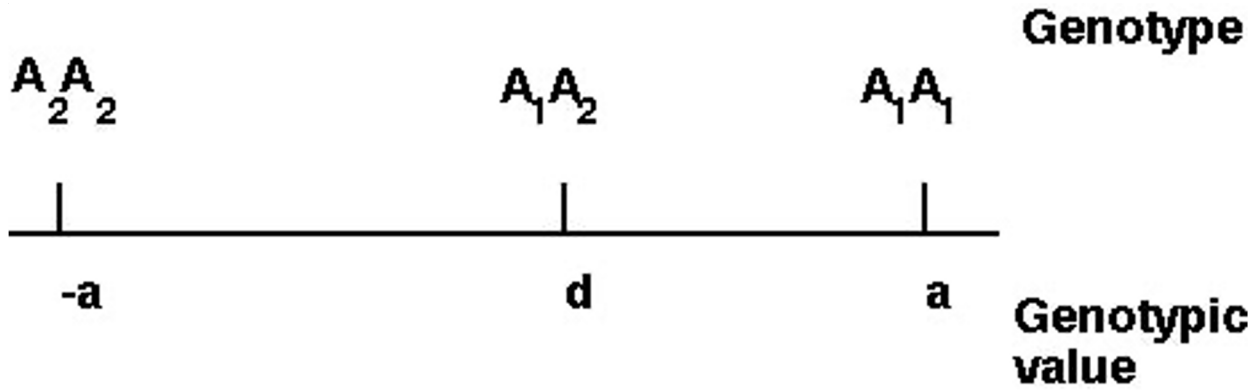
Values and means in a single locus

Values and means in a single locus

- Genetic values
- Population mean
- Average allele effect
- Average allele substitution effect
- Breeding value

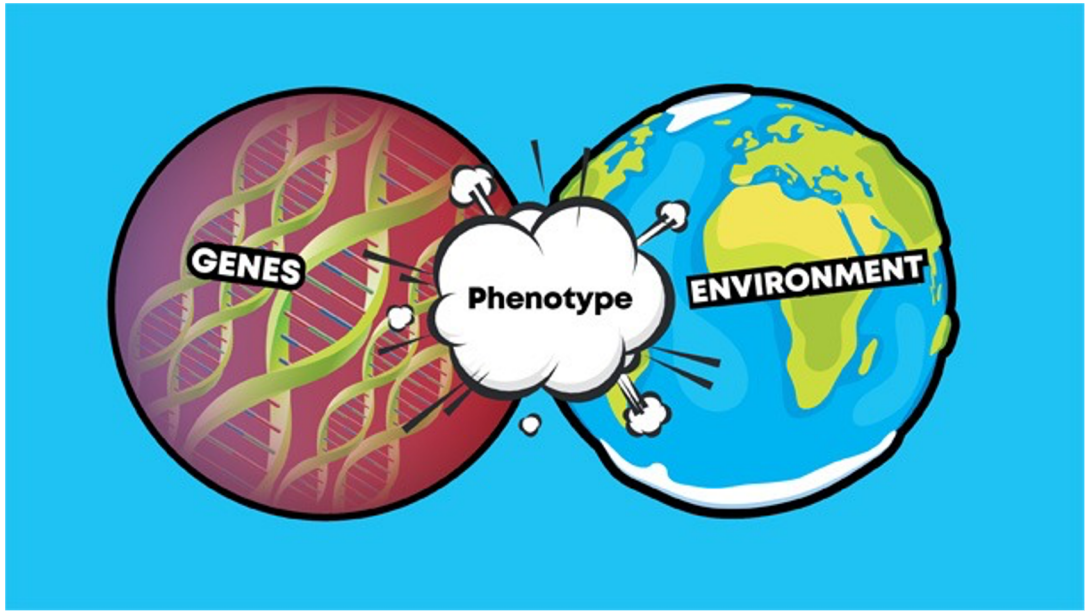


Phenotype

$$P = G + E$$

Where

P is the phenotypic value
G is the genotypic value
E is the environmental deviation



The mean environmental deviation in the population as a whole is taken to be zero

