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Genotypic evaluation for yield and its attributes under imposed moisture stress conditions in groundnut (*Arachis hypogaea* L.)*

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ABSTRACT

A field experiment was carried out at ICRISAT, Patancheru, A. P. during **rabi**/summer season to screen 20 groundnut genotypes under three drought conditions. The genotype ICGV 86031 performed better both under normal and stress conditions. Genotypes ICGV 93261, 93269, 93277 and KRG 1 had high yield and less per cent yield reduction under the stress conditions.

Key words : Genotypes, groundnut, moisture stress, yield, yield attributes

INTRODUCTION

Area and production of groundnut are mainly confined to the rainfed areas under semi-arid tropics, wherein, occurrence of intermittent moisture stress due to erratic rainfall is a common feature and the productivity is low (997 kg/ha) as compared to irrigated post-rainy season (1512 kg/ha). For any significant improvement in groundnut production, its productivity under rainfed conditions will have to be improved substantially by growing drought-tolerant (including tolerance to other major stress factors) and water use efficient cultivars. Though several reports have addressed this issue (Babitha and Reddy, 2001; Murthy *et al.*, 2002; Nautiyal *et al.*, 2002), the loss of genetic potentiality is a common feature with lapse of time. Hence, continuous breeding efforts must be on to identify or to develop new varieties with drought resistant characters. This study aims at identifying superior lines for high productivity both under normal and stress conditions.

MATERIALS AND METHODS

Field experiment was conducted at ICRISAT, Patancheru, Andhra Pradesh, India during the post-rainy season of December 1999 to April 2000 in Alfisols. A strip plot design was adopted with three drought treatments and 20 genotypes (cultivated varieties and the advanced breeding lines (Table 1) in three replicates with a plot size of 4 x 1.2 m. Seeds were sown on 4 December 1999 with spacing of 30 x 10 cm. Germination took nearly 20 days in all the genotypes, because of low night temperature. Three treatments were : No drought (Normal condition; regular irrigation), Mid-season drought (MSD; irrigation withheld between 50-100 DAS) and End-season drought (ESD; irrigation withheld between 100 DAS to harvest). Irrigation was provided through line source sprinkler irrigation system. No rainfall was received throughout the crop duration (Table 2).

Observations on post-harvest parameters viz., number of mature pods, 100-kernel weight, sound mature kernel percentage and oil content were made on randomly selected five plants from each plot. Net plot of 2 x 1.2 m (i. e. 2.4 m^2) was harvested and pod yield per plot was determined.

From the randomly selected hundred kernels, mature, sound and healthy seeds were separated, counted and calculated the sound mature kernel percentage. A sample of 20 g seeds from each plot was subjected to oil estimation by Nuclear Magnetic Resonance Spectrophotometer (NMR) at RRS, Raichur and

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Table 1. Genotypes used in the study

S. No.	Genotypes	Year of release	Centre developed	No. of days after sowing to harvest
1.	TMV 2	1940	TNAU, Tindivanam	128
2.	TAG 24	1978	BARC, Bombay	128
3.	JL 24	1978	Jalgaon	135
4.	KRG 1	1981	RRS, Raichur	135
5.	R 8808	1994	-do-	135
6.	S 206	1969	-do-	135
7.	R 9251	1996	-do-	135
8.	R 9214	a	-do-	135
9.	R 9227	a	-do	135
10.	K 134	1993	APAU, Kadiri	135
11.	D 39d	a	UAS, Dharwad	135
12.	ICGV 93277	a	ICRISAT, Patancheru	135
13.	ICGV 92118	a	-do-	143
14.	ICGV 86031	1982	-do-	143
15.	ICGV 86635	a	-do-	143
16.	ICGV 92113	a	-do-	143
17.	ICGV 92120	a	-do-	143
18.	ICGV 93260	a	-do-	143
19.	ICGV 93261	a	-do-	143
20.	ICGV 93269	a	-do-	143

a : Advanced breeding lines.
All the genotypes are of Spanish bunch types except ICGV 92120 (Virginia Bunch).

Table 2. Monthly average weather data from December 1999 to April 2000 at ICRISAT, Patancheru

Month	Rainfall (mm)	Temperature (°C) Max.	Temperature (°C) Min.
December 1999	0	28.13	09.94
January 2000	0	29.83	11.37
February 2000	0	31.18	15.66
March 2000	0	35.04	15.80
April 2000	0	39.41	20.53

oil content was expressed as per cent. Analysis was carried out according to strip plot design using Genstat package.

