Numerical Problems (Heritability & Genetic Gain)

1. **The inbred lines of wheat are crossed. In the F1 the variance in wheat yield is 1.5, the F1 is selfed, in the F2 the variance in wheat yield is 6.5. Estimate the H in broad sense of wheat yield in the experiment.**

Solution:

Given,

Variance in F_1 is due to environment (Ve) = 1.5

Phenotypic variance in F_2 (Vp) = 6.5

Heritability in broad sense (H) = $\frac{Vg}{Vp}$

Vp = Vg + Ve

6.5 = Vg + 1.5

Vg = 5

Heritability in broad sense (H) = $\frac{Vg}{Vp}$

$= \frac{5}{6.5}$

= 0.76923

2. With the help of following data, calculate H and interpret the result.

SV	DF	SS	MSS
Genotype	48	419.4	10.8
Replication	2	0.08	0.04
Error	96	12.3	0.13

Solution:

Heritability (H) = $\frac{Vg}{Vp}$

Vg = $\frac{MSS\ due\ to\ genotype - MSS\ due\ to\ error}{R}$

Vg = $\frac{10.8-0.13}{3}$

= 3.5566

Vp = Vg + Ve

Vp = 3.5566 + 0.13

Vp = 3.6866

Heritability (H) = $\frac{Vg}{Vp}$

= $\frac{3.5566}{3.6866}$

= 0.96474

3. Calculate the H from the following information.

Population	Variance
P_1	11
P_2	10.32
F_1	5.23
F_2	90.35
BC_1	47.35
BC_2	54.29

Solution:

$$\text{Heritability (H)} = \frac{Vg}{Vp}$$

Vp = Vg + Ve

Vp = Variance in F2 = 90.35

$$\text{Ve} = \frac{P1+P2+F1}{3}$$

$$= \frac{11+10.32+5.23}{3}$$

= 8.85

Vp = Vg + Ve

Vg = 90.35 – 8.85

= 81.5

Heritability (H) = $\frac{Vg}{Vp}$

$= \frac{81.5}{90.35}$

= 0.90204

4. Estimate H through parent offspring regression method from the following available data:

Mid parent value(X)	**Individual offspring (y)**
20	25
18	21
25	20
17	20
21	26
22	25

Solution:

Mid parent value(X)	**Individual Offspring(Y)**	XY	$\sum X^2$
20	25	500	400
18	21	378	324
25	20	500	625
17	20	340	289
21	26	546	441
22	25	550	484
$\sum X = 123$	$\sum Y = 137$	$\sum XY = 2814$	$\sum X^2 = 2563$

$$b = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sum X^2 - \frac{(\sum X)^2}{N}}$$

$$= \frac{2814 - \frac{123*137}{6}}{2563 - \frac{15129}{6}}$$

$$= \frac{2814 - 2808.5}{2563 - 2521.5}$$

$$= \frac{5.5}{41.5}$$

$$= 0.1325$$

H = b (if mid-parents given)

H = 2b (if single parent value given)

Question:

1. **For a quantity trait in a random population, mean is 100 and the variance is 240. The narrow sense heritability is 0.5. What is the expected mean of the next generation, if the top 10 % plants are used as parents.**

Solution:

Mean of base population (Xo) = 100

Variance (Va) = 240

Narrow sense heritability (h^2) = 0.5

Mean of the progeny (Xp) = ?

Selection intensity = 10 %

We know that,

R = Xp – Xo

And,

R= k. h^2 σp

= 1.76 * 0.5 * 15.5

= 13.64

$\sigma P = \sqrt{Va}$

= 15.5

R = Xp – Xo

Xp = 13.64 + 100

= 113.64

2. In the same population above, if the breeder wants the next generation to have a mean is at least 120, what population of the top plants should be used for breeding?

Solution:

Mean of the progeny (Xp) = 120

K = ?

We know,

R = Xp – Xo

= 120 – 100

= 20

R= K. h^2 σp

K = $\frac{R}{h^2 \sigma p}$

$\sigma P = \sqrt{Va}$

= 15.5

= 2.58

So, selection intensity = near 1 %

Selection intensity %	Value of K
1	2.64
2	2.42
5	2.06
10	1.76
20	1.4

3. **For a quantitative trait in a RPM, the mean is 100 and the variance is 240. The regression of the offspring on mid parent value is 0.25. Truncation selection is practiced with a selection differential of 32. What is the expected mean in the next generation?**

Solution:

Mean of base population (Xo) = 100

$b = h^2 = 0.25$

Selection differential (S) = 32

Expected mean in next gen. (Xp) =?

$R = Sh^2$

$= 32 * 0.25$

$= 8$

$R = Xp - Xo$

$Xp = 8 + 100$

$= 108$

4. The mean days to maturity and variance are 120 and 144 respectively. A plant breeder selected the top 5% plants from base population and found mean days to maturity 110 in the next generation. Find the genetic gain and the heritability of the trait.

Solution:

Mean days to maturity (Xo) = 120

Variance (Va) = 144

Selection intensity = 5%

Value of K at 5% selection intensity = 2.06

Selection intensity %	Value of K
1	2.64
2	2.42
5	2.06
10	1.76
20	1.4

Mean days to maturity in next gen. (Xp) = 110

Genetic gain (R) =?

Heritability (h^2) =?

R = Xp – Xo

= 110 – 120

= -10

(-ve sign indicated it is the condition of genetic gain. That means the variety matures 10 days earlier)

Now,

$R = K.\ h^2\ \sigma p$

$\sigma P = \sqrt{Va}$

$= 12$

$h^2 = \frac{R}{K\sigma p}$

$= \frac{10}{2.06*12}$

$= 0.40$