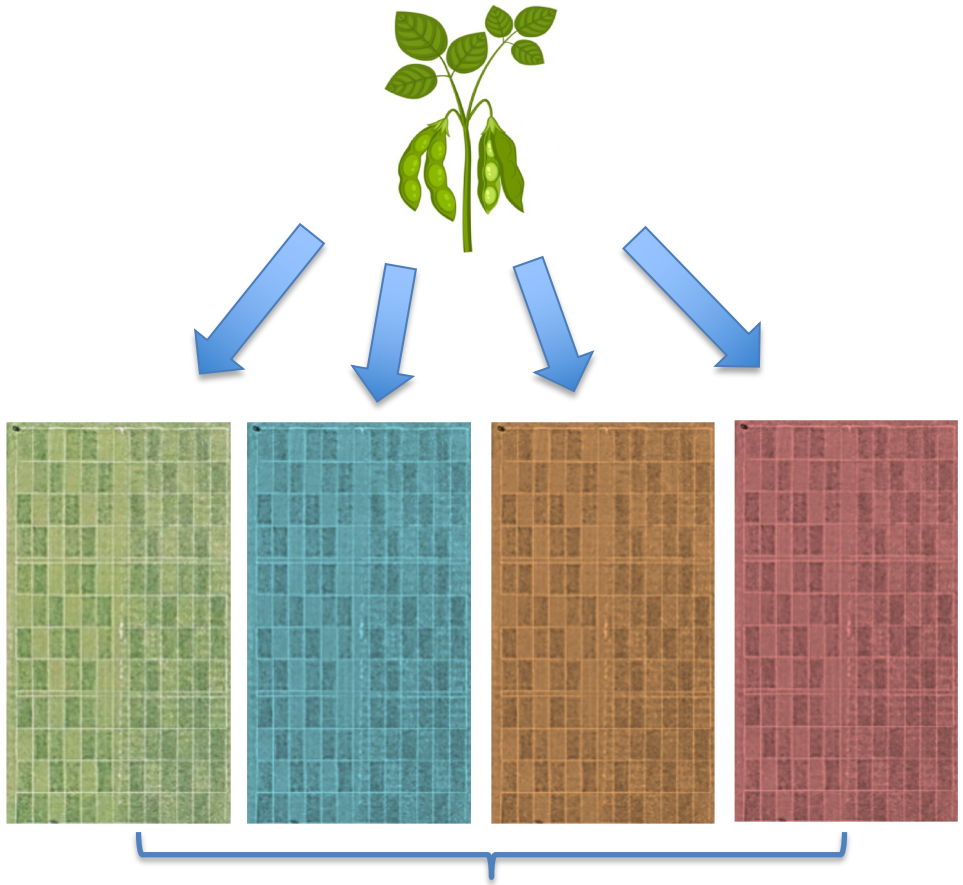
P = G

Phenotype

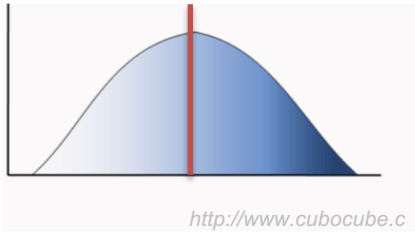
$$P = G + E$$

Where

P is the phenotypic value
G is the genotypic value
E is the environmental deviation



Mean environmental deviation would be zero

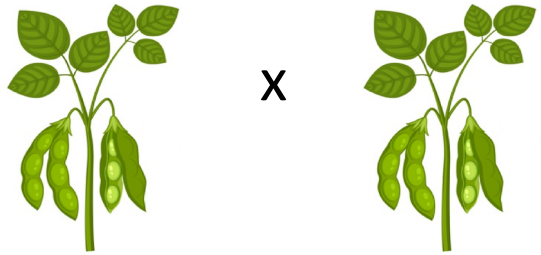


The mean environmental deviation in the population as a whole is taken to be zero

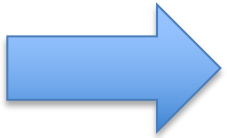
P = G

Genotype

A1A2 x **A1A2**

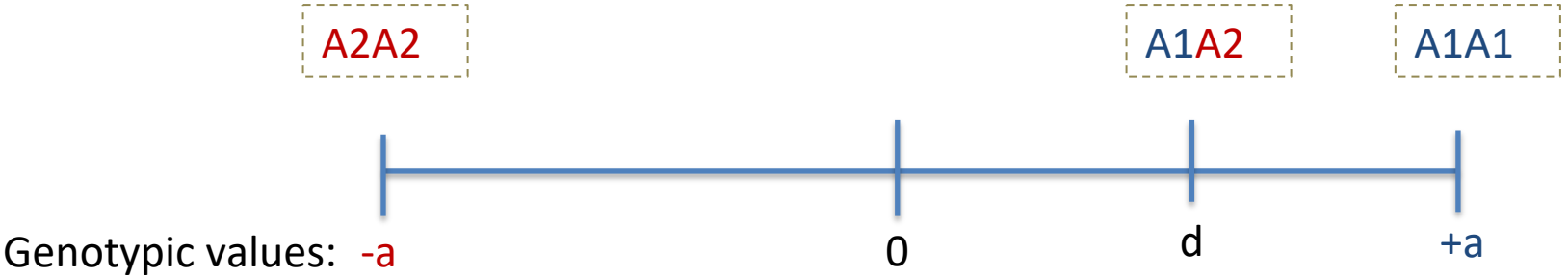


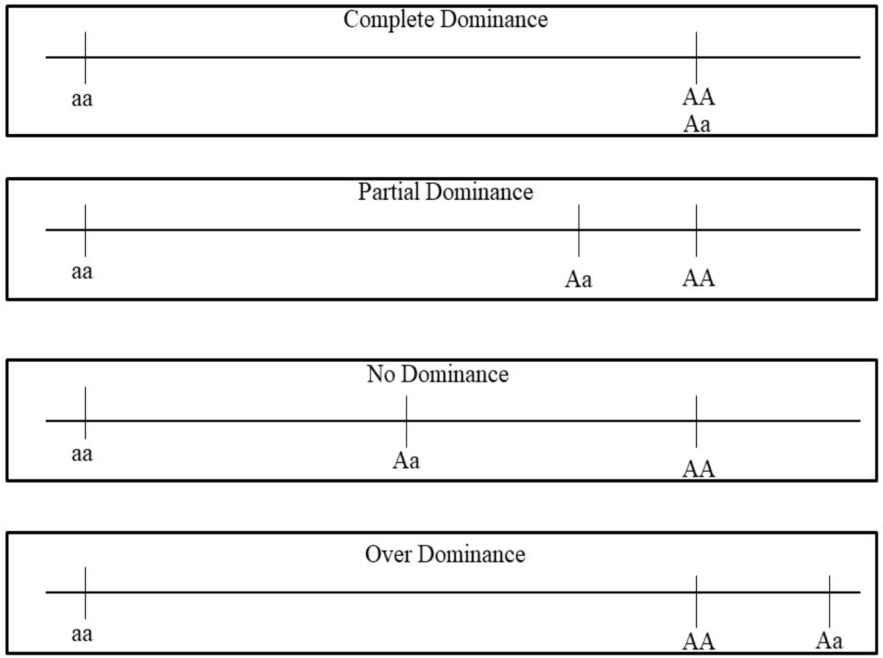
		Female gametes	
		A1	**A2**
Male gametes	A1	(A1A1) p^2	(A1A2) pq
	A2	(A1A2) pq	(A2A2) q^2



