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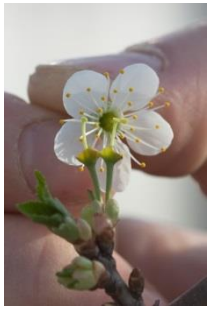
POLLINATION AND GERMINATION METHODS IN CHERRY BREEDING - A SURVEY



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CHERRY 2016

Final Meeting COST Action FA1104

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Survey sent to all COST participants (Task 3).
Aim to show:

1. European state of art of **pollination** and **germination methods** used in breeding of sweet and sour cherry

2. Evaluate **success rates** – efficiency

3. Identify potential **areas for improvement/lack of knowledge**

Response: 13 countries: 15 sweet cherry, 7 sour cherry

Thank you very much to all of you for data!

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Questionaire scheme (125 question answer –options, 4 subfields each (type, frequency, success rate, remarks), Filled in separately for sweet and sour cherry, but much overlap

Main areas

1. Genetic material and background used in breeding (16 question -answer options)
2. Pollination methods, cause for failure, abortion, harvest time (60 question-answers options)
3. Seed treatments – dormancy breakage - germination methods (37 question-answer options)
4. Embryo rescue – special tecniques (12 question answer options)

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Selected results – examples. **Sweet cherry**

Sweet cherry				Indicate basis of data (1 or 2)	
Indications made on basis of - 1). 3-5 last years in a continous breeding programme or 2). a single years breeding project (set No.)					
		Country ID. And info basis	RPi1, SP1, G1, I2, T1, P1, B, SCA1, H1, F1 , L, Gr1, RBu1, SNS1, Be2		
1. Genetic material and background used in breeding	Which type of crossing/hybridising is done in your institute? (one to several)	Country	Estimated frequency of type compared to all crosses	General succes rate for achieving offspring, range 1= 0, 10 = 100 % succes (number of fruits out of pollinated flowers)	Notes for methods **Acceptable success?**
1	Intraspecific crosses cultivar to cultivar	Rpi, SP, G			
2	We only cross known compatible cultivars	SP, G, I, T, P, B, SCA, H, F, L, Gr, Rbu, SNS	SP:90-100%, I:100%, T:70%, P:70%, B:85% SCA:70%, H:100%, F:90%, Gr:20%, Rbu:100%, SNS:100%	SP:3, G: 0-40%, I:seeds8 -plants6, T:8, P:5(10-30% fruit), B:3-6, SCA:8(20-40 % fruitset), H:3, F:1-3, Gr:1, Rbu:7(25-30% fruitset), SNS:8(20-40% fruit set)	G: hand pollination, P: full and semicompatible, SCA: full and semi compatible biol study, SNS:full compatibility
3	We attempt crosses with incompatible cultivars	B, SCA, L	B:5%, SCA:10%	B:1, SCA: 0-3	SCA: incompatibility breakdown study
4	We cross without knowledge of incompatibility	Rpi, SP, P, SCA, H,L	SP:<1%; P: 10%, SCA:10%, H:5%	SP:1, P:5(10-30% fruit), SCA:8(20-40% fruit set)	P: SCA: with unknown s type
5	We investigate reciprocal crosses as standard	SP, T, Gr	SP:2-10%, T:30%, Gr:10%	SP:1, T:8	
6	We attempt selfing in self fertile cultivars	Rpi, G, P, B, H, F, Gr, Be	P:10%, B:5%, H:10%, F:10%, Gr:70%	P:3(10% fruit), B:3-4, F:3-4, Gr:1	P: with known s genotype
7	We attempt selfing in self incompatible cultivars	Rpi, G, P, B, SCA,	P:10%, B:5%, SCA:10%	P:1(0-2% fruit), B:1, SCA:0-3, H:2,	P: with known s genotype, SCA: incompatibility breakdown study
8	We attempt crossing of different ploidi levels	Rpi, G, H	H:5	H:0-1	
9	We attempt interspecific hybridization	species name			
10	1. Most important species for hybridization	Rpi P. cerasus, SP: P cerasifera, G: P armeniaca	SP:<1%,	SP:0.01, G: 0-50%	
11	2. Second most important species for hybridization	SP: Japanese plum, G: P persica	SP:<1%	SP:0.02	
12	3. Third most important species for hybridization	SP: P armeniaca, G: P canescens	SP:<1%,	SP:0.03, G: 16-50%	
13	4. Fourth most important species for hybridization	G: P cerasus			
14	5. Fifth most important species for hybridization				
15	We investigate reciprocal crosses as standard	G: no			
16	We attempt crosses of different chromosome no.	Rpi, G: P cerasus			