Per cent yield reduction under the stress conditions was calculated as follows :

$$\text{Per cent yield reduction under MSD/ESD} = \frac{\text{Yield under normal condition} - \text{Yield under MSD/ESD}}{\text{Yield under normal condition}} \times 100$$

Z distribution was followed between absolute yield and per cent yield reduction under the stress. The Z value for each genotype was calculated as here mentioned.

$$\text{Z value for pod yield of a variety under stress} = \frac{\text{Pod yield of a genotype under stress} - \text{Mean pod yield of all genotypes under stress}}{\text{Standard deviation for pod yield of all genotypes under stress}}$$

$$\text{Z value for per cent yield reduction under stress of a variety} = \frac{\text{Per cent yield reduction of a genotype under stress} - \text{Per cent yield reduction of all genotypes under stress}}{\text{Standard deviation for per cent yield reduction of all genotypes under stress}}$$

RESULTS AND DISCUSSION

The data on mature pod number across the genotypes revealed that MSD had more adverse effect on production of mature pod number compared to the ESD (Table 3). This was mainly due to the time of exposure to drought stress i. e. 50-100 DAS (MSD), as it was coincided with the initiation of pegs and development of pegs and pods and early pod filling stage. Similar conclusions were also drawn by Golakiya and Patel (1992). Further, short duration genotypes (based on Table 1) showed more reduction of mature pod number under MSD than ESD when compared to medium/long duration types. This was due to short duration types which were able to initiate and develop pods early and complete the crop duration at an early stage. Similar results were observed by Pallas *et al.* (1979) and Wright *et al.* (1991). Basu *et al.* (2003) reported the difference in number of mature pods per plant due to rainy and post-rainy season.

Mean 100-kernel weight was significantly reduced due to the stress conditions. Similar results were observed by Basu *et al.* (2003) and Izge and Olorunju (2000). The reduction was more under MSD compared to the ESD. With regards to this, Vanagamudi *et al.* (1987) reported reduction in 100-kernel weight due to stress conditions at pod filling, pod initiation and maturation stages. Similarly, Yao *et al.* (1982) also reported a maximum reduction in 100-kernel weight due to drought at the seed development stage followed by drought at the flowering and pod ripening stage. In the present study, the MSD stage is comparable to that of the said conditions.

Mean sound mature kernel percentage was decreased by 8.0 and 16.4%, respectively, in MSD and ESD over the control. More reduction in ESD could be because ESD coincides with seed filling stage. With regards to oil percentage, MSD had no effect on reduction of oil percentage. However, ESD decreased the oil per cent to the tune of 9.56 over the control, since ESD coincides with kernel filling. Rehmianna *et al.* (2004) reported that all genotypes showed poor seed filling and low proportion of sound mature seeds resulting in low shelling outturn.

Mean pod yield was reduced significantly under both the stress conditions (Table 4). In this regard Izge and Olorunju (2000), Murthy *et al.* (2002), Basu *et al.* (2003) and Nadga *et al.* (2003) also reported reduction in yield due to drought stress. The reduction was more under ESD than the MSD, indicating that the genotypes were more sensitive to ESD, as ESD coincides with the pod/seed development and maturation stage. Pathak *et al.* (1988) also reported reduction in pod yield and was highest at pod development stage.

Among the genotypes tested, based on their absolute yield, under normal condition ICGV 86031 and R 9227 were in the highest yielding group. It may be due to higher potential of these genotypes for pod yield than the other genotypes. Under both the stress conditions, ICGV 86031 maintained its high yield, but R 9227 was sensitive to ESD. Other genotypes the performance of which was at par with ICGV 86031 under MSD were R 9214, ICGV 93260, R 9227, ICGV 93269, 93277, 93261, S 206 and KRG 1, and the genotypes under ESD were ICGV 92120, R 8808, ICGV 93269, 93261, R 9214, TMV 2, KRG 1, TAG 24 and ICGV 93277. Similarly, a number of genotypes were screened for drought resistance and selections were made based on yield and yield parameters and physiological parameters (Basu *et al.*, 2003; Deshmukh *et al.*, 2003; Nadga *et al.*, 2003, Nigam *et al.*, 2003, Reddy *et al.*, 2003; Vasundhara and Reddy, 2003).

