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## Selecting groundnut genotypes efficient in utilizing native Zinc in a Zinc deficient soil

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**Abstract**

Experiment was conducted in a farmer's holding at Peryumpathi village of Zamin Kaliyapuram Block of Coimbatore district (10°77'32.9" N, 76°93'13.7"E. The experiment was conducted with forty groundnut genotypes replicated three times in Randomized Block Design (RBD). The crop was grown up to maturity and harvested. The soil was deficient in available zinc (Zn) status with DTPA - Zn content of 0.92 mg kg<sup>-1</sup>. The genotypes exhibited high variation with respect to yield, Zn content and Zn uptake. The highest pod yield was registered in JL 24 (2592 kg ha<sup>-1</sup>) which was comparable with CO 7 (2559 kg ha<sup>-1</sup>), ABHAYA (2556 kg ha<sup>-1</sup>) and TMV 7 (2546 kg ha<sup>-1</sup>). The genotypes Abhaya (1866 kg ha<sup>-1</sup>) and ALR 3 (1848 kg ha<sup>-1</sup>) recorded the highest kernel yield and the genotypes VRI 13153 (799 kg ha<sup>-1</sup>) and VRI 13154 (814 kg ha<sup>-1</sup>) recorded lowest kernel compared to other genotypes. The genotype Dharani (54.7 mg kg<sup>-1</sup>) exhibited higher kernel zinc content while the lowest was recorded in VRI 13154 (18.1 mg kg<sup>-1</sup>). Kernel zinc uptake ranged from 14.7 g ha<sup>-1</sup> to 100.5 g ha<sup>-1</sup> with mean value of 44.9 g ha<sup>-1</sup>. The genotypes viz., VRI 8, TMV 2, TMV 7, JL 24, Narayani and Dharani were found to be efficient genotypes showing higher uptake of zinc even at low zinc soil condition. Based on the yield data and Zn content, genotypes, CO7, ALR 3, TMV 7, TMV 13, JL 24 and ABHAYA were identified as efficient genotypes with respect to kernel yield. DHARANI, NARAYANI, TCGS1157, TMV 7, VRI 8, TMV 1, TMV 2, TAG 24 and TMV 13 were grouped as efficient genotypes with regard to kernel zinc content.

**Keywords:** Groundnut, Genotypes, Uptake, Yield, Zinc and native zinc

**Introduction**

Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed crop in Indian farming occupying 45 per cent of total oilseed production. India ranks first in respect of area and second in respect of production after China and is grown on variety of soils. India accounts for about 27 per cent of global area (8.71 million hectares) and ranks fourth in terms of groundnut production (Rai *et al.*, 2016) [12]. Tamil nadu ranks fourth in terms of groundnut area (4.419 lakh ha) and third in production (9.737 lakh tonnes).

The low productivity in groundnut is mainly due to the fact that the crop is mostly grown in rain-fed, low fertility soils. Micronutrients, particularly Zn, plays an important role in stepping up the productivity of groundnut. In a field experiment on groundnut nutrition, the yield losses due to Zn deficiency were found to be 13.3 per cent to 20 per cent (Singh *et al.*, 2004) [6].

Zinc deficiency has been reported in almost 49 countries of the world (Alloway, 2004) [1]. Soil analysis of major soil series of India indicated that zinc (Zn) is the most limiting micronutrient affecting production and availability of crops though the total Zn content in soil is several times higher in magnitude than available Zn. Presently in India, Zn deficiency occurs in 48 per cent soils and is expected to increase upto 63 per cent by the year 2025 (Singh, 2009) [16]. Low zinc solubility and high fixation aggravate the deficiency under different soil conditions. As a result the Zn content in edible parts is decreasing and may have a strong impact on human health.

Zinc status of a plant can be improved by applying organic and inorganic fertilizers. But there are several constraints in application of fertilizers. One being the increasing cost of Zn based fertilizers. Secondly applied Zn fertilizer undergoes a number of chemical reactions which reduce its availability to plants. Genotypes of plants vary widely in their tolerance to zinc deficient soils. One of the economic and efficient strategies is the exploitation of plant genetic capacity for efficient zinc acquisition from native zinc pool and its uptake and utilization.