Different species priority

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Selected results – examples. **Sweet cherry**

Better env control should give better results?

2. Pollination r	Place of pollination event	Country	Estimated frequency of type compared to all pollinations	General succes rate for achieving offspring, range 1= 0, 10 = 100 % succes (number of fruits out of pollinated flowers)	Notes for methods
17	Pollination in field /orchard in planted trees	Rpi, SP, G, I, T, P, B, SCA, H, F, L, Gr, Rbu, SNS, Be	Rpi:100%, SP: 98%, I:100%, T:100%, P:60%, B:100%, SCA:100%, H:100%, F:30%, Rbu:100%, SNS:100%	SP:2, I:seeds8 -plants6, T:8, P:5(10-30% fruit), B:3-6, SCA:8, H:2, F:1-3, RBU:7(25-30% fruitset), SNS:8(20-40% fruitset)	Hand poll or bumblebees, Be: polllination trials new cvs
18	Pollination in greenhouse in potted trees	SP, G, P, H, F	SP:2 %, P:40%, H:10%, F:70%	SP:1, P: 5(10-30 % fruit), F2-4	H: start in2014, F:poll. By bumble bees
19	Pollination in laboratory or other, describe				
20	How do you obtain pollen at right time?				
21	We pollinate cultivars that overlap in flowering time	Rpi, SP, G, I, P, B, SCA, H, F, Gr, Rbu, SNS	Rpi:60%, SP:20%, I:20%, P: 70%, B:40%, SCA:80%, H:50, Rbu:80%, SNS:80%	SP:3, I:seeds8 -plants6, B:3-6	Rbu: SNS: flower time evaluation for each cv
22	We force branches or potted trees in greenhouses to get earlier flowering	SP, G, P, B, SCA, H, F, L	SP:1%, P:10%, B:10%, SCA:10%, H:50%	SP:1,	
23	We delay flowering by cold storage of potted trees or branches	SP, F	SP:1%	SP:2	
24	We collect pollen and store this dry and cold for use later same year	Rpi, SP, G, I, P, B, SCA, H, F, Gr, Rbu, SNS	Rpi:100%, SP:30%, I:40%, P:20%, B:50%, SCA:10%, H:20%, Rbu:20%, SNS:20%	SP:2, B:3-6	
25	We collect pollen and store this dry and cold for use next year	SP, G, I, H	SP:45%, I:40%, H:10%	SP:2	
26	How do you harvest, store, and check pollen ?				
27	We rub open flowers against mesh net and collect anthers and pollen	Rpi, SP, G, F, L, Gr, Rbu, SNS	Rpi:100%, SP:95%		G: F: only collect pollen from balloon stage
28	Other method of harvesting pollen? Describe	G , I, T, P, B, SCA, H, Gr	T:100%, B:100%		G: separate anthers with tweezers, I: collect anthers with tweezers, T:SCA:collect anthers on cardboard late balloon, P:collect with fingers from late balloon, B:collect at white bud, H:rub anthers by finger before opening

It is possible but what is best?