When per cent yield reduction was considered, it was more under ESD (42.82%) than MSD (31.55%). All genotypes exhibited this trend of per cent reduction except JL 24, TMV 2 and TAG 24, which exhibited less yield reduction under ESD attributing to their earliness in maturity than the other genotypes. The genotypes which showed less per cent yield reduction than the mean reduction under both the stress conditions were KRG 1, R 9251, K 134, ICGV 92113, 93261, 93269 and 93277. Similarly, genotypes under MSD were S 206, R 9214 and D 39d and the genotypes under ESD were JL 24, TMV 2, TAG 24 and ICGV 92120. The genotypes R 9227 and ICGV 92118 showed more per cent yield reduction under both the stress conditions, genotypes JL 24, TMV 2 under MSD and genotypes ICGV 86635, 93260 under ESD.

Table 3. Mean yield attributes of 20 genotypes under different drought conditions

Genotype	Mean number of mature pods/plant				Mean 100-seed weight (g)				Mean sound mature kernel (%)				Oil percentage			
	ND	MSD	ESD	Mean	ND	MSD	ESD	Mean	ND	MSD	ESD	Mean	ND	MSD	ESD	Mean
TMV 2	9.5	5.1	7.3	7.3	29.3	25.0	26.5	26.9	76.7	74.3	62.7	71.2	43.4	44.9	40.2	42.9
TAG 24	8.1	7.5	9.0	8.2	38.9	33.1	36.3	36.1	74.7	68.7	71.3	71.6	43.0	42.0	38.8	41.3
JL 24	10.1	3.9	6.1	6.7	37.4	30.2	35.5	34.4	81.7	74.7	74.3	76.9	43.7	45.5	41.9	43.7
KRG 1	13.6	6.9	6.4	9.0	30.8	26.8	26.7	28.1	73.3	73.0	68.7	71.7	45.1	44.0	40.6	43.3
R 8808	6.5	5.7	6.3	6.2	40.6	31.7	35.2	35.8	86.7	80.0	72.7	79.8	44.1	44.4	40.6	43.0
S 206	16.7	6.6	6.5	9.9	30.9	24.8	26.2	27.3	77.3	75.7	71.3	74.8	44.2	44.6	37.7	42.2
R 9251	10.5	6.0	10.1	8.9	32.4	29.8	28.1	30.1	72.7	72.3	61.7	68.9	39.9	40.5	37.2	39.2
R 9214	9.3	4.7	6.9	7.0	37.2	34.3	33.7	35.1	78.0	81.3	73.3	77.5	44.7	44.4	40.4	43.2
R 9227	6.1	5.9	6.2	6.1	38.4	34.0	32.0	34.8	74.3	72.3	55.3	67.3	43.2	45.0	39.9	42.7
K 134	11.2	10.0	5.8	9.0	33.8	27.7	26.1	29.2	85.7	73.3	64.3	74.4	44.3	44.3	37.5	42.1
D 39d	12.1	4.9	4.7	7.2	34.6	32.3	26.9	31.3	78.7	77.7	70.0	75.4	48.8	47.2	45.1	47.0
ICGV9 3277	7.5	4.4	5.9	5.9	33.2	29.6	27.4	30.1	69.0	65.0	64.0	66.0	41.9	42.4	39.6	41.3
ICGV9 2118	5.1	1.7	2.9	3.2	35.5	29.5	31.8	32.3	76.0	69.3	51.7	65.7	39.3	41.3	38.3	39.6
ICGV8 6031	8.5	3.9	3.7	5.4	49.6	30.2	49.3	43.0	78.3	68.7	79.6	75.6	47.8	44.9	45.2	46.0
ICGV8 6635	7.3	1.8	3.1	4.0	37.1	31.7	33.5	34.1	77.7	65.3	65.3	69.4	42.5	42.5	36.6	40.5
ICGV9 2113	7.4	3.4	6.5	5.8	45.2	32.5	38.4	38.7	80.7	71.0	70.3	74.0	47.3	46.5	43.7	45.8
ICGV9 2120	8.5	3.0	7.1	6.2	33.8	28.0	31.3	31.0	84.0	74.3	72.3	76.9	44.7	45.8	43.5	44.7
ICGV9 3260	11.1	3.6	5.7	8.2	32.8	26.3	30.2	29.8	76.3	72.7	70.7	73.2	43.1	42.2	39.8	41.7
ICGV9 3261	11.3	6.1	7.4	6.3	33.5	27.1	29.4	30.0	80.0	69.7	59.3	69.7	43.3	43.1	38.8	41.7
ICGV9 3269	8.7	4.6	5.5	5.9	51.4	36.7	42.1	43.4	86.0	71.7	70.7	76.1	46.9	44.8	43.5	45.1
Mean	9.4	5.0	6.2	6.2	36.8	30.1	32.3	33.1	78.3	72.6	67.5	72.8	44.1	44.0	40.5	42.8

	S. Em±	LSD	S. Em±	LSD	S. Em±	LSD	S. Em±	LSD
Drought	0.540	2.122	0.206	0.808	1.911	7.505	0.516	2.025
Genotype	0.723	2.071	0.890	2.548	2.221	6.358	0.557	1.593
G x T	1.682	4.720	1.704	4.773	4.265	12.052	1.057	3.001
G at the same level of T	1.643	4.607	1.740	4.877	3.914	10.965	0.947	2.652
T at the same level of G	1.842	5.186	1.797	5.060	4.296	12.177	1.050	2.989

Table 4. Pod yield and per cent yield reduction of 20 genotypes under different drought conditions

Genotype	Pod yield (g/2.4 m² plot)				Per cent yield reduction		Z value			
							Pod yield		Per cent yield reduction	
	ND	MSD	ESD	Mean	MSD	ESD	MSD	ESD	MSD	ESD
TMV 2	731	346	488	521	52.66	33.26	-1.77	0.59	1.81	-0.84
TAG 24	665	428	454	516	35.62	31.84	-0.98	0.13	0.35	-0.97
JL 24	591	274	437	434	53.56	25.99	-2.45	-0.09	1.89	-1.48
KRG 1	685	568	482	578	17.02	29.57	0.35	0.52	-1.25	-1.17
R 8808	899	543	507	650	39.63	43.55	0.11	0.86	0.69	0.06
S 206	645	571	359	525	11.47	44.45	0.39	-1.15	-1.72	0.14
R 9251	548	437	430	472	20.24	21.56	-0.89	-0.18	-0.97	-1.87
R 9214	896	675	488	686	24.67	45.59	1.38	0.60	-0.59	0.24
R 9227	1080	632	390	701	41.48	63.91	0.97	-0.73	0.85	1.86
K 134	621	473	377	490	23.82	39.35	-0.55	-0.91	-0.66	-0.31
D 39d	615	502	343	486	18.37	44.18	-0.28	-1.36	-1.13	0.12
ICGV 93277	739	575	477	597	22.28	35.47	0.42	0.45	-0.80	-0.65
ICGV 92118	955	535	353	614	43.95	63.09	0.04	-1.23	1.06	1.79
ICGV 86031	1133	713	623	823	37.03	45.02	1.74	2.42	0.47	0.19
ICGV 86635	762	511	328	534	32.95	56.97	-0.19	-1.56	0.12	1.25
ICGV 92113	652	525	382	520	19.47	41.41	-0.05	-0.83	-1.04	-0.12
ICGV 92120	782	525	523	610	32.90	33.07	-0.06	1.07	0.12	-0.86
ICGV 93260	938	637	451	675	32.09	51.94	1.01	0.10	0.05	0.80
ICGV 93261	791	565	490	615	28.65	38.11	0.32	0.62	-0.25	-0.42
ICGV 93269	787	585	493	622	25.68	37.43	0.51	0.66	-0.50	-0.48
Mean	776	531	444	584	31.55	42.82				

	S. Em±	LSD
Drought	22.33	87.68
Genotype	39.38	112.74
G x T	63.08	117.21
G at the same level of T	60.31	169.03
T at the same level of G	58.92	166.30

Z distribution was followed for absolute yield vs per cent reduction in yield for MSD (Fig. 1) and ESD (Fig. 2). From this, it is clear that genotypes ICGV 93261, 93269, 93277, R 9214, KRG 1 and S 206 exhibited high yield and less per cent yield reduction than the mean under MSD and the genotypes ICGV 93261, 93269, 93277, TAG 24, TMV 2, KRG 1 and ICGV 92120 under ESD. The four genotypes ICGV 93261, 93269, 93277 and KRG 1 were best for both the stress conditions. In addition ICGV 86031 was found to have extremetly high yield of 1132.9 g/plot with per cent yield reduction equivalent to the genotypic mean, such variety can be utilized for normal situation to achieve higher yields. Nageshwara Rao *et al.* (1989) also identified groundnut genotypes having high yield potential with low sensitivity to drought under a range of single and multiple drought pattern. Genotype R 9251 though had lesser yield, but its per cent yield reduction was less when compared to all genotypes under both the stress conditions. This genotype could be used in breeding programme to increase its yield potential or used in crossing programme.

