Combining ability analysis and gene action for economic traits in tepary bean (*Phaseolus acutifolius A. Gray*) under non-stress and drought stress conditions

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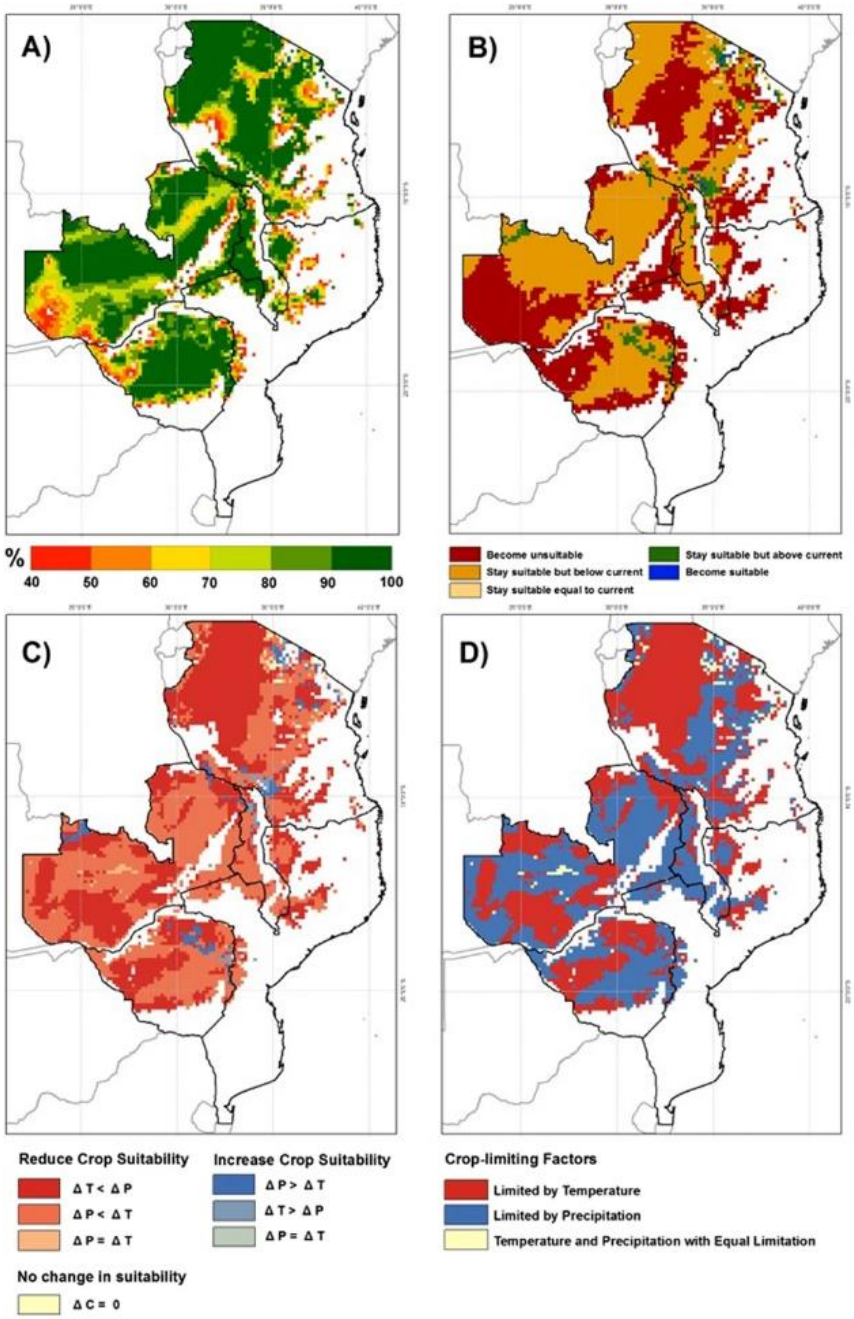
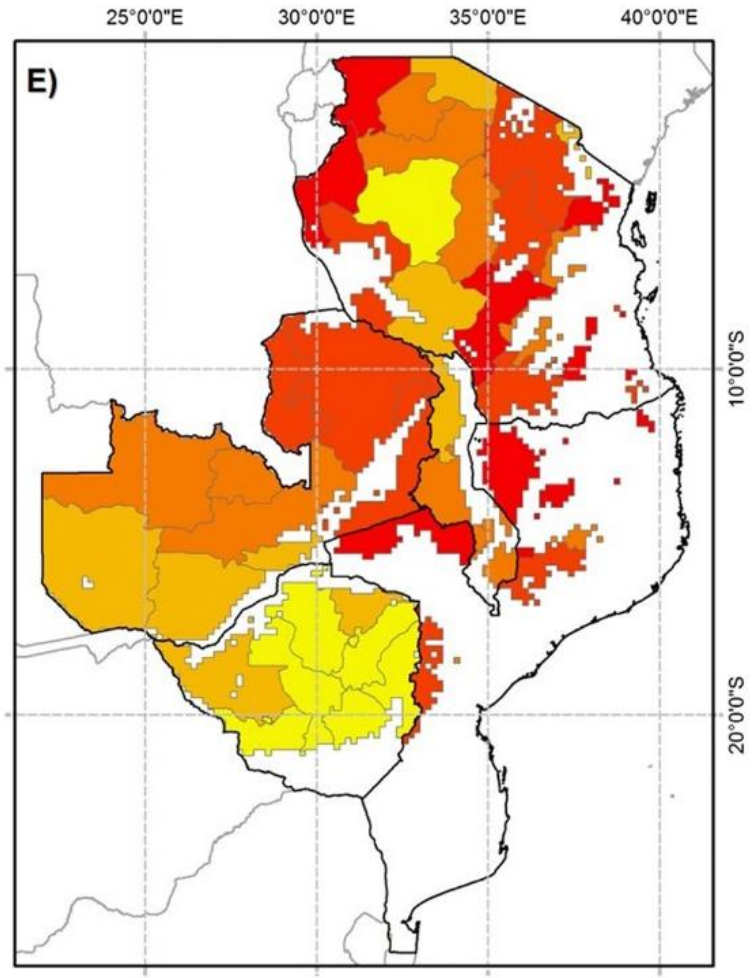
Kirkhouse Trust Annual Meeting 2023, Livingstone, Zambia