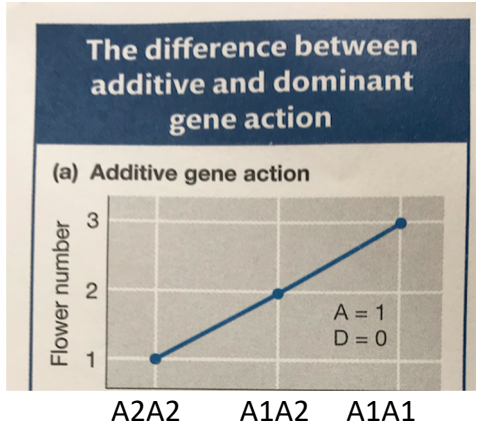
	A1A1	**A1A2**	**A2A2**
HW-Freq	p^2	2pq	q^2

Genotype



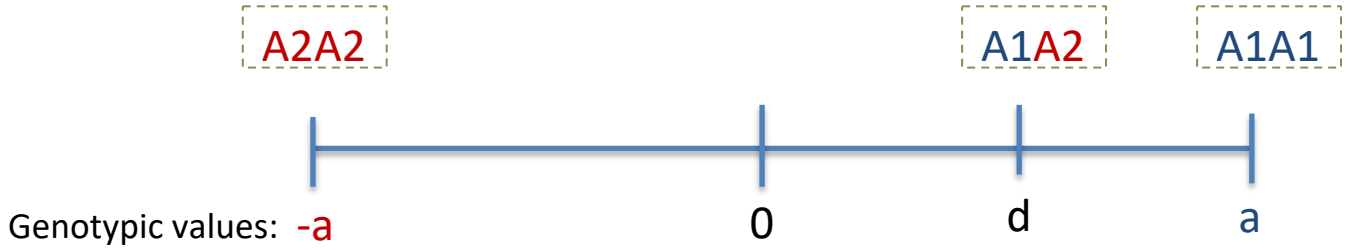


simmental.org



Griffiths et al 2012

Population mean



Genotype	Freq	Value	Freq × Value
A1A1	p^2	a	p^2a
A1A2	2pq	d	2pqd
A2A2	q^2	-a	$-q^2a$
Sum	1		a(p-q)+2pqd