This study reveals that stress at any stage after flowering had adverse effect on pod yield and related parameters. However the genotypic differences exist for performance and sensitivity to stress is also dependent upon the crop duration to suit for rainfed situations.

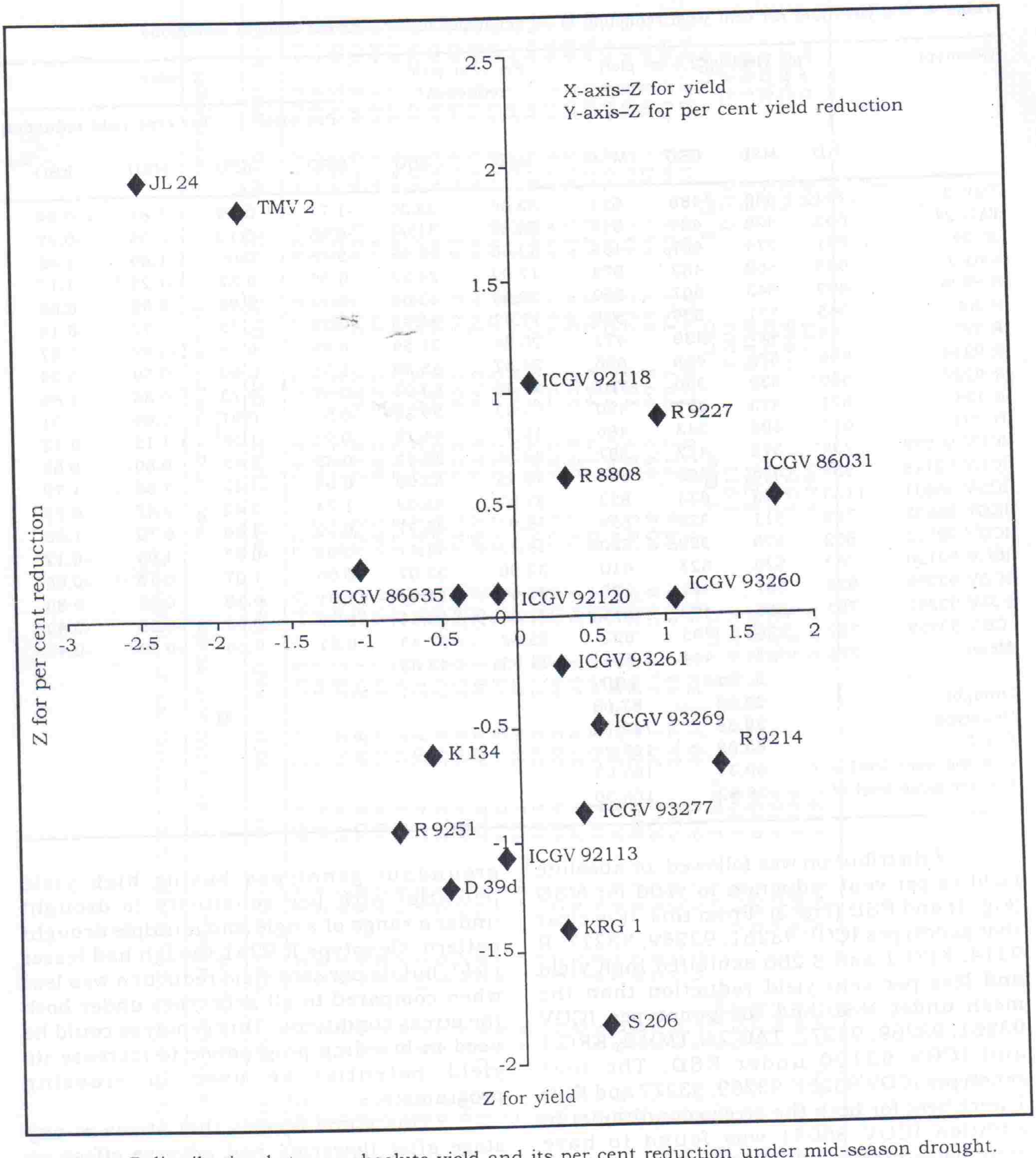

Fig. 1. Z distribution between absolute yield and its per cent reduction under mid-season drought.