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Selected results – examples. **Sweet cherry**

29	What temperature do you dry anthers and pollen at? Room temperature or exact? Describe	Rpi:room, SP:room, G: room, I:room temp, T:room, P: room, B:room, SCA:room, H:room, F:room, L:room, Gr: room, Rbu:room, SNS:room	Rpi:100%, SCA:100%		
30	What RH do you dry anthers/ pollen at?	SP:room 40%RH; G: room RH, I:room RH, T:room RH, P roomRH, B: room, SCA:room, H:room RH, F:room RH, L:room, Gr:room, Rbu:room, SNS:room			
31	What is the average duration of drying time?	Rpi:days, SP:48-72H, G: 2 days, I:24-48 h, T:2-4 days, P:24-48 h , B:24h, SCA:2-3 days, H:1-2 days, F:24-48 h, L:24 h, Gr:5-7 days, Rbu:3-4 days, SNS:3-4 days			
32	What temperature do you store pollen at?	Rpi:room, SP:-20°C, G: short time 4°C - long -20°C, I:-20°C, T:room temp few days, P:5°C 2-3 weeks, SCA:room temp 2-3 days, H:2-4°C dry, F:4°C, L:5°C, Gr: no storage-use directly, RBu:4°C, SNS: petri dishes			
33	What containers do you normally store pollen in?	Rpi:glass, SP: 2-5ml tubes, G: glass tubes, I:10cc plastic tubes, T: pill tubes with desiccants, P: glass vials, B:glass tubes, SCA: glass or plastic vials, Eppendorfer vials, F:small tubes, L:glass, Gr: petri dishes, Rbu:petri dishes			
34	Do you check viability/vitality of pollen by staining? (compound?) TC, Indigo carmine, FDA, others? Note	Rpi:indigo carmine, G:no, T:FDA and TTC, b: if time, F:no			
35	Do you check germinability and growth vigour of pollen on agar?	SP, G, I, T, P, SCA, F, L	P:30%, SCA:100%	SP:6	T:P:SCA: 1 % agar and 10-15 % sucrose,
36	Do you check germinability of pollen in liquid medium? Note type	F:no			
37	Can pollen only be stored 1 year in your opinion?	Rpi:yes, SP:yes, G: yes longer at -20°C, I: yes, P:nk, F:nk, L: yes, Gr:yes			
38	Can pollen be stored several years without loosing germinability?	SP:yes, G: maybe, I:not known, P: nk, F:nk, Gr:nk			SP:-20°C 5-15 % loss per year

40-60 % flowers not succesfully fertilised:
Are these optimal methods or does it just function okay?
Pollen quality – vigour? Do we need super pollen?

Do we get good/relevant evaluation?

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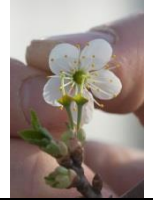
Selected results – examples. **Sweet cherry**