Knowledge about extent of genetic variation among the existing genotypes is a primary step and there are only a few reports in groundnut (Singh 2004 [15]; Singh and Basu 2005a [14]) in this regard. Grouping of groundnut genotypes on the basis of their yield, Zn content and Zn uptake will be useful in identifying suitable genotypes for cultivation in zinc deficient soils and selection of parents for breeding programmes to develop Zn efficient cultivars. With this

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background, a field experiment was conducted to screen the groundnut genotypes effective in utilization of native zinc.

### Material and Methods

Field experiment for evaluating the groundnut genotypes for their zinc efficiency was conducted at Perumpathy village of Pollachi block, Coimbatore district [10°77'32.9" N, 76°93'13.7"E] in a Zn deficient soil. A total of 40 groundnut genotypes representing released and pre release cultures were collected and used for the study (Table 1). Each genotype was sown in three rows in plots of (4 m x 5 m) with a spacing of 30 cm x 10 cm in a randomized block design with three replications. The crop was grown by adopting recommended package of practices during September to December, 2018. All the genotypes received uniform application of nitrogen (20 kg ha<sup>-1</sup>) as urea, phosphorus (50 kg ha<sup>-1</sup>) as single superphosphate and potassium (75 kg ha<sup>-1</sup>) as muriate of potash.

The experimental soil was sandy loam in texture and neutral in reaction with pH of 6.90. The soil was low in nitrogen (137.2 kg ha<sup>-1</sup>), medium in phosphorus (12.5 kg ha<sup>-1</sup>), and potassium (135.0 kg ha<sup>-1</sup>), and sufficient with respect to Fe (26.57 mg kg<sup>-1</sup>), Mn (16.12 mg kg<sup>-1</sup>) and Cu (1.02 mg kg<sup>-1</sup>). The soil was deficient with respect to available Zn with DTPA - Zn value of 0.92 mg kg<sup>-1</sup>. Plants were harvested at maturity and after drying, the mean root, haulm, pod and kernel yield was recorded. Plant samples (kernel, haulm and root) were analyzed for zinc content (Lindsay and Norvell, 1978) [9]. Using the obtained analytical data, Zn uptake was computed.

Based on the yield data, kernel zinc content and uptake, genotypes were grouped into inefficient, if the varietal mean is less than median – standard deviation and efficient, if the mean is more than median + standard deviation (Gill *et al.*, 2004) [6].

### Results and Discussion

#### Pod, kernel and haulm yield of groundnut genotypes different significantly in the Zn deficient soil.

##### Pod and Kernel Yield

Pod, kernel and haulm yield of groundnut genotypes studied showed distinct variation (Table 2). The highest pod yield was recorded in JL 24 (2592 kg ha<sup>-1</sup>) and was comparable with CO 7 (2559 kg ha<sup>-1</sup>), ABHAYA (2556 kg ha<sup>-1</sup>), TMV 7 (2546 kg ha<sup>-1</sup>), TMV 13 (2531 kg ha<sup>-1</sup>), ALR 3 (2515 kg ha<sup>-1</sup>), CO 6 (2456 kg ha<sup>-1</sup>), K6 (2456 kg ha<sup>-1</sup>), DHARANI (2454 kg ha<sup>-1</sup>), VRI 5 (2424 kg ha<sup>-1</sup>) and lowest pod yield was recorded in VRI 13153 (1245 kg ha<sup>-1</sup>).

A vary wide variation with regard to kernel yield was recorded and it varied from 799 to 1848 kg ha<sup>-1</sup>. Under zinc deficient soil condition the genotypes Abhaya (1866 kg ha<sup>-1</sup>) and ALR 3 (1848 kg ha<sup>-1</sup>) recorded highest kernel yield and the genotypes VRI 13153 (799 kg ha<sup>-1</sup>) and VRI 13154 (814 kg ha<sup>-1</sup>) recorded lowest kernel yield compared to other genotypes. Similar results were also recorded by Nagaraj *et al.* (2001) [11].

A high positive correlation (0.67) was observed between Zn content (Kernel) and pod yield indicating the role of Zn in influencing the pod yield. Since the crop has not received any external Zn application the variation in Zn content indicates the differential ability of the genotypes in utilizing the soil native Zn and the role of zinc in influencing the crop yield since the crop has received uniform application of other nutrients.

Zinc through activation of various enzymes and increased basic metabolic rate in plants facilitated the synthesis of nucleic acids and hormones, which in turn enhanced the seed yield due to greater availability of nutrients and photosynthates and resulting in increased kernel yield.