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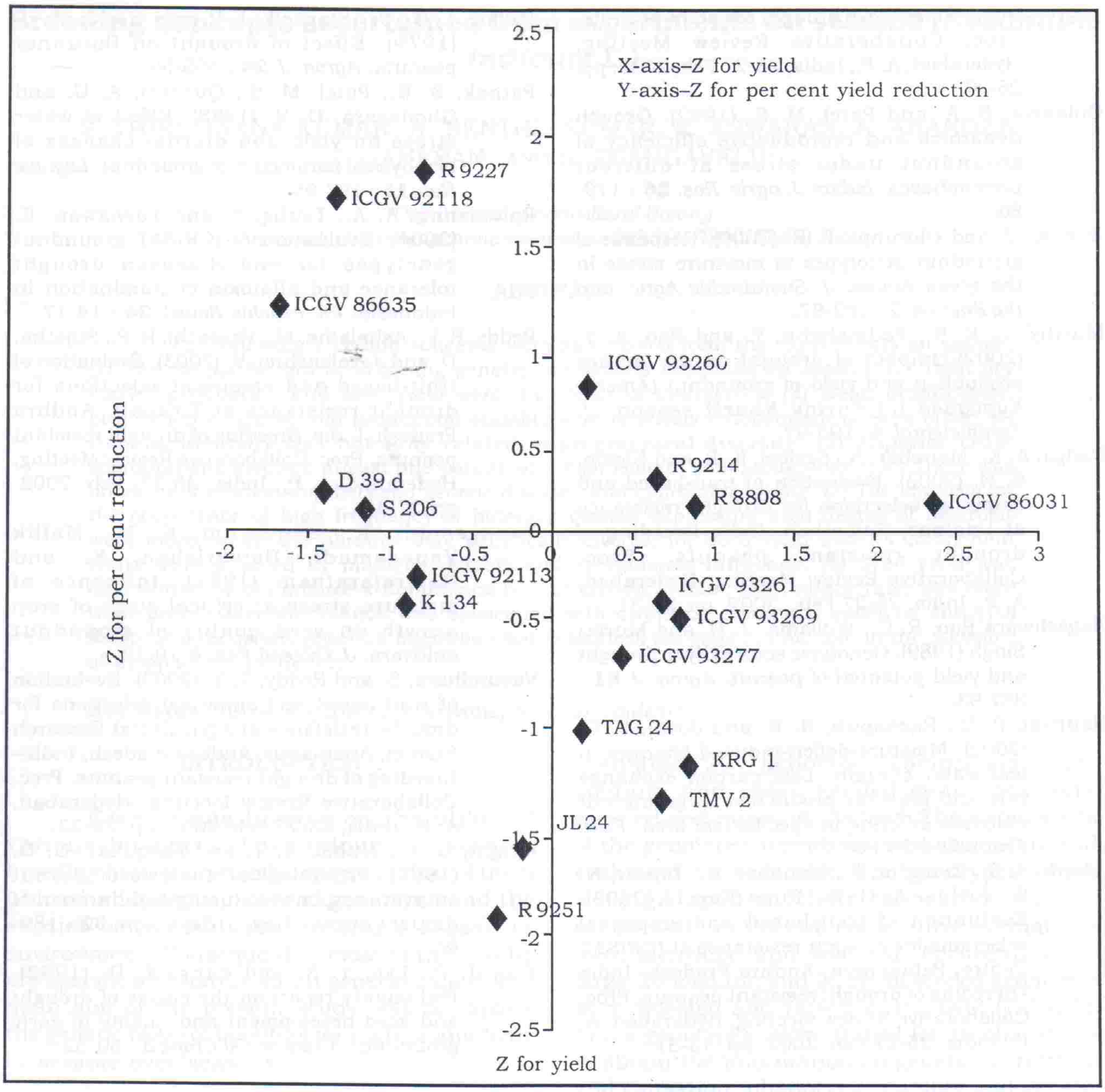

Fig. 2. Z distribution between absolute yield and its per cent reduction under end-season drought.

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