39	Emasculation and bagging of flowers				
40	We always emasculate flowers and always bag them before and after pollination	Rpi, SP, T, P, B, SCA, H, Gr, Rbu SNS	SP:30%, T:100%, P:80%, SCA:100%, Rbu:80%, SNS:80%	SP:1	T: SCA: Rbu: remove bags 10-15 days after, B:only selfcompatible cvs, H: only emasculate in self compatible cvs - bag before and after, SNS:remove bags after 7-10 days
41	We sometimes do not emasculate flowers in self incompatible cultivars	Rpi, SP, G, I, P, B, L, Rbu, SNS	SP:60%, P:20%, Rbu:5%, SNS:20%	SP:8	Rpi: bag before and after, SNS: trial - but make poll. Difficult
42	We don't bag emasculated flowers after pollination	SP, I, P, F	SP:10%, P:100%	SP:1	
43	Other methods, describe	FG, Be			F: emasculate without bagging-low rate of 'contaminations' in mapping progenies, G: use lanolin, Be: bagging of branches with curtain, hand pollinate 8 times of 15 flowers, don't remove anthers
44	Open versus controlled pollination				
45	We use open pollination by neighbours plants	Rpi, SP, T, B, SCA, H, F, L, Gr, SNS, Be	SP:1-5%, T:100%, B:10%, SCA:100%, H:50%, SNS:100%	SP:8	B:use OP as controlto estimate G of control cross, F:only when control cross is not succesful
46	We use controlled crosses	Rpi, SP, G, I, B, H, F, L, Gr	SP:95-99%, B:90%, H:50%	SP:5	
47	Methods of pollen transfer				
48	Manually - rubbing flower to flower	I, H, Gr	H:10%		H: only in self fertilisation
49	We use a brush with pollen from a jar	SP, G, T, B, F, L, Gr	SP:80-90%, T:100%, B:80%	SP:3, G:3-6, B:3-6	
50	We use other manual methods	Rpi, P, B, SCA, H, F, Rbu, SNS	B:20%, SCA:100%,SNS:100%	B:3-6	Rpi:P:SCA:Rbu:SNS: finger, H: toothpick from Eppendorfer, F:use lab glass tubes instead of brush
51	We use honey bees in 'net tents'				
52	We use bumble bees in 'net tents'	Rpi, SP, I, H, F	SP:5-20%	SP:8	F: in field cages or in tunnels - two adjacent trees, one potted tree or branches in bucket of water
53	Other insects for pollen transfer? Describe				
54	We only pollinate once on same flower	Rpi, B, Gr	B:20%	B:2-3	
55	We pollinate twice or more on same flower	SP, I, T, P, B, SCA, H, F, L	SP:60%, T:100%, B:80%, SCA:100%	SP:3, B:3-6	SP:increase succes rate 5%, T:P:SCA:twice, F: if many crosses or bad weather only once
56	We feel that rubbing-damage to stigma helps in pollen germination	SP	SP:no		

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Selected results – examples. **Sweet cherry**

Negative climate challenges are important for pollination succes, causes differ between EU regions (extreme temperatures and ± rain)

57	Potential environmental causes for failure?				
58	We experience that frost during flowering is a serious cause for non survival of crosses.	SP:yes, G:yes, I:no, T (some genotypes), P, B yes, SCA: yes, H:yes, F:no(rarely, protect with candles), L:yes, Rbu:yes, SNS:yes			P: big problems in some years, B: 10-20% per year-96-100% in 2008, F:rarely frost in Bordeaux during flowering-protection by candles
59	We experience that heavy rain and cold weather during flowering and fertilization may destroy survival of crosses. (not related to bee activity)	Rpi:yes, SP:yes, G: yes, I:no exp, T: depend o genotype, P:yes, B: yes, SCA:yes, F:yes, L:yes, Gr:yes, Rbu:yes, SNS:yes	Climate		P: big problems in 2013, SCA: depend on cv
60	We experience that draught and high temperatures during flowering is a serious cause for non survival of crosses.	Rpi:yes, SP:yes, G: yes, I:No exp, P, SCA, F:yes, L.yes, Rbu:yes, SNS:yes			G: at high temperature the egg cell die faster and pollen tube reach ovule to late, SCA: big problem in 2009 and 2014
61	How many flowers do you normally pollinate pr combination of parents?	Rpi, SP, G, T, P, B, SCA, H, F, L, Gr, Rbu, SNS	Rpi:hundreds, SP:1000-5000, G:500-1000, T:800, P:200-300, B:1000-5000, SCA:600, H:1000, F:1500-2000, L:300-600, Gr:2000, Rbu:300, SNS:500	B:3-6	
62	Do you calculate and record exact pollination succes in each combination for future purposes	Rpi, SP, G, I, T, P, B, SCA, H, F, Rbu, SNS, Be	Rpi:sometimes, SP:yes 100%, G: no, I: no, F:yes		T:P: SCA: penetration of pollentube into nucellus, fruitset twice after 3-4 weeks and at maturity, B: data from 2008-2013, F:only at maturity, Be: count before and after June drop

Have anyone done power analysis on necessary numbers – likelyhood for success?