**Table 1:** Details of genotypes used in the study

Genotype	Characteristics
CO 1	Ah 6279 X TMV 3, 105 days, Bunch type
CO 2	EMS mutant from POL 1, 105 days, Bunch type
CO 3	Derivative of VG 55X JL 24, 115 – 120 days, Bunch type
CO 4	Derivative of TMV 10 X ICGV 82, 115 – 120 days, Bunch type
CO 5	Multiple cross derivative, 125 – 130 days, Semi spreading type
CO 6	Derivative of CS 9 X ICGS 5, 125 – 130 days, spreading type
CO 7	Derivative of ICGV 87290 X ICGV 87846, 105 – 110 days, Spreading type
ALR 1	Derivative of Pol 2 X PPG 4, 125 days, Bunch type
ALR 2	ICGV 86011 X (Dh 320 X USA 2) X NCAc 2232, 105 days, Bunch type
ALR 3	Derivative of (R33 – 1 X ICGV 68) X (NCAC 17090 X ALR 1), 110 – 115 days, Bunch type
VRI 2	Derivative of JL 24 X CO 2, 100 -105 days, Bunch type
VRI 5	Derivative of CG 26 X ICGS 44, 105 – 110 days, Bunch type
VRI 6	Derivative of ALR 2 X VG 9513, 120 -125 days, Bunch type
VRI 7	Derivative of TMV 1 X JL 24, 120 – 125 days, Spreading type
VRI 8	Derivative of ALR 3 / AK 303, 105 110 days, Bunch type
TMV 1	Mass selection from west African variety 'Saloum culture Ah 25, 140 days, Spreading type
TMV 2	Mass selection from 'Gudiyatham Bunch' AH. 32, 110 days, Bunch type
TMV 7	Pureline selection from Tennessee white, 100 – 105 days, Bunch type
TMV 13	Selection from Pollachi red, 100 – 105 days, Bunch type
AVK-2015-3	Culture
ALG - 320	Culture
AMABC - 2017 -8	Culture
INS-2016-10	Culture
AMABC- 2017-1	Culture
AMABC- 2017-2	Culture
GPBD – 4	Vikas, 100 – 110 days, Bunch type
TAG 24	Derivative of TGS – 2 X TGE – 1, 100 days, Bunch type
JL 24	Mass selection from Taiwan, 100 days, Bunch type

ICGV 07772	ICRISAT variety
VRI 16084	Culture
NARAYANI	Derivative of JL 24 X Ah 316 / S100 – 105 days
TCGS 1157	Culture, Bunch type
ABHAYA	Derivative of K – 134 X TAG 24, 105 – 110 days
DHARANI	Derivative of VRI – 2 X TCGP – 6, 100 – 105 days
ICGV-9	95 - 120 days, Bunch type
K 6	100 -110 days, Bunch type
ICGV 000350	Derivative of ICGV – 87290 X ICGV – 87846, 105 – 109 days
POLLACHI 1	Selection from Malaysian bunch variety, 105 days, Bunch type
VRI 13154	Culture
VRI 13153	Culture

**Table 2:** Haulm, pod and kernel yield (kg ha<sup>-1</sup>) at harvest stage of groundnut genotypes under zinc deficient condition

