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(*Carthamus tinctorius* L.)

**Control of spatial variability in safflower (*Carthamus tinctorius* L.) germplasm
evaluation under dryland conditions**

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(*Carthamus tinctorius* L.)

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(Gilmour *et al.*, 1997)

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(Pearce, 1984; Hinkelmann and Kempthorne,)
(1994).

(Gilmour *et al.*, 1997)

(Sabbe and Marx 1987; Cressie, 1991)

(Patterson and Williams, 1976)

(Sarker *et al.*, 2001)

(Wilkinson *et al.*, 1983)

(Cullis and Glesson, 1991)

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(Akaike, 1974)

(Restricted Maximum Likelihood) REML

Genstat

Grondona *et al.*,)

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(1996;Gilmour *et al.*, 1997; Sarker *et al.*, 2001

$$y = m + X t + Z u + x + e$$

t

m

u ()

x

e

u t

Z X

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o

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o

(Wald)

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(χ^2)

(Genstat 5 Committee, 1997)

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%

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(Akaike, 1974)

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(/ /)

(Deviance)

REML

(AIC)

(AICD)

(/)

:

$$\text{Deviance} = -2\text{REML} - \log(\text{likelihood}) + K$$

$$\text{AICD} = \text{Deviance} + 2q$$

K

Grondona *et al.*, 1996;)

(Sarker *et al.*, 2001)

q

(Gilmour *et al.*, 1997

AICD

.(Sarker *et al.*, 2001)

(Singh, 2002)

Genstat

REML

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(Nyquist, 1991)

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.(Blum, 1985)

Table 1. Parameters of 18 spatial variation models in evaluation of safflower germplasm under dryland conditions.

Model	AICD			Wald		
	Grain Yield	Plant Height	Days to Flowering	Grain Yield	Plant Height	Days to Flowering
Randomized complete blocks design (RCBD)	1206.44	461.95	132.52			
RCBD with first order auto-correlated errors along rows (RCBD)	1166.12	444.92	132.42			
RCBD with first order auto-correlated errors along rows and along columns (RcArAr)	1168.12	442.04	134.35			
Lattice design (Lt)	1160.86	439.37	134.52			
Lt with Ar (LtAr)	1161.24	441.37	134.42			
Lt with ArAr (LtArAr)	1162.11	442.68	136.35			
Rc with Linear trends (RcL)	1204.60	466.36	138.22	0	0.012	0.093
Rc with L and Ar (RcLAr)	1162.62	449.06	138.09	0.018	0.015	0.097
Rc with L and ArAr (RcLArAr)	1164.60	446.21	140.02	0.018	0.013	0.097
Lt with Linear trends (LtL)	1157.12	443.13	140.22	0	0.02	0.093
Lt with L and Ar (LtLAr)	1157.56	445.13	140.09	0	0.02	0.097
Lt with L and ArAr (LtLArAr)	1158.42	446.48	142.02	0	0.019	0.097
Rc with cubic splines in column numbers (RcCs)	1206.02	466.44	140.22	0	0.013	0.093
Rc with Cs and Ar (RcCsAr)	1164.62	450.51	140.09	0.018	0.016	0.097
Rc with Cs and ArAr (RcCsArAr)	1166.60	447.90	142.02	0.018	0.013	0.097
Lt with Cs	1159.12	445.04	142.22	0	0.02	0.093
Lt with Cs and Ar (LtCsAr)	1159.56	447.04	142.09	0	0.02	0.097
Lt with Cs and ArAr (LtCsArAr)	1160.42	448.36	144.02	0	0.019	0.097

Table 2. Relative efficiency of selected models over randomized complete block design

Characteristic	The best model	Relative efficiency	Heritability	SE of heritability
Grain yield	Lattice with first order auto-correlated errors along rows	209.66	0.46	0.091
Plant height	Lattice	151.05	0.71	0.054
Days to flowering	Randomised complete blocks design bloks with first order auto-correlated errors along rows	100.32	0.96	0.009

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(Alizadeh, 2003; Alizadeh, 2005)

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Grondona *et al.*,)

(1996; Gilmour *et al.*, 1997; Sarker *et al.*, 2001

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Table3. Original and adjusted grain yield, plant height and day to flowering in safflower germplasm under dryland conditions

Entry	(/)		()		Days to Flowering		(/)		()		Days to Flowering		
	Grain Yield (kg/ha)		Plant Height (cm)		Days to Flowering		Grain Yield (kg/ha)		Plant Height (cm)		Days to Flowering		
Entry	Adj	Obs.	Adj	Obs	Adj	Obs	Adj	Obs	Adj	Obs	Adj	Obs	
1	548	689	45	48	103	103	51	761	756	58	58	110	110
2	370	533	46	49	105	105	52	542	558	55	55	111	111
3	342	536	51	53	107	107	53	458	506	58	57	112	112
4	583	747	50	52	105	105	54	613	631	50	49	105	105
5	600	761	53	55	107	107	55	752	767	57	56	108	108
6	331	486	39	42	102	102	56	700	708	64	63	112	112
7	652	811	55	56	107	107	57	522	533	59	58	111	111
8	370	483	45	47	104	104	58	284	250	61	60	123	123
9	553	697	55	57	110	110	59	553	550	58	56	110	110
10	477	572	51	53	104	104	60	785	733	54	52	107	107
11	819	903	49	52	107	107	61	416	397	52	52	110	110
12	614	719	53	55	104	104	62	605	608	49	49	105	105
13	569	706	52	54	108	108	63	538	572	49	48	103	103
14	599	706	70	72	117	117	64	643	647	52	51	105	105
15	638	742	49	52	111	111	65	620	622	47	46	104	104
16	574	672	56	59	110	110	66	857	853	57	57	108	108
17	668	769	54	56	108	108	67	759	758	64	63	108	108
18	553	608	45	47	102	102	68	533	486	49	47	108	108
19	516	603	47	48	104	104	69	529	514	51	50	110	110
20	476	514	48	49	109	109	70	714	650	48	46	102	102
21	737	756	46	49	103	103	71	736	636	52	51	110	110
22	504	544	50	53	104	104	72	581	503	48	46	108	108
23	495	567	52	54	107	107	73	1061	1014	55	53	108	108
24	523	564	54	57	112	112	74	805	728	51	49	107	107
25	773	811	63	66	112	112	75	857	778	47	45	108	108
26	812	844	64	67	112	112	76	661	575	56	55	111	111
27	434	469	54	56	114	114	77	563	481	52	49	107	107
28	299	289	55	57	124	124	78	603	475	56	53	107	107
29	415	436	47	49	108	108	79	569	472	47	45	110	110
30	680	653	48	49	109	109	80	643	497	55	52	112	112
31	622	656	49	50	111	111	81	753	653	53	54	110	110
32	520	575	49	49	107	107	82	678	600	47	46	103	103
33	666	753	55	54	108	108	83	551	504	53	52	110	110
34	466	522	53	53	104	104	84	763	686	56	55	108	108
35	713	767	60	60	112	112	85	424	344	53	53	111	111
36	572	619	58	59	109	109	86	503	417	40	40	103	103
37	585	636	58	58	108	108	87	594	511	44	43	107	107
38	634	639	48	47	105	105	88	576	447	44	43	110	110
39	413	450	53	53	111	111	89	675	578	55	54	110	110
40	698	686	60	59	110	110	90	663	517	56	54	111	111
41	565	589	61	62	112	112	91	811	656	54	53	109	109
42	782	828	46	47	105	105	92	761	628	53	52	110	110
43	518	594	63	64	113	113	93	957	856	50	48	108	108
44	662	708	60	60	112	112	94	665	533	38	37	108	108
45	567	611	52	53	108	108	95	768	633	49	48	107	107
46	873	911	55	56	108	108	96	666	525	53	52	111	111
47	262	303	52	52	108	108	97	668	531	53	51	105	105
48	394	389	49	49	117	117	98	803	619	56	54	110	110
49	412	439	54	54	105	105	99	885	733	52	50	111	111
50	722	700	60	60	111	111	100	692	492	42	40	105	105

Adj.= Adjusted

Obs.=Observed

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Control of spatial variability in safflower (*Carthamus tinctorius* L.) germplasm evaluation under dryland conditions

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ABSTRACT

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Effective assessment of genotypes superiority is possible by identification of spatial variability and selection of appropriate methods of statistical analysis. In order to select suitable genotypes for advanced trials in dryland conditions, 100 safflower pure lines were evaluated using simple lattice by accounting for spatial variability. Results showed that, the lattice design with correlated errors along rows, the lattice design and the randomized complete block, design with first order auto-correlated errors along rows were the best models and most effective in accounting for spatial variability in grain yield, plant height and days to flowering, respectively. There was not any evidence for fixed trend in this experiment. Broad sense heritability estimates revealed a significant genetic potential for selection for all of the measured characters. Based on the selected models, the best linear unbiased estimates for all genotypes were calculated and the superior genotypes were selected regarding related standard errors. Since the criterion used was based on maximum information of the data, the interpretations drawn from the best model for each trait would give the most realistic assessment of the performance of genotypes. Hence, for breeding objectives, it is recommended that at first a best model be identified to describe the spatial variation in the data, followed by evaluation of the genotypes based on that model.

Key words: Spatial Variability, Experimental design, Safflower, Germplasm.

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