$$u = \frac{1}{n}\sum_{i=1}^{n} X_i$$

$$u = \sum_{i=1}^{k} f_i X_i$$

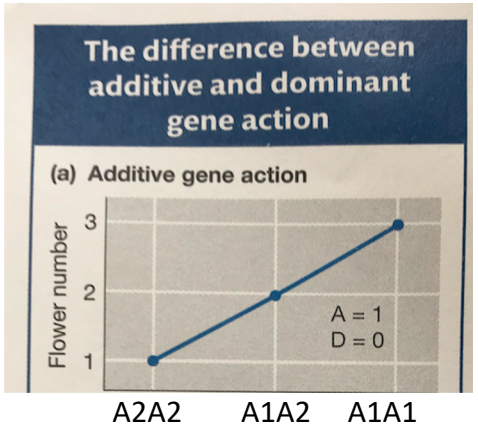
$$E[u] = a(p-q) + 2pqd$$

$$E[u] = a(p-q)$$

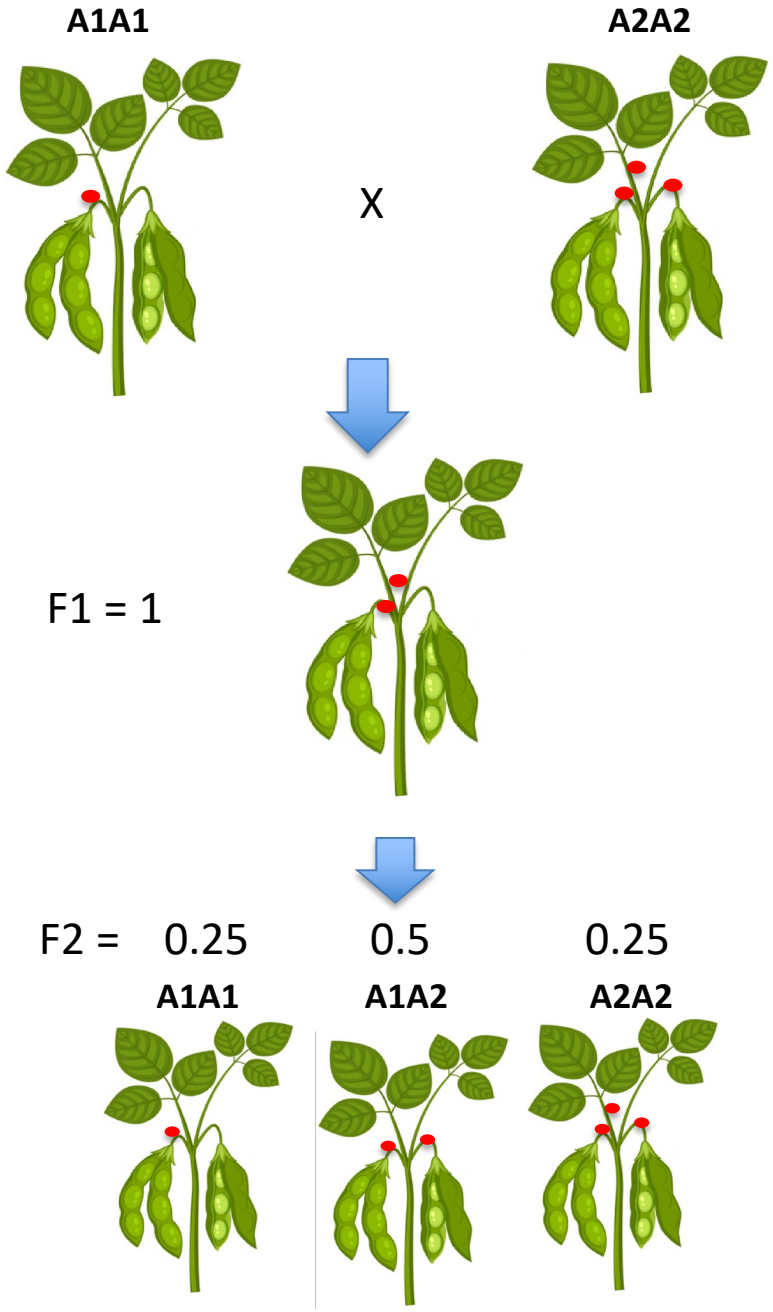
Population mean

$$u = \sum_{i=1}^{k} f_i X_i$$

Genotype	Freq	Value	Freq × Value
A1A1	p^2	a	p^2a
A1A2	2pq	d	2pqd
A2A2	q^2	-a	$-q^2a$
Sum	1		a(p-q)+2pqd



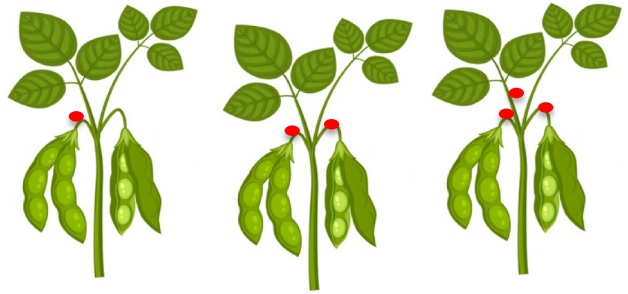
Griffiths et al 2012



Population mean

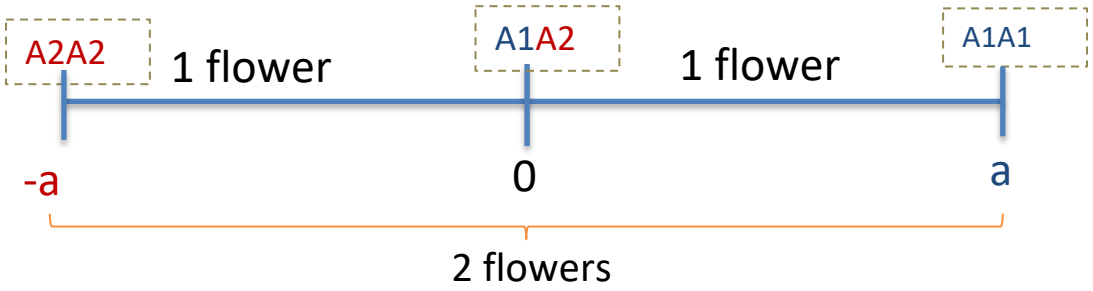
F2 = 0.25 0.5 0.25

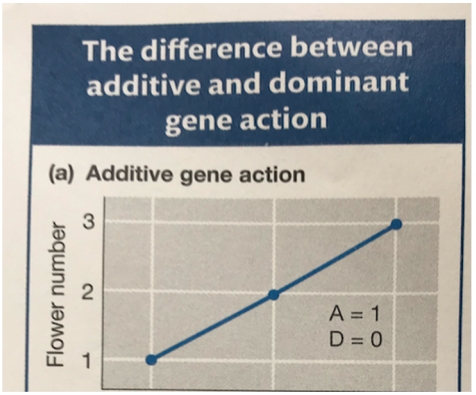
A1A1 **A1A2** **A2A2**



Genotype	Freq	Value	Freq × Value
A1A1	p^2	a	p^2a
A1A2	2pq	d	2pqd
A2A2	q^2	-a	$-q^2a$
Sum	1		a(p-q)+2pqd