S. No	Genotypes	Yield (kg ha <sup>-1</sup> )			Plant zinc content (mg kg <sup>-1</sup> )			Plant zinc uptake (g ha <sup>-1</sup> )		
		Haulm Yield	Pod Yield	Kernel Yield	Kernel	Haulm	Root	Kernel	Haulm	Root
1	CO1	2438	1426	990	31.2	18.8	17.2	30.9	45.8	9.0
2	CO2	2737	1256	954	31.2	23.5	10.3	29.8	64.3	8.0
3	CO3	1743	1407	985	32.1	31.3	13.2	31.6	32.7	7.4
4	CO4	3086	2383	1675	31.1	33.5	17.6	52.1	103.4	12.3
5	CO5	2100	2346	1728	31.0	21.3	14.2	53.6	44.7	12.1
6	CO6	2239	2456	1726	30.1	32.2	22.1	52.0	72.1	11.6
7	CO7	1993	2559	1818	25.8	29.0	13.6	46.9	57.8	9.7
8	ALR1	2629	1925	1434	35.3	31.0	15.3	50.6	81.5	9.3
9	ALR2	2012	1377	987	34.2	11.4	14.2	33.7	14.2	12.0
10	ALR3	2226	2515	1848	33.1	15.8	17.6	61.2	35.2	12.1
11	VRI2	2276	2325	1492	17.9	19.2	16.2	26.7	43.7	12.3
12	VRI5	2554	2424	1757	19.1	22.1	17.2	33.6	56.4	10.1
13	VRI6	2117	1281	906	18.4	13.7	12.6	16.7	29.0	6.3
14	VRI7	2459	2241	1608	18.6	14.5	14.2	29.9	20.8	9.9
15	VRI8	2315	2326	1667	40.9	17.9	15.1	68.2	41.5	9.6
16	TMV1	3816	2277	1466	49.8	14.4	15.8	73.0	51.1	14.8
17	TMV2	1971	1987	1342	40.5	13.8	14.2	54.3	13.4	8.9
18	TMV7	1997	2546	1844	54.5	32.5	15.2	100.5	48.7	9.1
19	TMV13	1997	2531	1800	32.1	29.9	17.2	57.8	59.7	12.0
20	AVK-2015-3	1694	2048	1336	33.4	22.4	21.3	44.6	33.5	10.6
21	ALG-320	1625	1750	1190	31.3	14.9	13.8	37.3	15.5	5.5
22	AMABC-2017-8	1672	2259	1524	28.7	21.8	20.7	43.7	23.4	9.9
23	INS-2016-10	1882	1794	1215	29.7	34.0	20.9	36.1	64.0	13.5
24	AMABC -2017-1	1907	1522	1024	32.7	16.5	15.4	33.5	31.5	7.0
25	AMABC-2017-2	1385	2142	1491	33.4	39.8	29.6	49.8	55.1	10.2
26	GPBD-4	2019	2038	1398	33.9	17.0	15.9	47.4	34.3	7.6
27	TAG-24	1798	2345	1645	40.9	18.8	16.8	60.2	33.8	12.8
28	JL-24	1937	2592	1838	39.5	18.5	14.7	72.6	35.8	9.8
29	ICGV 0772	1265	2023	1379	28.7	19.1	18.0	39.6	37.7	4.8
30	VRI 16084	1234	1643	1123	21.2	14.2	13.1	23.8	9.6	4.7
31	NARAYANI	1452	2144	1470	45.1	22.8	21.7	66.3	22.1	8.4
32	TCGS 1157	1668	1800	1262	42.2	20.5	14.2	53.3	34.2	7.8
33	ABHAYA	3054	2556	1866	19.3	23.2	16.2	36.0	70.9	11.2
34	DHARANI	2253	2454	1779	54.7	23.3	14.7	97.3	48.0	9.2
35	ICGV-9	1566	1327	877	25.6	25.7	24.6	22.4	25.2	11.1
36	K-6	3285	2456	1514	26.5	22.3	15.2	40.1	64.4	11.3
37	ICGV-000350	1787	1994	1329	23.5	23.1	22	31.2	41.3	9.4
38	POLLACHI 1	1024	1428	979	29.3	22.8	21.7	28.7	13.3	6.0
39	VRI 13154	1021	1287	814	18.1	20.1	18.2	14.7	11.5	4.3
40	VRI 13153	1224	1245	799	18.6	20.7	18.6	14.9	12.0	4.4
	Mean	2036	2010	1396	31.5	22.0	17.3	44.9	40.8	9.4
	SED	26.5	27.3	48	1.46	1.47	1.22	0.014	0.015	0.65
	CD (P = 0.05)	52.8	54.4	96	2.93	2.92	2.43	0.029	0.030	1.29

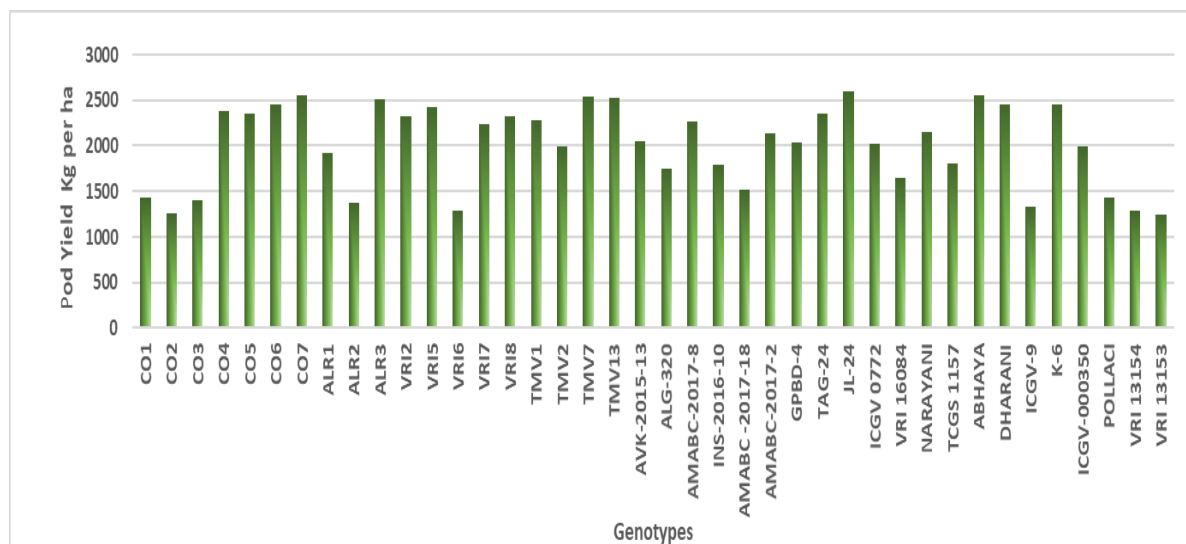


Fig 1: Genotypic influence on Pod Yield

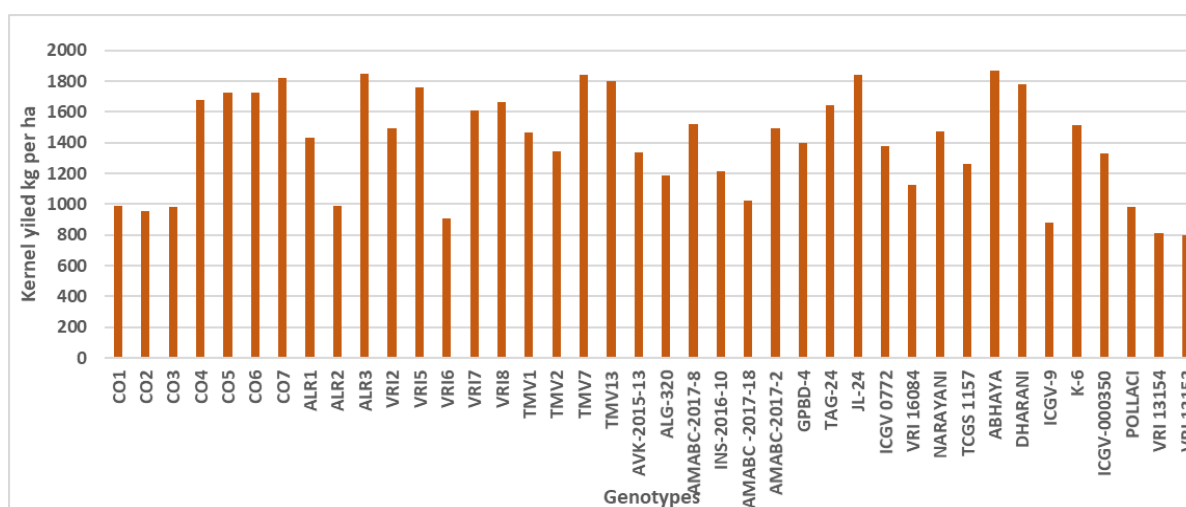


Fig 2: Genotypic influence on Kernel Yield

### Haulm yield

The variability for haulm yield in groundnut genotypes ranged from 574 kg ha<sup>-1</sup> (VRI 13154) to 3816 kg ha<sup>-1</sup> (TMV 1) with a mean of 1840 kg ha<sup>-1</sup>. The genotypes with higher haulm yield were TMV 1 (3816 kg ha<sup>-1</sup>), K 6 (3285 kg ha<sup>-1</sup>), CO 4 (3086 kg ha<sup>-1</sup>), ABHAYA (3054 kg ha<sup>-1</sup>), CO 2 (2737 kg ha<sup>-1</sup>), ALR 1 (2629 kg ha<sup>-1</sup>), VRI 5 (2554 kg ha<sup>-1</sup>), CO 1 (2438 kg ha<sup>-1</sup>), VRI 8 (2316 kg ha<sup>-1</sup>). This was due to the involvement of micronutrients especially zinc in regulatory functions, auxin production which ultimately improved the vegetative growth of the plant (Mahakulkar *et al.*, 1994) [10].

