensis* seeds during storage at 10°C and 90%R.H. for up to 60 days (Bilia et al., 1999)

(†) Storage period (days)



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RECALCITRANT SEED STORAGE

HIGH WATER CONTENT

TEMPERATURE

SEED LONGEVITY



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RECALCITRANT SEED STORAGE

- ALTERNATIVES

- Moist or imbibed storage

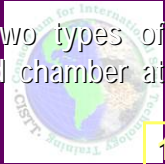
- Partial dehydration technique



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Material / environment	Storage period (days)						
	0	30	60	90	120	135	150
Plastic / laboratory	52	56	<u>77</u>	<u>63</u>	<u>62</u>	<u>64</u>	23
Plastic / 10°C	52	22	36	18	15	08	12
Multiwall paper/ laboratory	52	00	00	00	00	00	00
Multiwall paper / 10°C	52	00	00	00	00	00	00

Germination (%) of rubber tree seeds stored in two types of packaging material in the laboratory and in cold chamber at 10°C (Pereira, 1980).



RECALCITRANT SEED STORAGE

- ALTERNATIVES
 - **Controlled atmosphere storage**
 - Embryo cryopreservation