$$p = \sqrt{0.25} = 0.5$$
$$q = 1 - p = 0.5$$



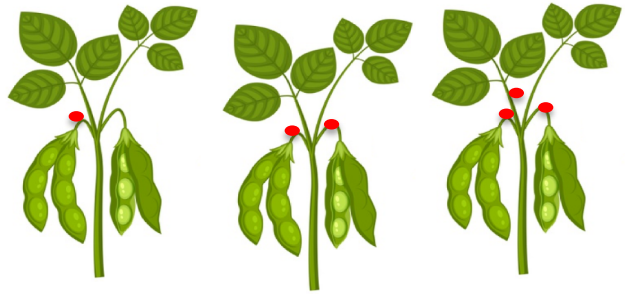


Griffiths et al 2012

Population mean

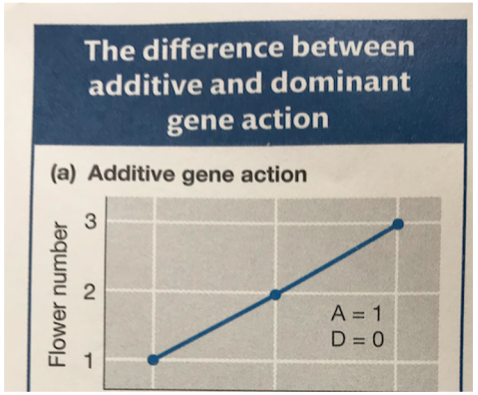
F2 = 0.25 0.5 0.25

A1A1 A1A2 A2A2

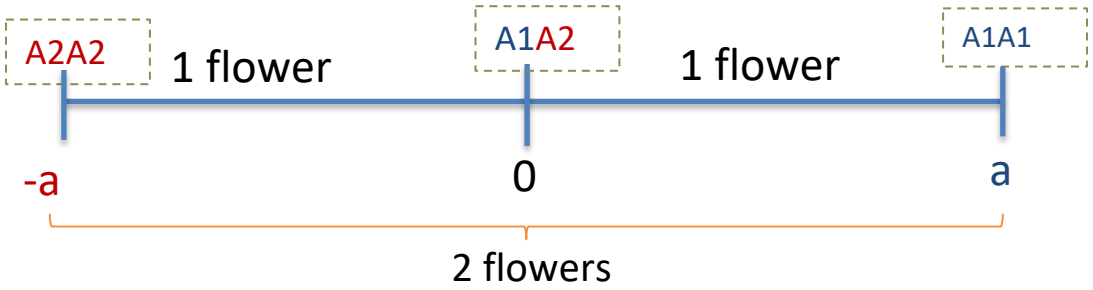


Genotype	Freq	Value	Freq × Value
A1A1	0.5^2	1	0.25*1
A1A2	2*0.5*0.5	0	2*0.5*0.5*0
A2A2	0.5^2	-1	-0.25*1
Sum	1		1(0.5-0.5)+2*0.5*0.5*0

a(p-q)+2pqd = 0



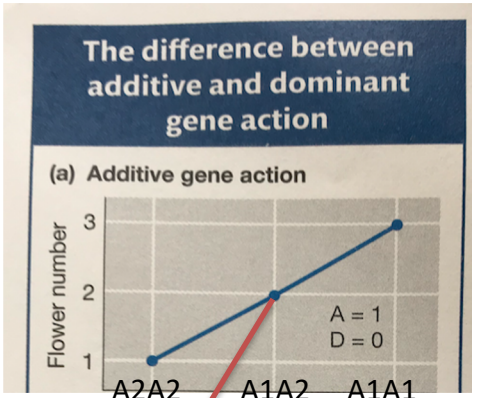
$$p = \sqrt{0.25} = 0.5$$
$$q = 1 - p = 0.5$$



Population mean

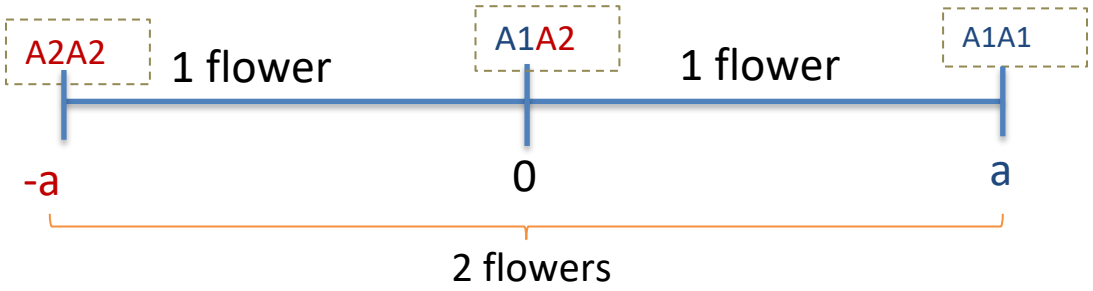
Genotype	Freq	Value	Freq × Value
A1A1	0.5^2	1	0.25*1
A1A2	2*0.5*0.5	0	2*0.5*0.5*0
A2A2	0.5^2	-1	-0.25*1
Sum	1		1(0.5-0.5)+2*0.5*0.5*0

$a(p-q)+2pqd = 0$



Griffiths et al 2012

This value of mean is measure from the mid-homozygote point, which is 2 flowers

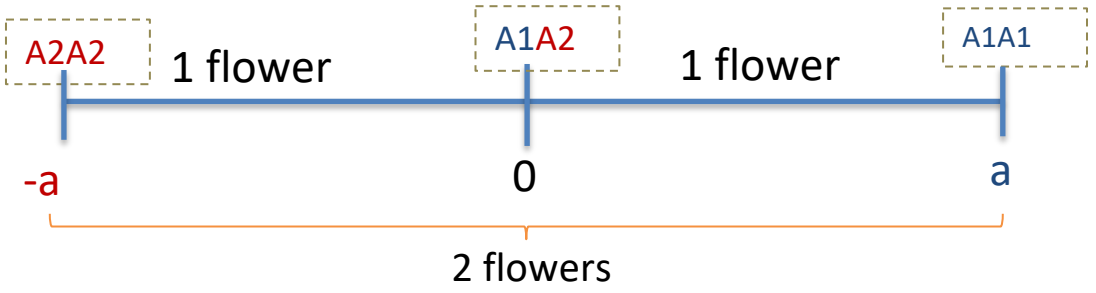


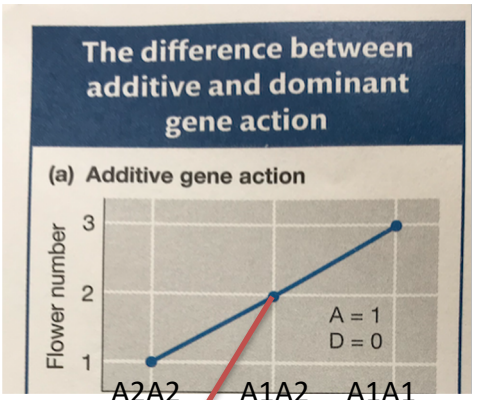
Population mean

Genotype	Freq	Value	Freq × Value
A1A1	0.9^2	1	0.81*1
A1A2	2*0.9*0.1	0	2*0.09*0
A2A2	0.1^2	-1	-0.01*1
Sum	1		1(0.8)+2*0.09*0