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Selected results – examples. **Sweet cherry**

Seed stratification and germination

3. Stratification, seed treatment and germination methods	Methods	Country	Estimated frequency of type compared to all methods	General succes rate for achieving germination, range 1= 0, 10 = 100 % succes	Comments notes
77	Procesing after fruit harvest				
78	We extract stones from fruits immediately after harvest (store refrigerated for 1-2 days)	Rpi, SP, G, I, T, P, B, H, F, L, Gr, Rbu, SNS	Rpi:100%, SP:100%, B:100%		F: if big lots maybe 1-2 days of storage
79	We allow fruits to ripen, rot or ferment for some days at ambient temperature				
80	We extract stones from fruits manually	Rpi, SP, G, I, T, P, B, H, F, L, Gr, Rbu, SNS	Rpi:100%, SP:100%, B:100%		F: use knife or stone removal machine
81	We extract stones from fruits by macerator, milling or fruit washer				
82	We dry stones to low moisture content 8-10 %, at temperature? duration? MC%?	G, T, P, B, Gr	P:30%,G: room temp and RH, B:room temp and RH, Gr:room		
83	We store dry stones at ambient temperature	G, P, B, Gr	B:30%, Gr:room		G:until stratification in autumn, B: 30-50% seeds for classical methods
84	We store dry stones in refrigerators, 3-5 C	Rpi	Rpi:50%		
85	We store dry stones in hermetic sealed containers in a freezer, Temperature?	Rbu			Rbu: store at -4°C
86	We stratify seeds immediately after harvest without drying and no storage	Rpi, I, P, B, H, F, L	Rpi:50%, P:70%, B:30% af all seeds, H:100%		B:only last two years- new test
87	Breaking dormancy - breaking endocarp imposed dormancy (always before cold)				
88	We sow intact stones in summer/autumn in field right after harvest and let nature overcome dormancy until germination next spring	Rpi, T, H, Gr	H:10	T: 7-8	H: soil must be wet during dormancy
89	We don't warm stratify at all but go directly to cold	Rpi, SP, G, I, P, H, F			
90	We warm-stratify fully moist stones in peat moss at approximately 20C for 2-4 weeks for eliminating endocarp imposed dormancy and achieveing synchronous germination	L			L: warm stratify about 4 weeks at 15-18°C

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Selected results – examples. **Sweet cherry**

98	Cold stratification to break endogenous/physiological dormancy in embryo				
99	We cold stratify fully moist seeds in peat moss at 3-5C for 12-16 weeks until first 5 % seeds have shown radicles (white root tips) indicating beginning of germination of the seed lot	SP, I, P, B, H, L	SP:50%, B:30-40% of all seeds	SP:8	SP:in perlite, I:riversand, P:peat-perlite (50-50%) or perlite, B: 4-5°C in perlite or sterile sand
100	We cold stratify fully moist seeds without medium (naked) at 3-5C for 12-16 weeks until first 5 % seeds have shown radicles (white root tips) indicating beginning of germination of the seed lot	G, Rbu, SNS, GR			SNS: after strat seeds were sown in substrate, but no germination obtained
101	We use a special medium mix, describe in note	G, P, H, F	G:95%	G:0-5	G: soak stones 24 hours, in wet sand in plastic bags 4°C 3-4 months, then remove endocarp and sow seeds, H:sand-perlite mix or special expert mix, F:moist vermiculite, disinfect seeds prior with calcium hypochloride
102	We sometimes experience longer chilling requirements than 16 weeks in some seed lots	Rpi, SP, P, B, F, L	B:1-2%		
103	We sow all seeds when 5-10 % have shown germination	H			H: after cold we remove endocarp before sowing in 'Prunus soil'
104	We allow all seeds to germinate in the cold and transplant seeds when they reach radicle length of 0,5 cm approximately	SP, I, P, B, H, F, Gr			
105	We avoid sowing at temperatures above 15C to avoid induction of secondary dormancy (that inhibit germination)	Gr			
106	We sow directly in the field at the ambient temperature, approx. soil temperature?	Rpi			
107	We sow in greenhouses. Control or not of temperature? Describe temperature range	Rpi, I, P, H F, L, Gr			I:no temperature check, P:controlled 16°C night-20°C day, H: around 20°C, F:25°C day and 20°C night, G: no temp control

Risk of induction of secondary dormancy in non-germinated seeds?

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Selected results – examples. **Sweet cherry**

4. Embryo rescue methods - specialised treatments	Methods	Country	Estimated frequency of type compared to all embryo rescue methods	General succes rate for achieving germination, range 1= 0, 10 = 100 % succes	Comments notes
118	We use embryo rescue germination of very early ripening cultivar crosses	Rpi, SP, G, H, F, Rbu, SNS	Rpi: in the past, SP:50%, G: very seldom	SP:6	
119	We use embryo rescue for germination of interspecific crosses	SP, G	SP:2%, G: very seldom	SP:6	
120	We use embryo rescue for germination of crosses with different ploidy levels				
121	We use embryo rescue/in vitro techniques for germination of normal developed seed	SP, F, Rbu, SNS	SP:48%, SNS:100%	SP:8	F: for early ripening cvs we use embryo rescue also for normal developed seeds if only few, Rbu:start 2014, SNS:only one year trial
122	Describe the standard method(s) of embryo rescue used in your lab, Agar type, nutrient medium, hormones concentrations? Light, temperature, chilling time?	SP, H, F , SNS			SP:WPM medium, 16h light, 24°C, H: protocol available*, F: protocol available* (Agar-classical nutrient medium Le Poivre- Heller solutions, no hormones), SNS: B&H media no Agar, chilling embryos 2-3 months then germinated at 16°C and later transplanted
123	How do you determine the optimal seed and fruit development stage for embryo rescue? Important markers and characters? Cultivar examples	SP, F			SP: studied cvs Ruby, 4-70, Burlat, F:between rose and red colour several days before maturity
124	What is in your opinion the most succesfull seed development stage to achieve embryo rescue in immature seeds? Cultivar examples	SP, F:nk			SP:before full maturity
	Have you attempted to further develop/ripen/mature very immature embryos from early cultivars in tissue culture media before later germination? Which media? Describe	SP	SP:2-3%	SP:0.1	

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Selected results – examples. Sour cherry

Success cross, yield?

1. Genetic material and background used in breeding	Which type of crossing/hybridising is done in your institute? (one to several)	set X for type	Estimated frequency of type compared to all crosses	General succes rate for achieving offspring, range 1= 0, 10 = 100 % succes
1	Intraspecific crosses cultivar to cultivar	SNS, T, D	SNS100, T100, D100	D90
2	We only cross known compatible cultivars	H, G, P	H100, P10	H30, P 80 --20-40 % FRUIT
3	We attempt crosses with incompatible cultivars	R		
4	We cross without knowledge of incompatibility	H, R, SNS, P, T, D	H10, SNS100, P90, T100, D100	H10, SNS80, P 80 --20-40 % FRUIT, T80, D90
5	We investigate reciprocal crosses as standard	D SOMETIME		
6	We attempt selfing in self fertile cultivars	H, R	H20	H10
7	We attempt selfing in self incompatible cultivars	R		
8	We attempt crossing of different ploidi levels	H	H10	H0-10
9	We attempt interspecific hybridization	species name	G10	
10	1. Most important species for hybridization	G- P.maackii, R- P.avium		
11	2. Second most important species for hybridizatio	G- P. spinosa, R -P. subhirtella		
12	3. Third most important species for hybridization	G- P. serotina, R - P. pseudocerasus		
13	4. Fourth most important species for hybridizatior	G- P. padus, R- P. nipponica		
14	5. Fifth most important species for hybridization	R - P. canescens		
15	We investigate reciprocal crosses as standard			
16	We attempt crosses of different chromosome no.	G - P.tomentosa/ P. avium, R		

Most methods are similar to P. avium methods (no embryo rescue reported!)