PRESENTATION OUTLINE

- Introduction
- Methodology
- Results & Discussion
- Conclusion





Climate prediction for common bean adopted from Hummel et al. 2018

- Very Low (< 17 %)
- Low (17 - 25 %)
- Moderate (26 - 29 %)
- High (30 - 36 %)
- Very High (37 - 50 %)

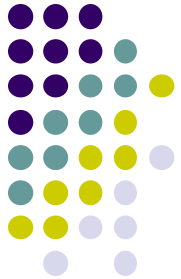
WHY TEPARY BEAN

- Majority of common bean growing areas in southeastern Africa will become unsuitable for bean cultivation by 2050[a].
- Terminal and intermittent drought stresses are most common in bean production zones.
- Tepary bean is an alternative source of protein and essential nutrients in SSA.
- Smallholder farmers in the SSA grow landraces that are low-yielding ~ 0.57 tons/ha*.

WHY TEPARY BEAN

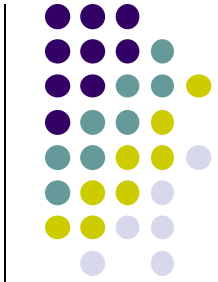
- Pre-breeding and breeding for enhanced drought tolerance is urgently required to deliver well-adapted and high-yielding varieties .
- Combining ability analysis is useful for identification of parental genotypes & promising progenies.
- Limited studies on GCA & SCA effects for economic traits under DS.