a(p-q)+2pqd = 0.8

$p = 0.9$
$q = 0.1$





Griffiths et al 2012

2 + 0.8 = 2.8 flowers

Population mean

Genotype	Freq	Value	Freq × Value
A1A1	p^2	a	p^2a
A1A2	2pq	d	2pqd
A2A2	q^2	-a	$-q^2a$
Sum	1		a(p-q)+2pqd

$$E[u] = a(p-q) + 2pqd$$

Single locus

The population mean resulting from joint effects of several loci is the sum of the contributions of each of separate loci

$$E[u] = \sum a(p-q) + 2\sum dpq$$

Several loci

Average allele effect

Deviation from the population mean of individuals which received an allele (A1 or A2) from one parent when the other allele come at random from the population

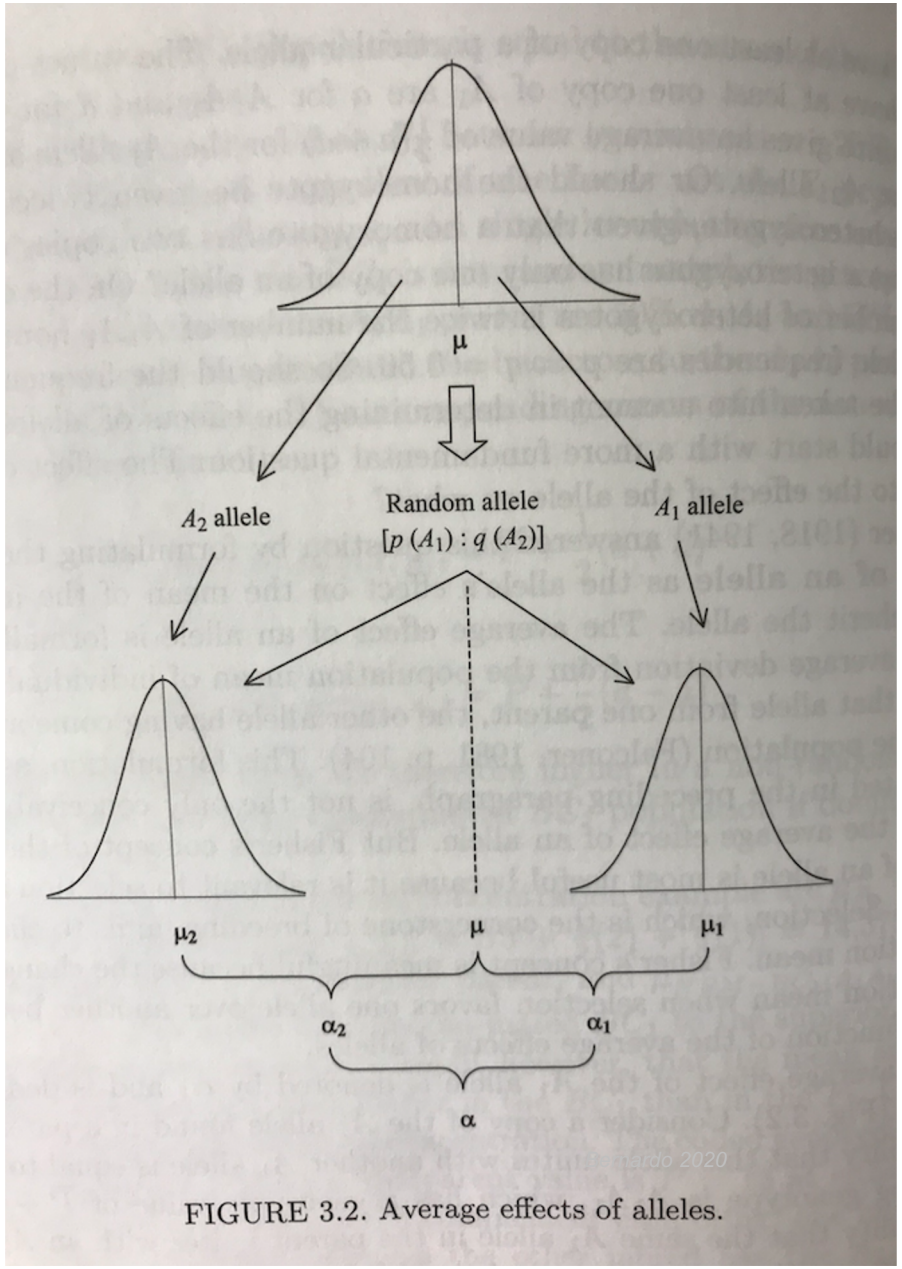


FIGURE 3.2. Average effects of alleles.