### Zinc content and uptake in groundnut genotypes (Table 2 and 3)

Zinc accumulation in different plant parts at harvest stage was in the order of kernel > haulm > root. Under zinc deficient soil condition, the kernel zinc content in groundnut genotypes ranged from 18.1 (VRI 13154) to 54.7 mg kg<sup>-1</sup> (Dharani) with a mean of 31.5 mg kg<sup>-1</sup>. The haulm Zn content varied from 11.4 (ALR 2) to 39.8 mg kg<sup>-1</sup> (AMABC-2017-2). The variation in zinc content might be due to the inherent ability of the genotypes to load higher zinc content in kernel. Similar findings were reported by Arunachalam *et al.* (2013) [12] in Groundnut. Jemila *et al.* (2017) [8] reported in pearl millet the different genotypes taken for study showed wide variation in total plant zinc concentration under no zinc treatment

which might be due the secretion of the phytosiderophore, a type of non proteinogenic amino acids from the root of efficient genotypes under zinc stress conditions and which are highly effective in complexing and mobilizing Zn from root apoplast to long distance transport of Zn within the plant.

The genotype TMV 1 (13.1 g ha<sup>-1</sup>) recorded highest root Zn uptake followed by TAG 24 (12.4 g ha<sup>-1</sup>) and were on par with each other. The kernel zinc uptake ranged from 14.7 g ha<sup>-1</sup> to 100.5 g ha<sup>-1</sup> with mean value of 44.9 g ha<sup>-1</sup>. Among the genotypes TMV 13 (100.5 g ha<sup>-1</sup>) recorded the highest Zn uptake and the lowest was registered in VRI 13154 (14.7 g ha<sup>-1</sup>). The genotypes viz., VRI 8, TMV 2, TMV 7, JL 24, Narayani and Dharani were found to be efficient genotypes showing higher uptake of zinc even at low zinc soil condition. Similar results were also recorded by Gowthami and Ananda (2017) [13]. This could be attributed to that the Zn efficient genotypes may possess a better absorption and root to shoot transport, probably due to a more efficient transport system such as ion channel or ion pump, compared with the zinc inefficient genotypes (Sudha and Stalin, 2015) [19]. The root zinc uptake was ranged from 4.3 g ha<sup>-1</sup> to 14.8 g ha<sup>-1</sup> with a mean value of 9.4 g ha<sup>-1</sup>. Among the genotypes TMV 1 (14.8 g ha<sup>-1</sup>) recorded the highest Zn uptake compared to other genotype. The lowest was registered in VRI 13154 (4.3 g ha<sup>-1</sup>).



### Grouping of Genotypes

Based on the yield data, Zn content and Zn uptake genotypes were grouped into inefficient if the varietal mean is less than median – standard deviation and efficient if the mean is more than median + standard deviation based on various parameters.

Parameters	Efficient Genotypes
Pod yield	CO7, TMV 7, JL 24 and ABHAYA
Kernal yield	CO7, ALR 3, TMV 7, TMV 13, JL 24 and ABHAYA
Kernal Zn Content	DHARANI, NARAYANI, TCG1157, TMV 7, VRI 8, TMV 1, TMV 2 AND TMV 13
Kernal Zn Uptake	VRI 8, TMV2, TMV 7, JL 24, NARAYANI and DHARANI

### Conclusion

When grown in a zinc deficient soil wide variation was observed among the genotypes indicating the differential ability of the genotypes in utilising the native soil Zn. The genotypes, CO7, ALR 3, TMV 7, TMV 13, JL 24 and ABHAYA were identified as efficient genotypes with respect to kernel yield. DHARANI, NARAYANI, TCG1157, TMV 7, VRI 8, TMV 1, TMV 2, TAG 24 and TMV 13 were grouped as efficient genotypes with regard to kernel zinc content.

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