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Overall types of pollination methods

1. **Open pollinated** by neighbor trees (used often)

2. **Controlled cross in field**: (manual pollination) (main standard)
   - A. pollen from trees flowering same time (+ by bumble bees in tents)
   - B. pollen from forced branches to advance flowering
   - C. dried pollen harvested previously and stored dry

3. **Controlled crosses in greenhouse** (potted trees) (pollen as above) less common, higher costs, better success in difficult climates.

4. **Reciprocal crosses** (only if difficult)

5. **Self fertilisation** (inbreeding)

6. **Experimental crosses** (interspecific, ploidy levels, incompatible cvs etc)

Almost never reach 90-100 % fruit set in any pollination method (commercial crop production normal with only 30-40% fruit set?)

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Overall types of seed treatment methods

1. '**Natures way'** harvest OP by neighbor trees and sow right away leaving dormancy breakage and germination to 'nature' (less common, very low cost, non-controlled crosses)

2. '**The full scale professional**' controlled stratification – 'Easy crosses', high number of seeds, extensive methods, low-medium cost methods. (most common)

3. '**The special case professional**' – Difficult crosses, low number of seeds or wish of fast-cycling-breeding, intensive methods, high cost methods
   A. Embryo culture (normal or immature seeds)
   B. Embryo rescue (very immature seeds)
   C. Fast cycling methods (normal seeds)

4. The frontier **experimental methods** to establish '**impossible crosses'** and new genotypes (examples)
   A. *In vitro* shoot culture methods (without germination)
   B. Somatic embryogenesis (without zygotic germination)
   C. Haploid –Double haploid culture, chromosome doubling
   D. Protoplast fusion
   E. Irradiation induced variation

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Limitations to this survey

- Limited to questions – answers provided (+ notes-remarks)
- Only some information given (not 100% completed for all)
- Only some information is available (succes rates not available on all individual steps only few stages + overall) (pollen quality, % seeds from pollinated flowers, % succesful seedlings obtained from seeds, ungerminated viable seeds discarded?)
- Confounding of different protocol steps – difficult to evaluate steps in applied setting
- Only generalized average estimates of successes over years and over many different crosses - memory based (not actual data, and actual variation in these)
- Only EU countries and Turkey participated (US, Chile, and others?)
- Interpretation and evaluation of options for improvement limited by current knowledge and understanding

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Conclusions

1. A few common methods of pollination, seed treatment and germination are used mainly and with generally ‘acceptable output’ allthough with some variation (no of poll flowers >>> seeds> seedlings)
2. Still room for some refining, optimising and rationalizing these methods to be more effective and less costly. (research needed in optimising pollination, pollen vigour - understand sucess-failure)
3. Some less intensive seed treatment methods seem to give more uncertain output over longer time but may be much cheaper (initially!)
4. High cost intensive methods may not be cost effective for normal seeds, only for few high interest and difficult crosses/seeds
5. How to get more for less? Can we develop methods to ‘target’ better the seed genotypes that we are looking for? (less seeds to germinate, less seedlings to evaluate?). Selective environments – maximise phenotypic response, screening seed DNA before germination, success-markers?

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Dissemination of information

This presentation on the COST Cherry homepage

Chapter 3 in Cherry book (Amy Iezzoni lead author)
General pollination and seed treatment methods description with literature review inputs and reference to the questionaire.

Technical report (to be finalized this spring - May)
Sending short technical report to participating institutes and countries with all collated information (who is doing what) to share and allow everyone to know who to contact for more information on methods and successes.

Possible scientific manuscript
Plan to write up a separate manuscript from these data for disseminating to a wider scientific audience (with support from some of you). (no deadline set)

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Thank you for your attention