Average allele effect

Type of gamete	Values and frequencies of genotypes produced			Mean value of genotypes	Population mean to be deducted	Average effect of gene
	A1A1	A1A2	A2A2			
	a	d	-a		a(p-q) + 2pqd	
A1	p	q		pa + qd	-[a(p-q) + 2dpq]	q[a+d(q-p)]
A2		p	q	-qa + pd	-[a(p-q) + 2dpq]	-p[a+d(q-p)]

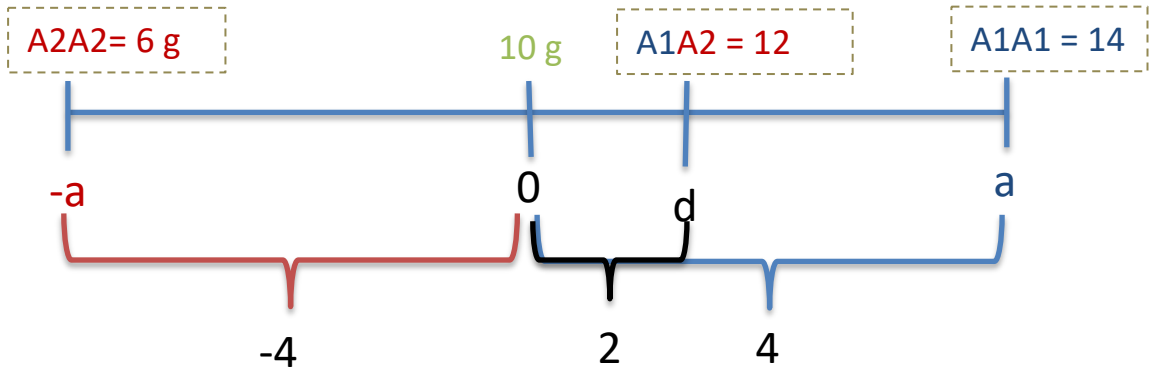
Falconer & Mackay 1996

$$Average\ effects\ of\ the\ alleles: \quad \alpha_1 = q[a + d(q - p)] \qquad \alpha_2 = -p[a + d(q - p)]$$

$$Average\ effects\ of\ gene\ supstitution: \quad \alpha = \alpha_1 - \alpha_2 = \mathrm{a} + \mathrm{d}(\mathrm{q} - \mathrm{p})$$

Average effects of gene substitution

$$\alpha = \alpha_1 - \alpha_2 = a + d(q - p)$$



$$\alpha = a + d(q - p)$$

Populations	p	q
Pop 1	0.9	0.1
Pop 2	0.6	0.4

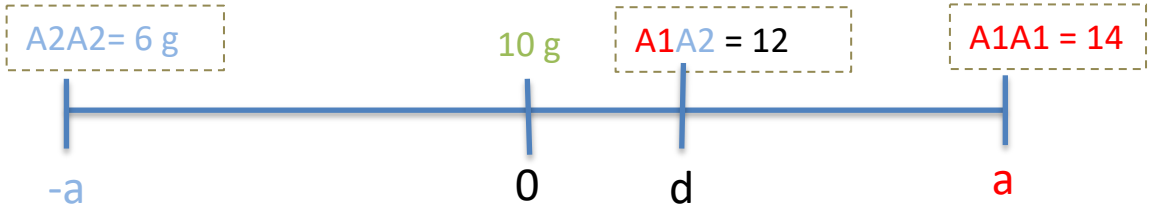
$$\alpha = 4 + 2(0.1 - 0.9) = 2.4$$

$$\alpha = 4 + 2(0.4 - 0.6) = 3.6$$

Average effects of gene substitution

Type of gamete	Values and frequencies of genotypes produced			Mean value of genotypes	Population mean to be deducted	Average effect of gene
	A1A1	A1A2	A2A2			
	a	d	-a			
A1	p	q		pa + qd	-[a(p-q) + 2dpq]	q[a+d(q-p)]
A2		p	q	-qa + pd	-[a(p-q) + 2dpq]	-p[a+d(q-p)]