OBJECTIVE



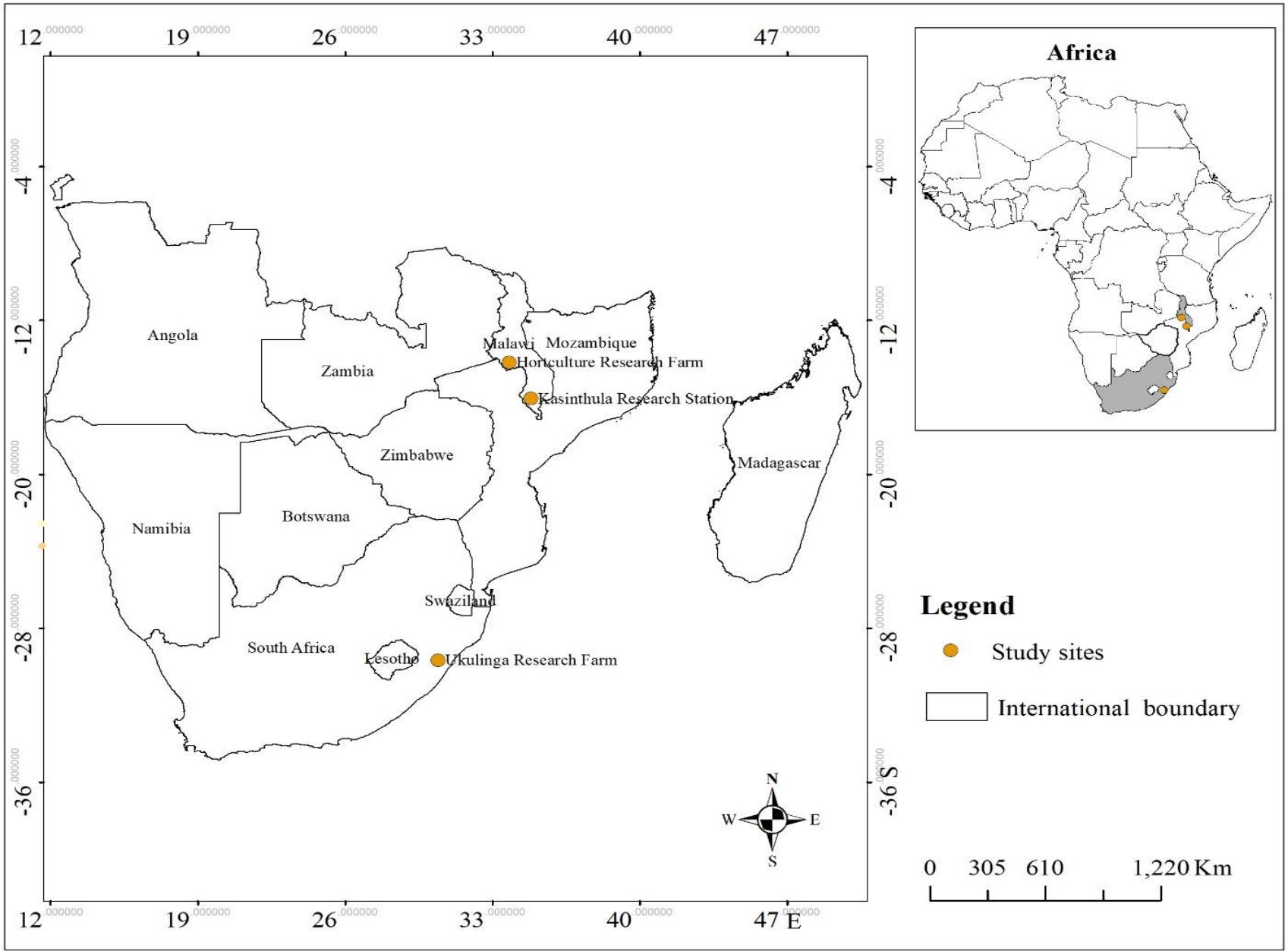
- To determine the combining ability effects and gene action conditioning seed yield and yield-related traits in selected tepary bean genotypes.

SELECTED PARENTS FOR CROSSING



Genotype	Origin	Description	Drought response	Category
Zimbabwe landrace	Zimbabwe	Landrace	Sensitive	Low
G40059	CIAT-Columbia	Breeding line	Moderately tolerant	Moderate
G40138	CIAT-Columbia	Breeding line	Very tolerant	High
G40145	CIAT-Columbia	Breeding line	Moderately tolerant	Moderate
G40148	CIAT-Columbia	Breeding line	Very tolerant	High
G40150	CIAT-Columbia	Breeding line	Very tolerant	High
Uchokwane	South Africa	Landrace	Sensitive	Low

STUDY SITES


12.000000
19.000000
26.000000
33.000000
40.000000
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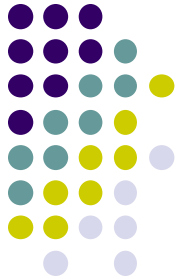
Angola
Zambia
Malawi
Mozambique
Horticulture Research Farm
Kasinthula Research Station
Zimbabwe
Madagascar
Namibia
Botswana
Swaziland
South Africa
Lesotho
Ukulinga Research Farm
N
W
E
S
36 S
47 E
Africa
Legend
Study sites
International boundary
0 305 610 1,220 Km

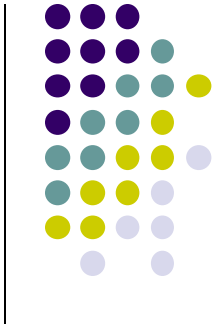
CROSSING METHODOLOGY & EVALUATION



- 7 x 7 Half diallel mating design, $21F_1 \Rightarrow F_2$
- 28 genotypes evaluated in 4 x 7 lattice design, 3 reps, 2 water regimes & 2 sites.
- 2 row plots, 3m long & 0.75 m wide.
- DS induced @ mid-pod filling stage.
- Data collected on DTF, DTM, NPP, NSP & SY
- Data analysis: ANOVA, Griffing's method II (F_1's and parents) and model I (fixed effects), Correlation.

CROSSING METHODOLOGY & EVALUATION

MEAN SQUARES UNDER NS

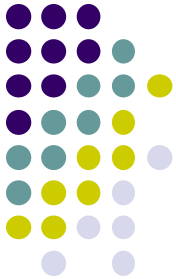


SOV	DF	DTF	DTM	NPP	NSP	SY
LOC	1	12.05*	3790.50***	0.45	4.67*	1145577.00*
LOC: REP	4	0.89ns	1.41ns	0.36ns	0.49ns	81067.43ns
LOC:REP:BLK	18	6.32***	78.15***	100.74***	1.20***	360820.50***
Genotypes	27	10.66**	67.87ns	312.38***	2.13***	1634031.00***
G X LOC	27	4.13***	67.07***	33.62*	0.19***	144166.70***
Error	90	0.02	12.3	18.27	0	50024.05

MEAN SQUARES UNDER DS

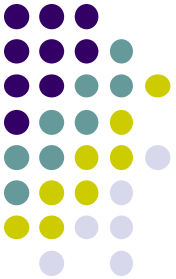
SOV	DF	DTF	DTM	NPP	NSP	SY
LOC	1	65.63*	4250.15***	1991.83***	8.78***	668072.80*
LOC: REP	4	3.46ns	14.58ns	4.71ns	0.05ns	60520.82ns
LOC:REP:BLK	18	3.07**	23.78	19.77***	0.53**	398519.50***
Genotypes	27	7.41ns	34.73ns	71.37**	1.42***	1032369.00***
G X LOC	27	5.46***	19.83	20.24***	0.19ns	127820.60***
Error	90	0.37	14.54	1.13	0.2	1441968

COMBINING ABILITY ESTIMATES UNDER NS



SOV	DF	DTF	DTM	NPP	NSP	SY
GCA	6	21.33**	99.69ns	1130.98**	6.27***	6132816.00**
SCA	21	7.61ns	73.95ns	78.49*	0.94***	348663.90**
GCA X LOC	6	1.76***	46.59***	52.21***	0.23***	308686.20***
SCA X LOC	21	4.81***	57.75***	28.31***	0.18***	97161.07***
Error	90	0.01	4.1	6.09	0.01	16674.68
BR		0.70	0.52	0.88	0.57	0.79
NSH CGD		0.44	0.16	0.78	0.50	0.68

COMBINING ABILITY ESTIMATES UNDER DS



SOV	DF	DTF	DTM	NPP	NSP	SY
GCA	6	10.31ns	47.36ns	81.67ns	3.69***	9422.72*
SCA	21	6.58ns	31.12ns	68.44**	0.77***	915341.00***
GCA X LOC	6	4.11***	21.23***	25.12***	0.12ns	244710.10***
SCA X LOC	21	5.85***	19.43***	18.84***	0.22***	94423.61***
Error	90	1.12	4.85	0.38	0.07	3140.91
BR		0.74	0.43	0.28	0.57	0.33
NSH CGD		0.18	0.13	0.19	0.29	0.28

HIGH YIELDING & DROUGHT TOLERANCE

GENOTYPES	SEED YIELD (KG/HA)	STI
PARENTS		
G40059	1304.94	0.92
G40138	1053.28	0.73
G40145	1210.46	0.84
G40148	1589.51	1.44
G40150	1724.12	1.08
F2 PROGENIES		
G40148 x G40059	1714.57	1.04
G40150 x G40145	1716.00	1.14
G40150 x G40138	1774.79	1.29
G40145 x G40059	2006.96	1.49
G40138 x G40059	2044.52	1.46

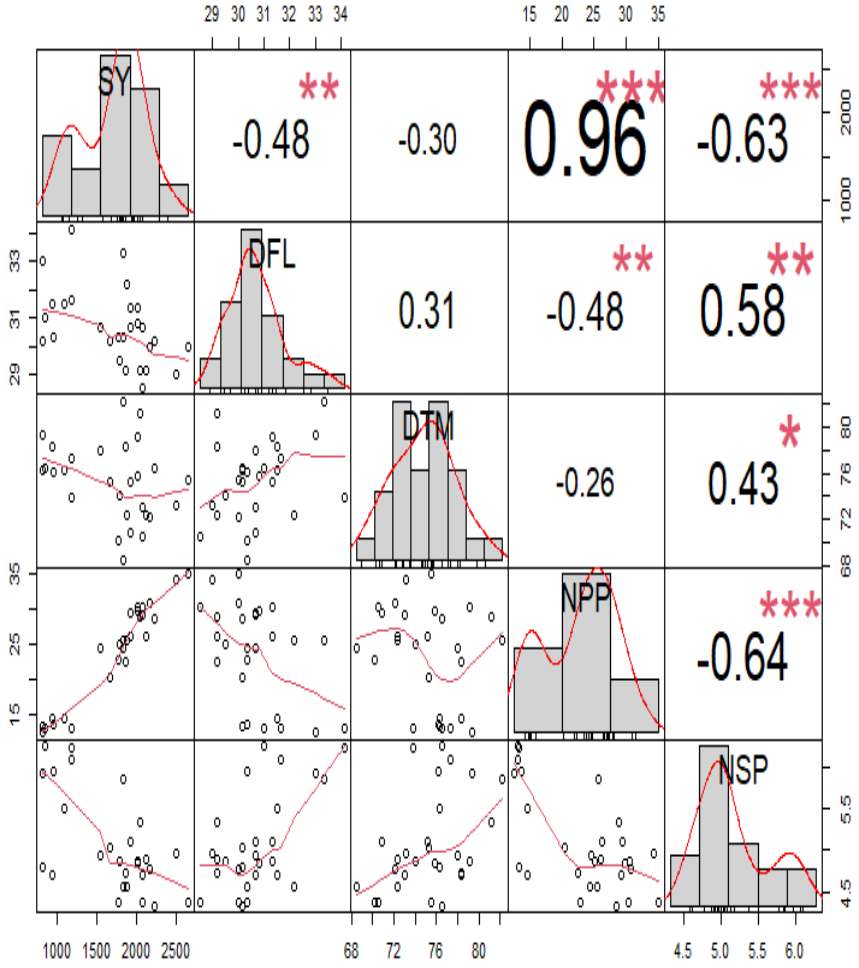
BEST GENERAL & SPECIFIC COMBINERS

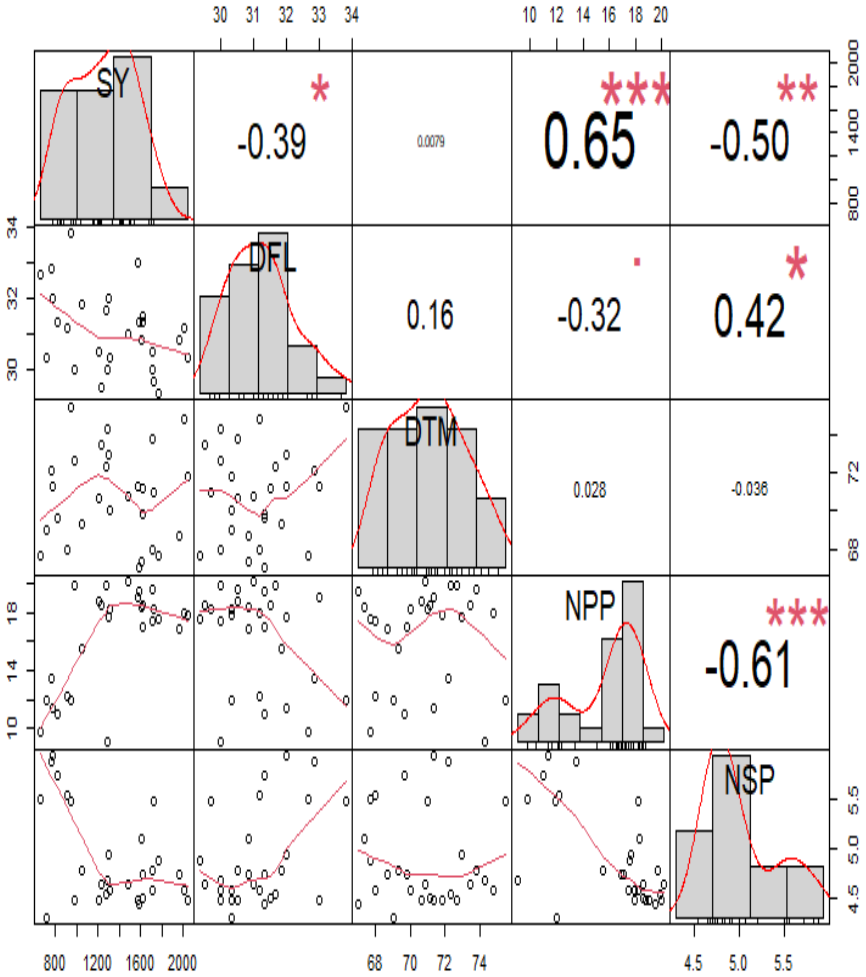
GENOTYPES	SEED YIELD (KG/HA)
PARENTS	GCA EFFECTS
G40059	51.12*
G40148	210.38***
G40150	126.55***
F2 PROGENIES	SCA EFFECTS
Uchokwane x G40138	115.79*
Uchokwane x G40059	140.39*
G40148 x G40138	175.61**
G40148 x G40145	178.04**
Uchokwane x G40150	232.22***
Uchokwane x G40148	268.98***
G40138 x G40059	334.89***

BEST GENERAL & SPECIFIC COMBINERS

GENOTYPES	SEED YIELD (KG/HA)
F2 PROGENIES	SCA EFFECTS
G40148 x Zimbabwe Landrace	365.23***
G40150 x Zimbabwe Landrace	423.53***
G40138 x Zimbabwe Landrace	571.26***

TRAIT ASSOCIATION





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THANK YOU