Can we use crossbreeding in Black Soldier Fly to improve production?

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Crossbreeding in farmed insects

BRILL WAGENINGEN ACADEMIC

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Journal of Insects as Food and Feed
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Cross-breeding of *Tenebrio molitor* strains from a large-scale perspective

C. Adamaki-Sotiraki[1], D. Deruytter[2], C.I. Rumbos[1] and C.G. Athanassiou[1]*

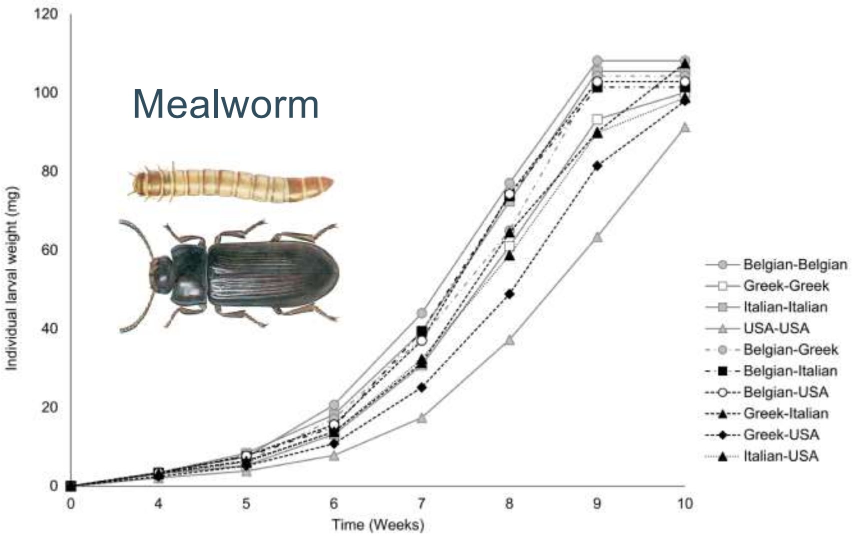

FIGURE 5 Average individual larval weight (mg) of 10 inbred and partially outbred lines of *Tenebrio molitor* over a period of 10 weeks. In all cases, values represent means (n = 4; F = 4.75; P = 0.001; df = 9, 39) (n = 4).

Silk moths

Int. J. Indust. Entomol. Vol. 2, No. 2, 2001, pp. 133~139

International Journal of *Industrial Entomology*

Manifestation of Hybrid Vigour and Cocoon Shape Variability in F1 Hybrids of the Mulberry Silkworm, *Bombyx mori* L.

Ravindra Singh*, D. Raghavendra Rao, V. Premalatha, Sipra Mondal, B. K. Kariappa, K. P. Jayaswal and R. K. Datta

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Journal of Entomology 6 (4): 188-197, 2009
ISSN 1812-5670

Evaluation and Identification of Superior Polyvoltine Crossbreeds of Mulberry Silkworm, *Bombyx mori* L.

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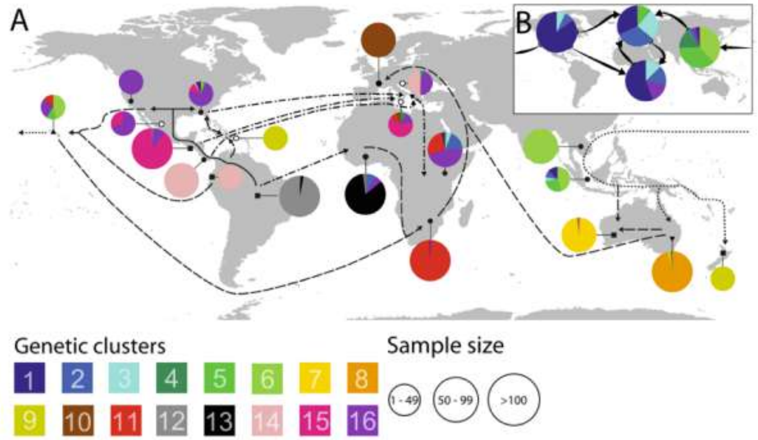
BSF diversity

- Exploiting BSF diversity ?
- Heterosis ?
- Outbreeding depression ?
- Mating compatibility ?



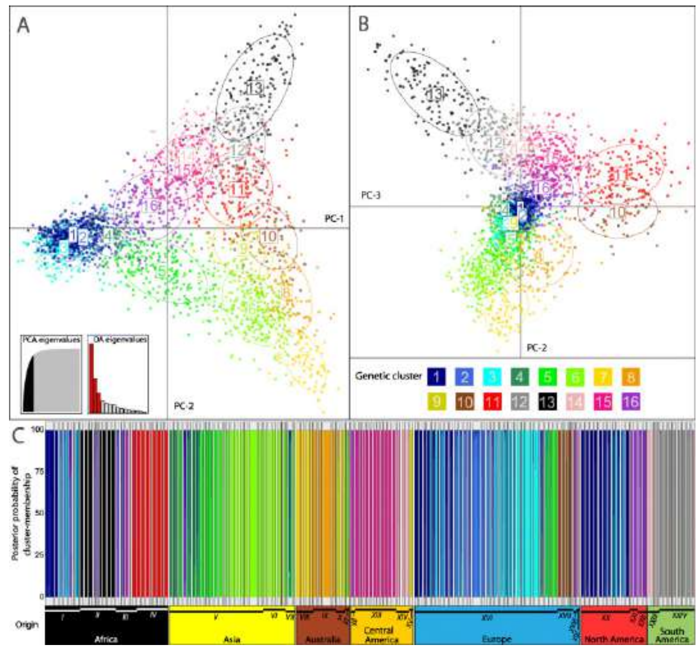
Kaya et al. BMC Biology (2021) 19:94
https://doi.org/10.1186/s12915-021-01029-w

BMC Biology

RESEARCH ARTICLE Open Access

Global population genetic structure and demographic trajectories of the black soldier fly, *Hermetia illucens*

Cengiz Kaya[1,2], Tomas N. Generalovic[3], Gunilla Ståhls[4], Martin Hauser[5], Ana C. Samayoa[6], Carlos G. Nunes-Silva[7], Heather Roxburgh[8], Jens Wohlfahrt[1], Ebenezer A. Ewusie[9], Marc Kenis[10], Yupa Hanboonsong[11], Jesus Orozco[12], Nancy Carrejo[13], Satoshi Nakamura[14], Laura Gasco[15], Santos Rojo[16], Chrysantus M. Tanga[17], Rudolf Meier[18], Clint Rhode[19], Christine J. Picard[20], Chris D. Jiggins[3], Florian Leiber[1], Jeffery K. Tomberlin[21], Martin Hasselmann[22], Wolf U. Blanckenhorn[2], Martin Kapun[2,23] and Christoph Sandrock[1*]



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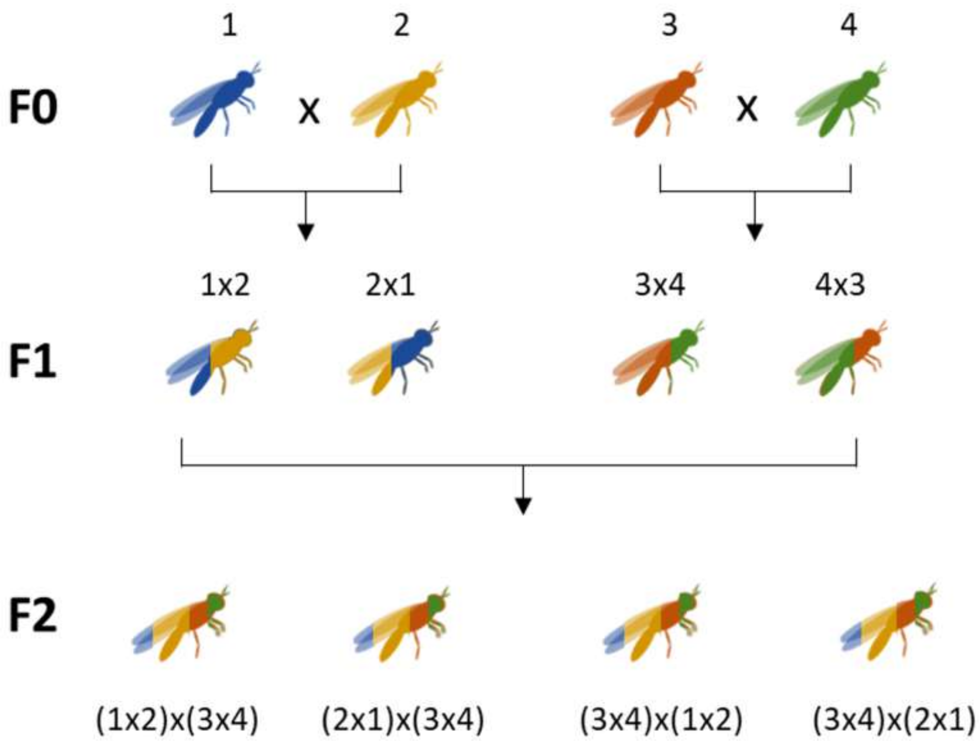
Experimental setup



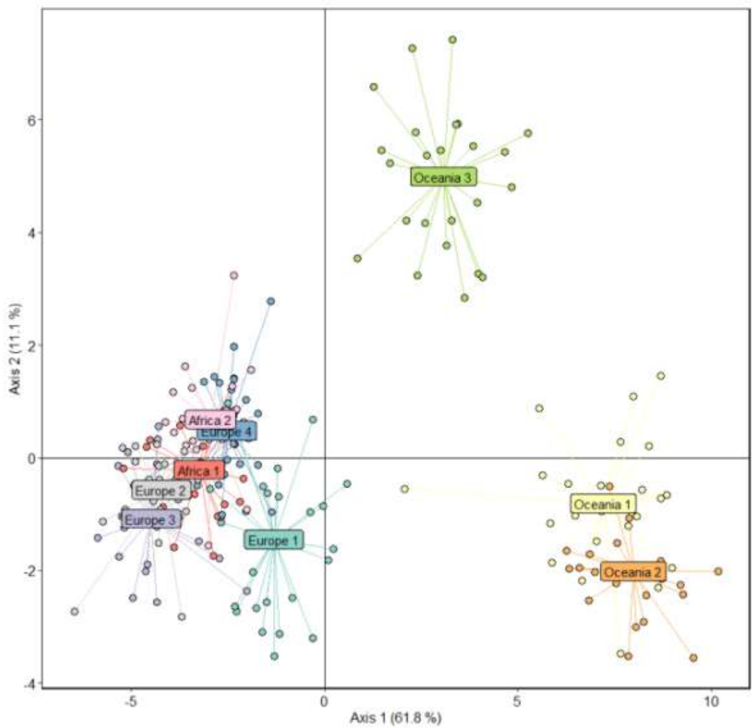
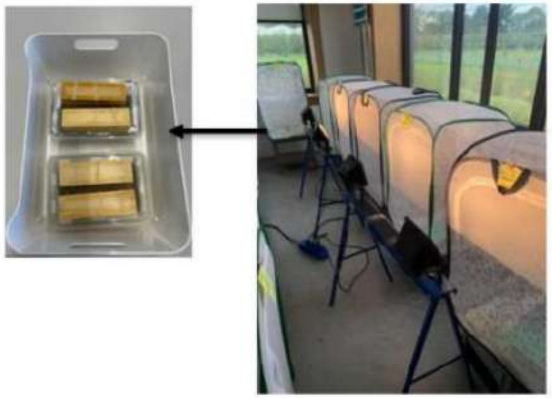


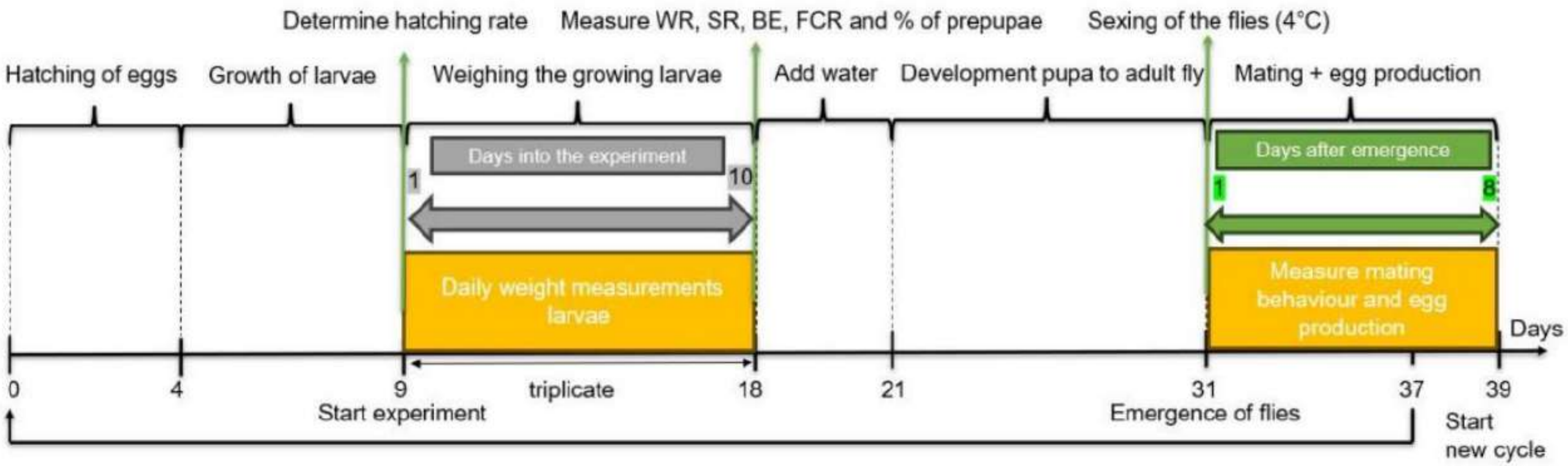
Figure from: Broeckx (2025)

Center for Animal Breeding and Genetics, Department of Biosystems
KU LEUVEN

Experimental setup

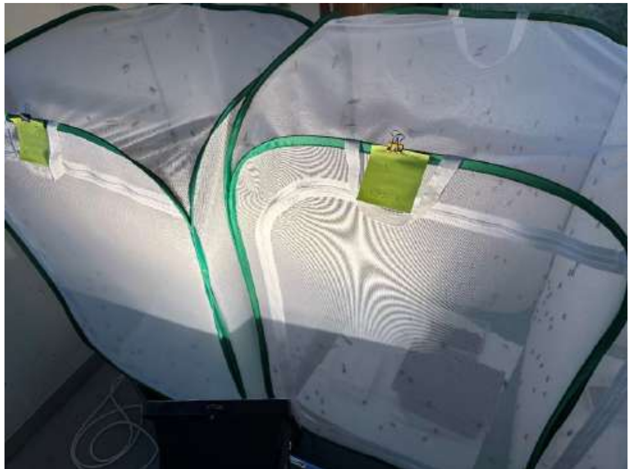
100g csm + 100g water | 240g csm + 360g water | 3.3kg csm + 4kg water





Experimental setup

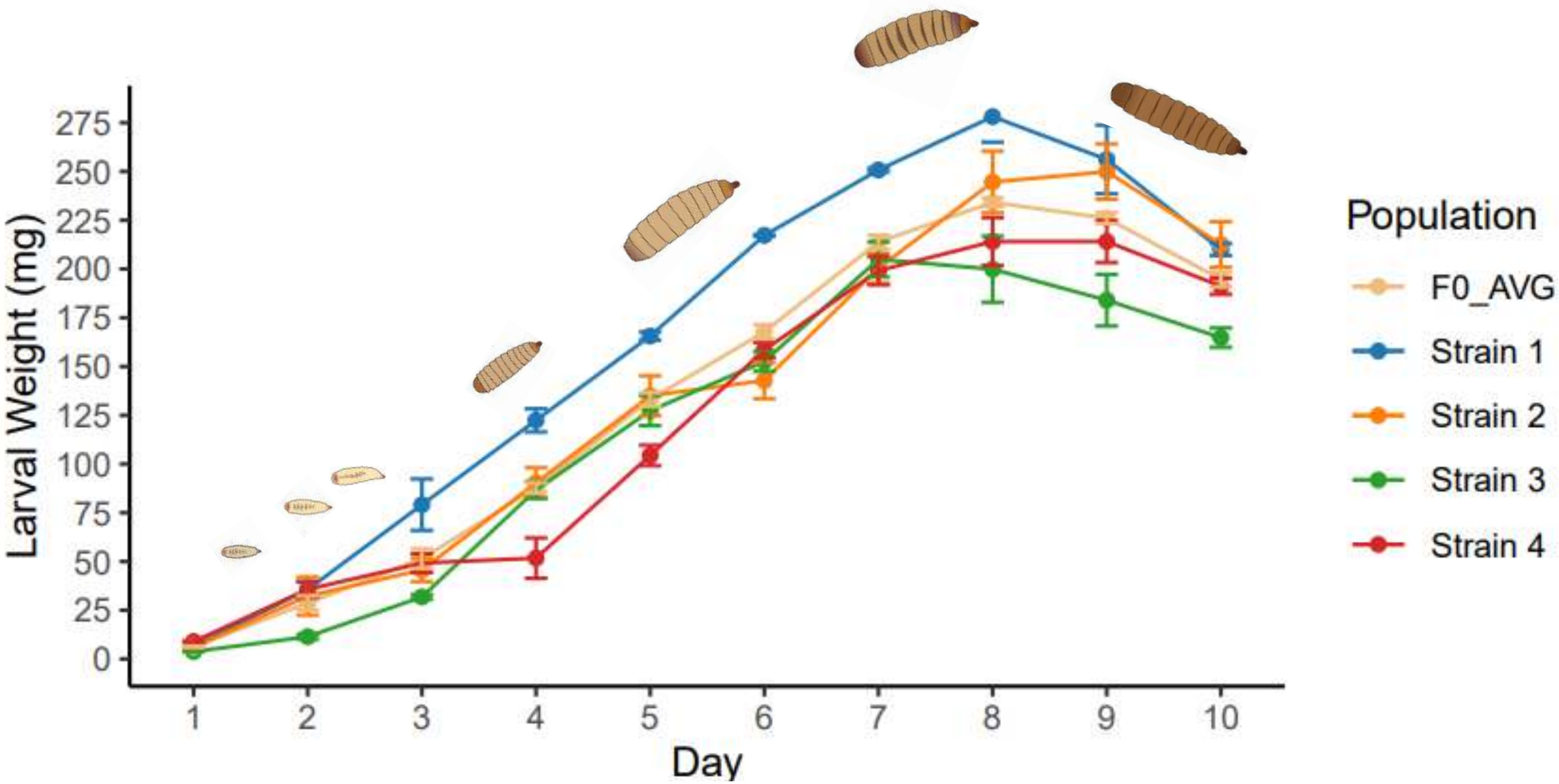
- All groups reared in triplo
- Reared on pilot-scale ± 7,500 larvae in each container (3.3kg chicken start mash and 4kg of water)
- Mating crosses with 500 ♂ and 500 ♀



Feed composition	
DM content	90.6 g/100 g fresh matter
Crude protein	20.4 g/100 g DM
Crude Ash	6.0 g/100 g DM
Fibre	20.9 g/100 g DM
Carbohydrate	48.2 g/100 g DM
Gross energy content	315 kcal/100 g DM
P	0.85 *g/100* g DM
Mg	0.25 *g/100* g DM
K	0.82 *g/100* g DM
Na	0.13 *g/100* g DM
Ca	1.14 *g/100* g DM
Zn	0.012 *g/100* g DM
Cu	0.002 *g/100* g DM
Fe	0.016 *g/100* g DM

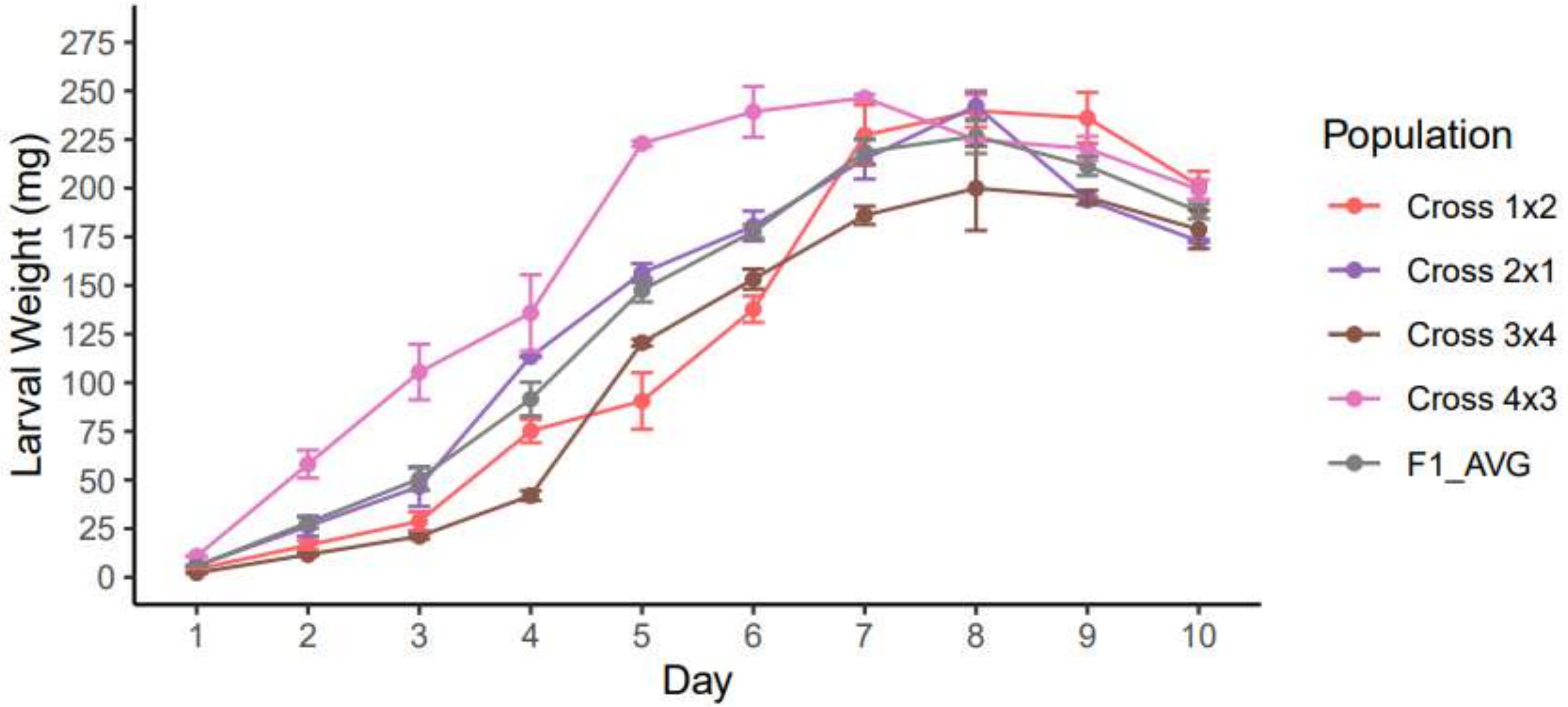
DM: Dry matter, from Broeckx et al., 2021

Larval performance – F0

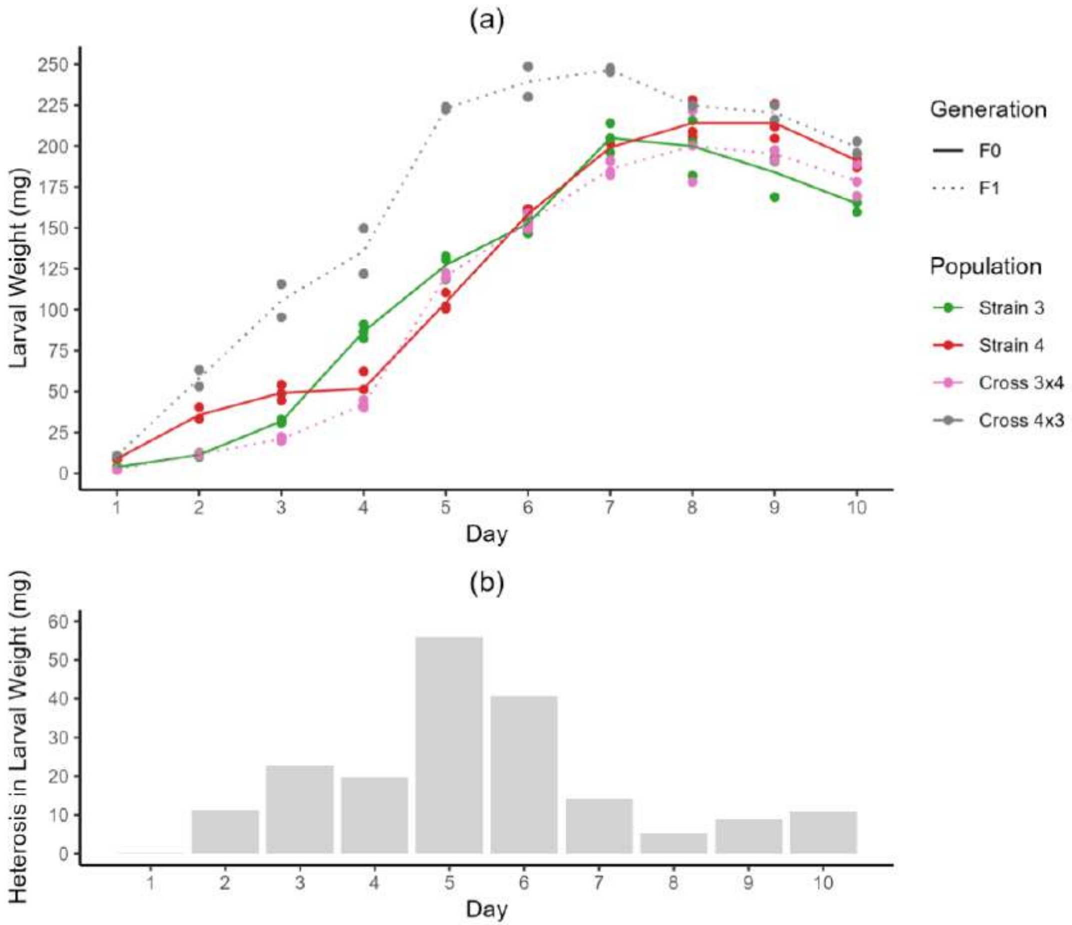


Center for Animal Breeding and Genetics, Department of Biosystems

Larval performance – F1

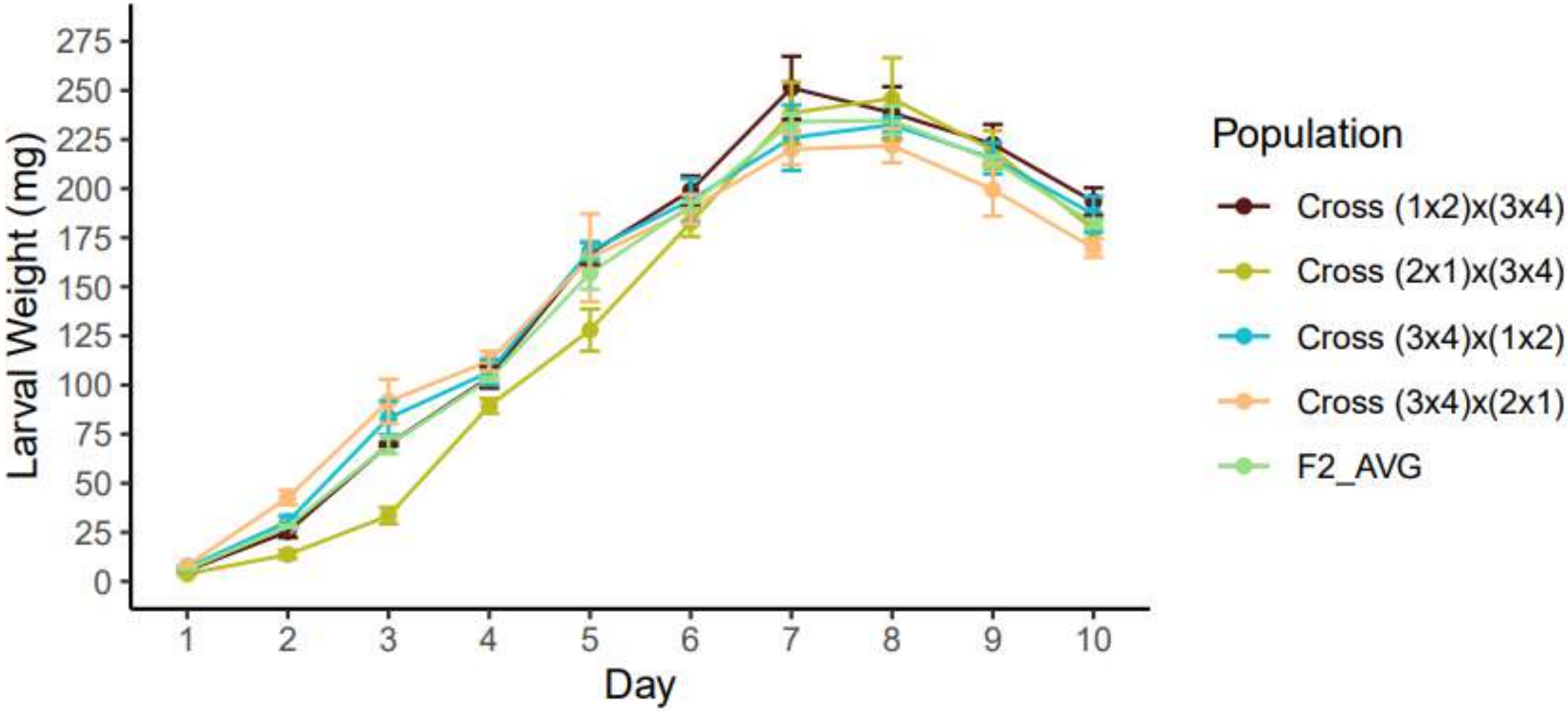


Heterosis in F1

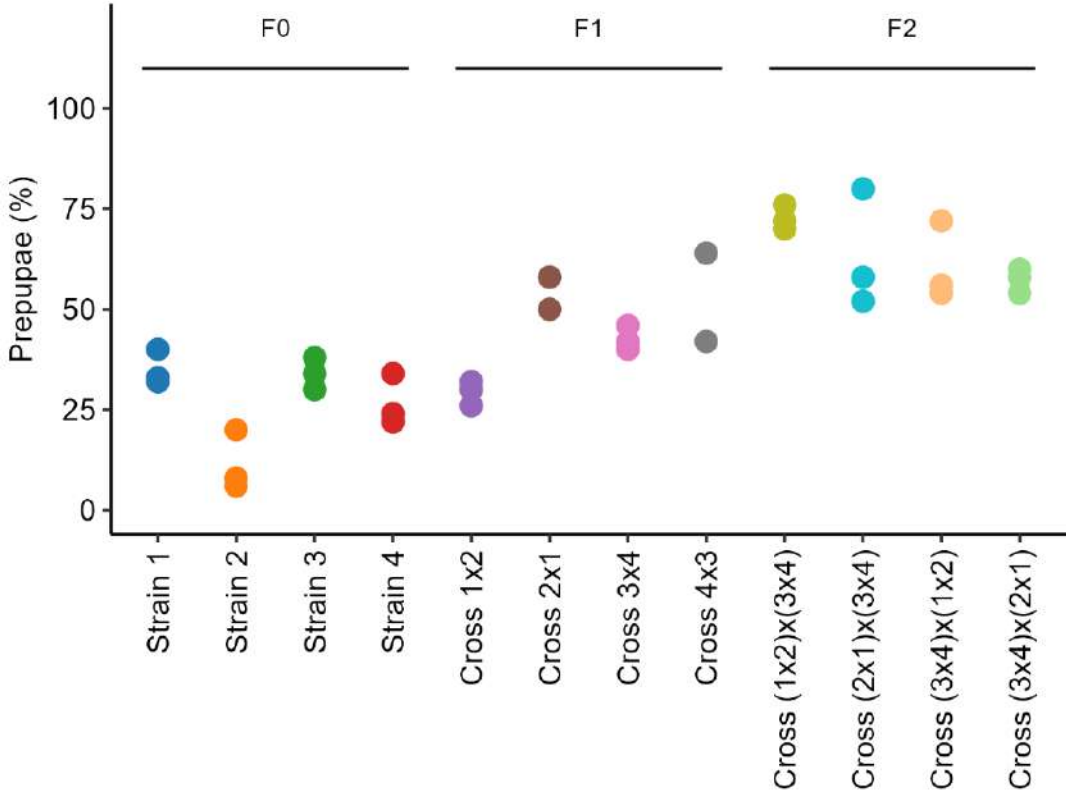


Reciprocal differences up to 32%

Larval performance – F2

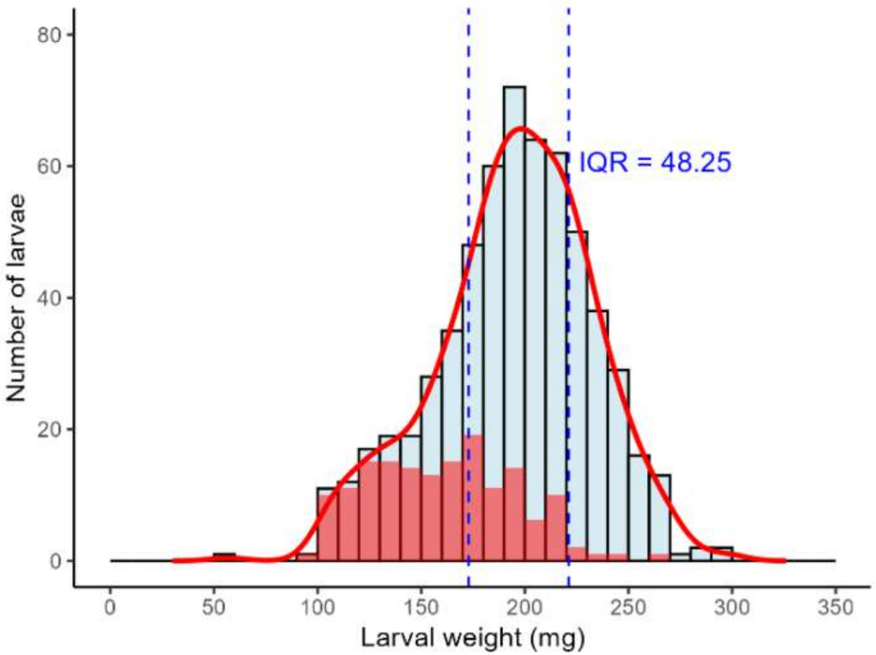


Crossbreds tend to develop faster …

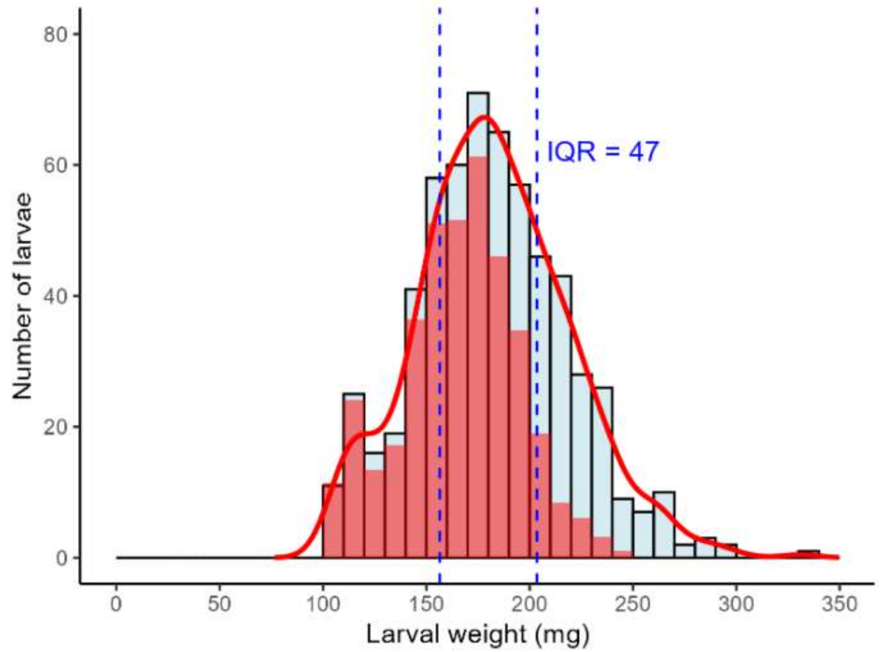


@ day 10 (harvest)

F0



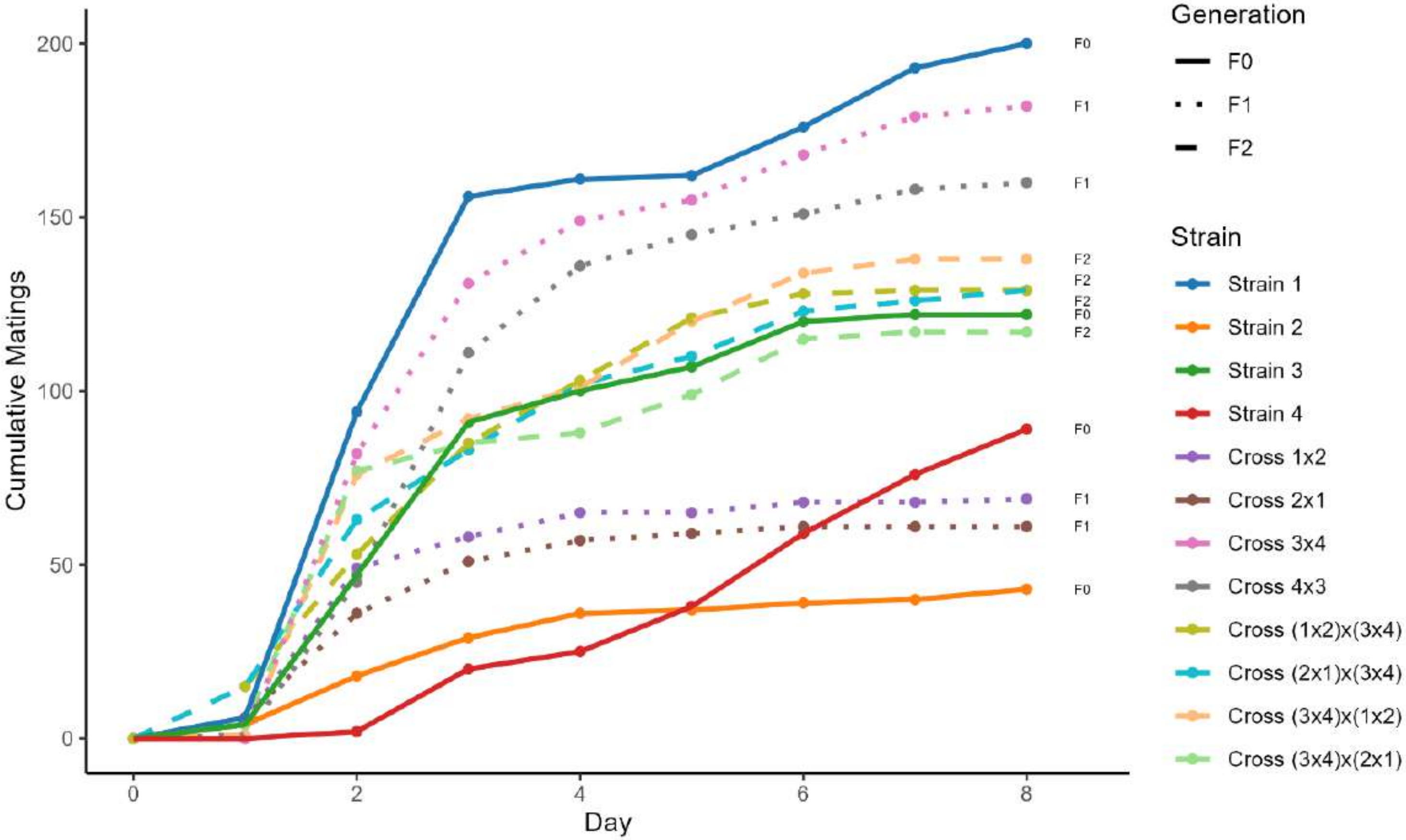
F2



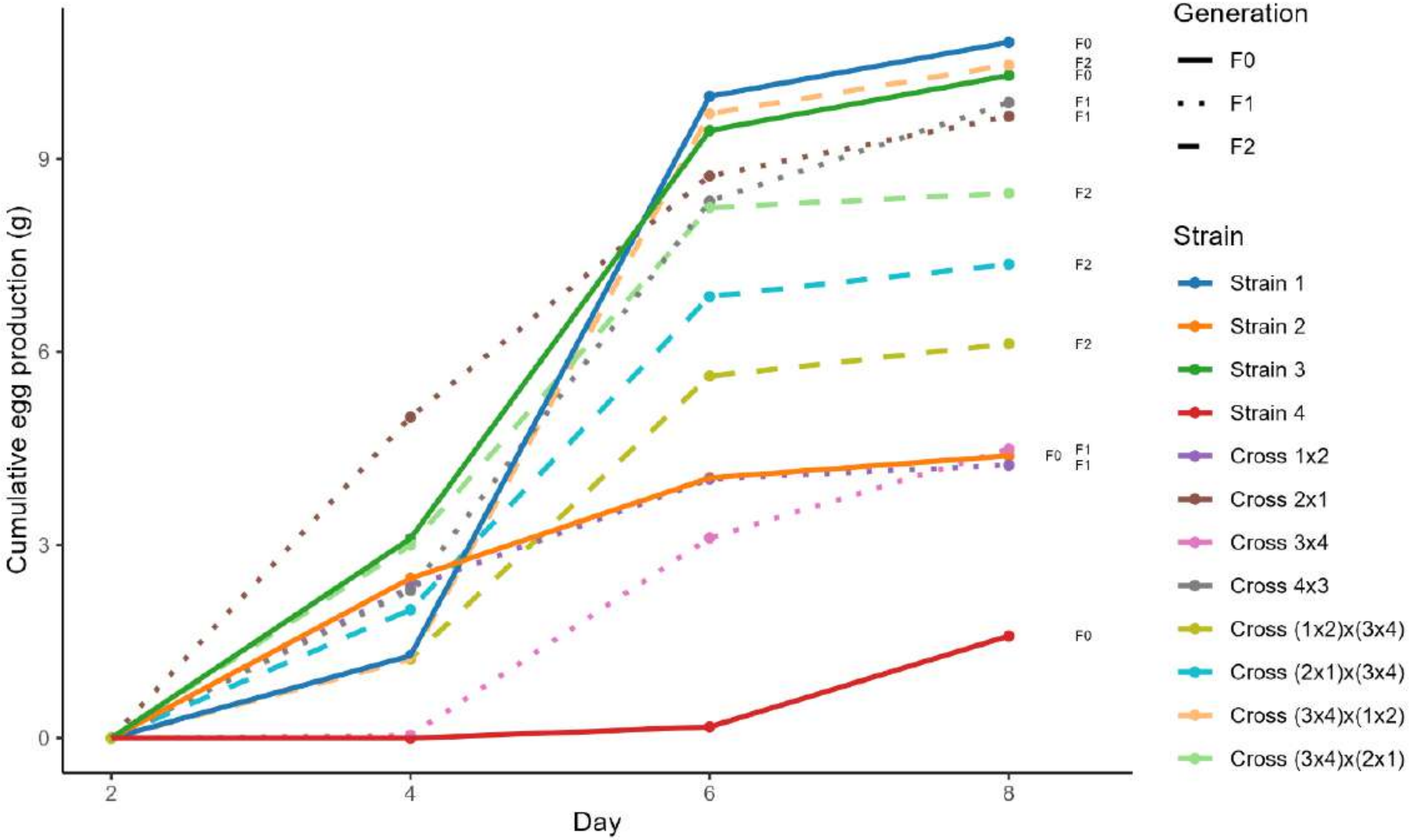
Red = proportion of prepupae

600 individually measured larvae

Mating compatibility ?



Cumulative egg production is cross-dependent



Egg production was 19% higher in F2 compared to F0

Computed total yields

Generation	Population	Total mass per container (g)	Larval dry matter content	Total egg production (g)	Larval survival rate (in %)	Total mass per population		Total dry mass per population	
						Absolute (in kg)	Difference from midparent	Absolute (in kg)	Difference from midparent
F0	1	1,442	0.352	10.81	91.5	67.9		23.9	
	2	1,351	0.357	4.39	83.8	23.7		8.4	
	3	1,188	0.371	10.30	94.2	54.9		20.4	
	4	1,323	0.352	1.59	92.4	9.2		3.2	
	Average	1,326	0.358	6.77	90.5	38.9		13.9	
F1	1x2	1,364	0.362	4.24	88.6	24.4	53%	8.8	55%
	2x1	1,264	0.366	9.66	96.4	56.1	122%	20.5	127%
	3x4	1,399	0.369	4.49	99.7	29.8	93%	11.0	93%
	4x3	1,302	0.362	9.88	87.4	53.5	167%	19.4	164%
	Average	1,332	0.365	7.07	93.0	41.0		14.9	
F2	(1x2)x(3x4)	1,256	0.366	6.13	100	36.6	135%	13.4	135%
	(2x1)x(3x4)	1,343	0.365	7.36	86.6	40.8	95%	14.9	94%
	(3x4)x(1x2)	1,143	0.364	10.46	81.6	46.5	171%	16.9	170%
	(3x4)x(2x1)	1,346	0.369	8.47	1.06	57.5	134%	21.2	135%
	Average	1,272	0.366	8.10	93.6	45.4		16.6	

Computed total yields

Generation	Population	Total mass per container (g)	Larval dry matter content	Total egg production (g)	Larval survival rate (in %)	Total mass per population: Absolute (in kg)	Total mass per population: Difference from midparent	Total dry mass per population: Absolute (in kg)	Total dry mass per population: Difference from midparent
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	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		3.2	
	Avera	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		3.9	
F1	1x2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.8	55%
	2x1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.5	127%
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	Average	1,272	0.366	8.10	93.6	45.4		16.6	

Total production increase of 16.5% for F2 compared to F0
(19.1% when comparing dry mass)

Can we use this in practice ?

- Development of new (hybrid) lines ?
- Earlier harvest possible ?
- Continuous creation/use of F1 ?
- Scalability ?

Take home message

- Crossbreeding is possible in BSF !
- Reciprocal growth differences are present
- Increased speed of development in F2 generation
- Heterosis seems present in specific crosses
- Egg production increased by 20% in hybrid flies

Acknowledgements

- FWO Travel credit (K204125N)
- KU Leuven Internal Funds (PDMT2/23/035)
- SymBIOnt Insect Pilot Plant (@ Thomas More, Geel Belgium)
- Jef Mondelaers for most of the practical work

Research Foundation Flanders
Opening new horizons

Research currently *in press* @ JIFF

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