Falconer & Mackay 1996



$$\alpha = \quad a + d(q - p)$$

$$\alpha_1 = q[a + d(q - p)] \quad = q\alpha$$

$$\alpha_2 = -p[a + d(q - p)] \quad = -p\alpha$$

Populations	p	q
Pop 1	0.9	0.1

$$\alpha = \quad 4 + 2(0.1 - 0.9) = 2.4$$

α_1 = 0.1*2.4 = 0.24

α_2 = -0.9*2.4 = -2.16

$\alpha = \alpha_1 - \alpha_2$ = 0.24 – (-2.16) = 2.4

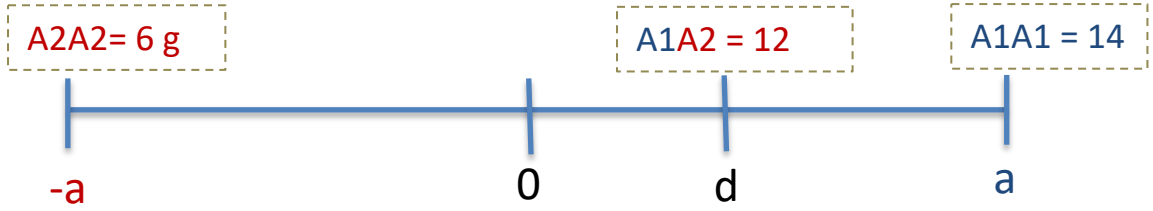
Average effects of gene substitution

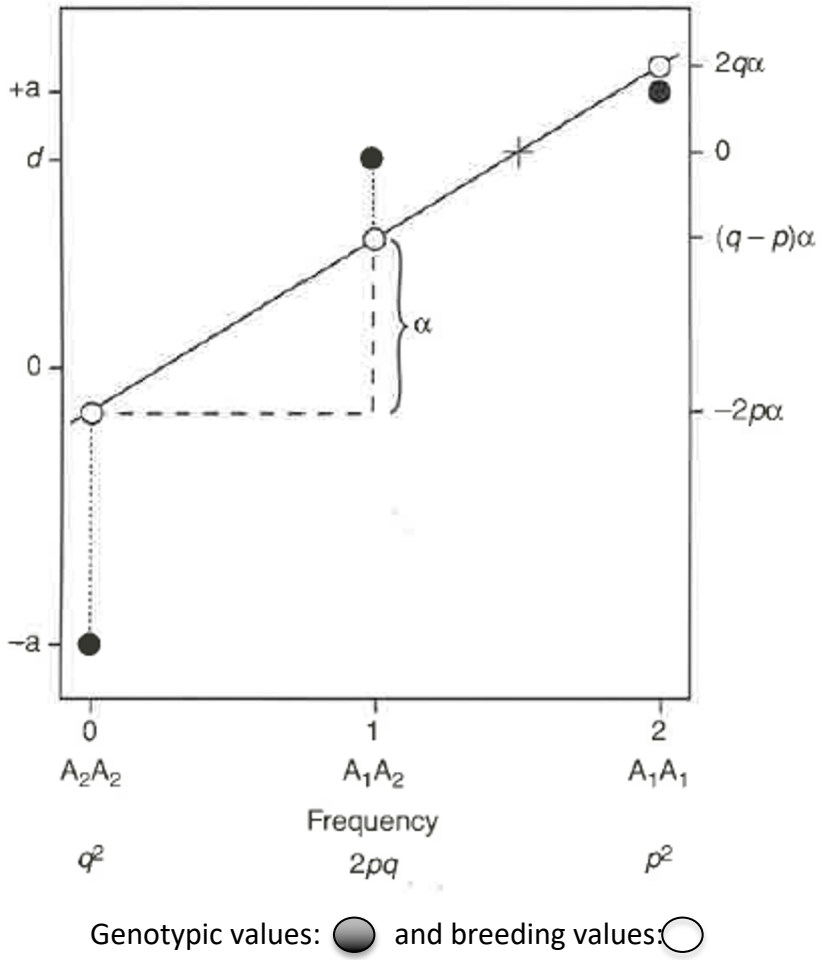
$$\alpha = a + d(q - p)$$

One half of the difference between the two homozygous

Deviation due to dominance

Breeding value
$2\alpha_1 = 2q\alpha$
$\alpha_1 + \alpha_2 = (q - p)\,\alpha$
$2\alpha_2 = -2p\alpha$

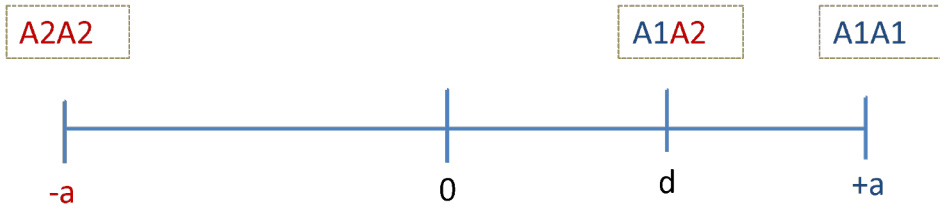




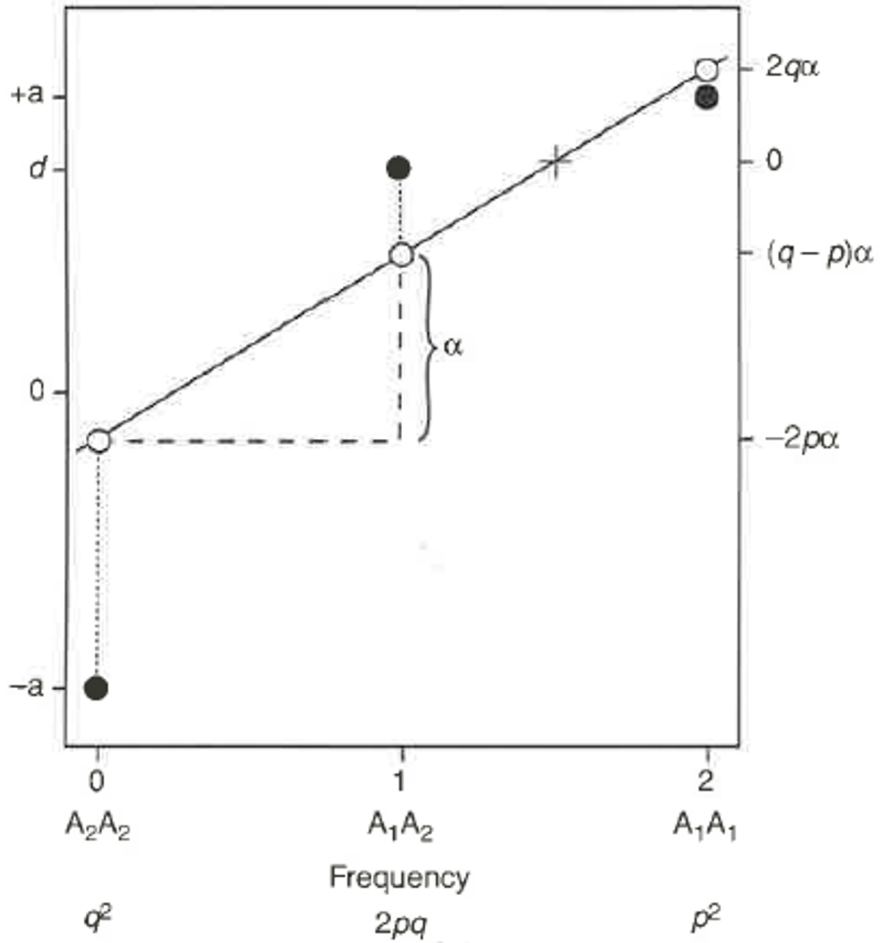
Falconer & Mackay 1996

Values and means in a single locus

Genotypic values:



Average effects of alleles:



Genotypic values: and breeding values: