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RESEARCH ARTICLE

ASSOCIATION OF SEED IRON AND ZINC CONTENT WITH SEED YIELD AND OTHER TRAITS IN SESAME (SESAMUM INDICUM L.)

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ABSTRACT

Selfed progenies derived from diverse populations were evaluated in two seasons at Agricultural Experimental Farm, University of Calcutta, Baruipur, West Bengal, India to investigate the correlation of seed iron (Fe) and zinc (Zn) content with seed yield and component traits in sesame. Significant genetic variability among the progenies was observed for Fe, Zn seed yield and other component traits. Significant and positive correlation was observed between Fe and Zn. Seed yield was significantly correlated positively with plant height, capsule no/plant and 1000 seed wt. While Fe content in seed was negatively associated with capsule length. The PCA revealed that seed yield per plant had a strong relation with capsules per plant and plant height suggesting the need for more emphasis on these components for increasing the seed yield in sesame. Zinc and iron also had a strong relationship but there are no significant relationship with seed yield per plant and micronutrients.

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INTRODUCTION

Traditional breeding for last two decades was mainly focused on breeding for high yield not only in cereals or pulses but also in oil seeds to meet the increased demand for increasing human population. In this process, nutritional value of grain or seed is often ignored. This unintentionally led to micronutrient malnutrition among poor people of developing country. World Health Organization (WHO, 2012) has figured out grain iron(Fe) and zinc(Zn) as limiting micronutrients for human health. The impact of deficiency in iron and zinc in human health is well known. Zinc deficiency induces the human health problem like impairment in physical development, brain function and immune system, weight loss, apetite loss, etc while iron deficiency leads to anemia, dizziness, headache, chest pain and frequent worm infestation. High yielding variety rich in such micronutrients may help to recovered from crop-based nutrient deficiency. But grain iron and zinc. Content are often negatively correlated with grain yield in crops like maize (Banziger and long, 2000), sorghum (Reddy *et al*., 2005) making the task of breeders arduous for developing level of micronutrient and grain yield simultaneously Sesame an important healthy oil seed crop, in several continue including India is after consumed as raw seed can mitigate malnutrition, if iron and Zn content in the seeds are enhanced.

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Clearly reassociations of micronutrients with seed yield can help plant breeders is planning breeding strategy augmenting content of Fe and Zn in seeds of sesame. So, the investigation was carried out in sesame to disclose the linkage of important nutritional components like Fe and Zn with seed yield and other quantitative traits.

MATERIALS and METHODS

The experimental material consisted of 50 diverse genotype different parts of Indian and aboard from USA, Belgium, Bulgaria and Bangladesh grown separately in 2 experiments in RCBD with 3 replications in rabi/summer season (February – May) 2014 at Agricultural Experimental Farm, University of Calcutta, Baruipur, West Bengal India. Each genotype was grown in 4 rows with 3m long and 30 cm spacing between rows, the micronutrient levels of soil measured in six samples (Three each at 0-15 cm and 15-30 cm depth) at the time of planting varied from 6.9mg/kg Fe and 2.4mg/kg Zn for the field. Data were recorded from 5 randomly selected plants in each replication for(1) plant height (2) days to flowering (3)primary branches/plant (4)secondary branches/plant (5) Internode length (cm) (6)days to maturity (7) capsule length (cm) (8) capsule breadth(cm) (9)1000 seed weight(gm) (10)seed yield/plant. The seeds were cleaned after harvest and precautions were taken to avoid any contamination with dust particle and other extrnous matter. The seed samples were analyzed for Fe and Zn by taking the digest using Atomic

Absorption Spectrophotometer (Agilant seed Fe and Zn content, seed yield and other morphological traits were analyzed for across .two years following a fixed model ANOVA of randomized complete block design (Gomez and Gomez, 1984) using MSTAT programme. The broad sense heritability was estimated as the ratio of genotypic variance to phenotypic variance. The correlation coefficients among the micronutrients, seed yield and its component traits were estimated using standard procedure.

RESULTS AND DISCUSSION

Average grain micronutrient across year was higher in EC – 310448(36) (231.50mg/kg Fe) and EC – 164966(50) (80.09mg/kg Zn) followed by analysis Of variance showed non-significant effect of year in Fe and Zn (Table).The difference in the soil Fe and Zn content between the two years were not reflected in the seed Fe and Zn content correlation between two season for Fe($r=0.66;p<0.01$), Zn($r=0.67;p,0.01$) was highly significant, indicating high level of Consistency in the rankings of entic across the two season for micronutrient content. ANOVA showed highly significant difference among genotype for all characters. The genotype had a wide range of Fe and Zn contents Velu *et al*. (2007) also recorded wide range in within population for micronutrients has also been reported for numerous other crops for instance in maize (Benziger and Long, 2000), sorghum (Reddy *et al*., 2005) and sesame (Pandey *et al*., 2016). Wide variation was also observed for seed yield and its other component traits under study among genotype. Thus the variability of wide range of variation for both kinds of nutritional and productive traits indicated the scope of development of Fe & Zn rich genotype in high yielding background of sesame through the exploitation within population variability. The magnitude of heritability was comparable for almost all the characters except for grain yield. The implies, low environmental influence and predominant role of genetic factors on the expression of Fe and Zn due to comparable genotypic and phenotypic variance while significant effect of environment was observed on grain yield. Aruselvi *et al*. (2007) in a study of 63 hybrids also observed higher heritability estimate for Fe and Zn. In the present investigation availability of substantial genetic variability for seed Fe and Zn coupled with high heritability (65-80%) indicated good project for solution of Fe and Zn rich genotype.

Correlation analysis

Significant and positive correlation was observed between Fe and Zn (Table) suggested that simultaneously component in likely to be highly effective. Highly significant correlation between Fe and Zn was earlier by (diapari *et al*, 2014) in chickpea. There was no correlation between seed yield and Fe and Zn contents in both the population indicating simultaneous selection foe Fe and Zn can be accomplished without compromising on seed yield. With Fe and Zn content in both the population indicated breeding for higher level of micronutrients without compromising the improvement for large grain size. And Zinc negatively correlated with days to 50% flowering, days to maturity and seed yield per plant. Highly significant positive phenotypic correlation coefficients was observed between seed yield/plant and plant height, capsules/plant and 1000 seed weight The results agreed with earlier Works by Sumathi and Murlidharan (2010). Khan *et al*., (2001), Uzun and Cagirgan (2001) and Sumathi *et al*., (2007) and Subramanian and Subramanian (1990). This emphasized that selection for higher Fe content would like to improve Zn also through correlated response in positive direction and 1000 seed weight in negative direction. The present findings of highly positive correlation between Fe and Zn find support Morgounov *et al*., 2007 in wheat. Correlation coefficient analysis is an important estimate in the determination of most effective statistics. Component breeding becomes simple task when there is a positive association of important characters. But when the characters are negatively associated, it would be difficult to exercise simultaneous selection for them in restructuring a variety. It is important to improve the micro-elements along with augmenting productive of crops. Some of the nutrients like Fe and Zn, obviously had a good impact on human nutrition. In fact both the elements to be positively associated and simply by conventional breeding program, it is possible to Fe and Zn content in seeds following simple breeding program. Among the morphological traits, seed yield was correlated positively with number of capsules/plant. Thus it is possible to increase seed yield further by augmenting this trait. Interestingly, Fe and Zn content were not correlated to either of the traits, thus restricting of plant type with high yield with higher content of Fe and Zn are achievable targets through simple breeding approach like transfer of gene for high Fe and Zn content to high yielding genotypes.

PCA analysis

Principal Component Analysis measures the importance and contribution of each component to total variance. It can be used for measurement of independent impact of a particular trait to the total variance whereas each coefficient of proper vectors indicates the degree of contribution of every original variable with which each principal component is associated. In present investigation, Principal component analysis has shown the genetic diversity of 50 genotypes following the Proportion of Variance Criterion by O'Rourke and Hatcher. According to this criterion, four principal components with cumulative variance of 66.93% (Table no: 4). which will provide a prominent idea of structure underlying the variables analyzed. For this study the first four axes obtained with Eigen value of > 1.0; which indicates that the identified traits within the axes exhibited great influence on the phenotype of the germplasm set. PCA1 accounted for 19.321 % of total variation in the population having the contribution from pH followed by Capsule per Plant, Seed Yield per Plant, 1000 Seed Weight and Zinc. Hence, the first component has phenological and yield related variables similar finding was reported by Sanni *et al.* (2008). Second Principal component accounts for 15.013% of total variation having major contribution of the traits like iron, zinc, Capsule per Plant and Seed Yield per Plant. Hence, the second component has micronutrient and agronomic traits. PCA 3 was accounted for 12.81% of total variation and the traits contribute most are capsule length, capsule breadth, primary branches and 1000 seed weight. PCA 5 was accounted for Days to 50 % Flowering, Days to Maturity and Capsule per Branch. PCA 4 was accounted for 10.213% of total variation and the having more contribution of the characters like Primary Branches, Secondary Branches and Days to 50% Flowering. Hence, from the current investigation the five three principal components contributing about half of the variance were plotted to observe relationships between the measured traits. The scree plots (Figure. 1) of PCA describe for first four eigen values and correspond to the whole percentage of the variance observed in the dataset.

Table 1. List of germplasm

S.NO.	NAME	Land race/ High yielding Varieties (HYV)	S.NO.	NAME	Land race/ High yielding Varieties (HYV)
1	RT348	HYV	26	IC – 204063	LOCAL LAND RACE
2	TMV 4	HYV	27	EC – 310448(36)	Exotic variety, Bulgaria
3	UMA	HYV	28	EC – 335004	Exotic variety, Bangladesh
4	CUMS 04	HYV	29	EC -334973(38)	Exotic variety, Bangladesh
5	RAMA	HYV	30	EC – 335004(34)	Exotic variety, Bangladesh
6	GT2	HYV	31	EC – 303433(17)	Exotic variety, USA
7	V12	LOCAL LAND RACE	32	EC – 164966(50)	Exotic variety, USA
8	OSC-593	HYV	33	EC – 164966(52)	Exotic variety, USA
9	V-10	LOCAL LAND RACE	34	EC – 310448(39)	Exotic variety, Bulgaria
10	AMRIT	HYV	35	EC – 41923 –(49)	Exotic variety, Bangladesh
11	B9	HYV	36	EC – 303432	Exotic variety, USA
12	RT-54	HYV	37	EC – 303439	Exotic variety, Bulgaria
13	SAVITRI	HYV	38	EC-306451	EXOGENOUS VARIETY
14	HUMRA	HYV	39	CUHY-57	C.U DEVELOPED VARIETY
15	TILLOTAMA	HYV	40	CUHY-23	C.U DEVELOPED VARIETY
16	NIC 8316	HYV	41	CR-11	C.U DEVELOPED VARIETY
17	NIRMALA	HYV	42	CUHY-24	C.U DEVELOPED VARIETY
18	TKG 355	HYV	43	CUMS-17	C.U DEVELOPED VARIETY
19	IC – 131490	LOCAL LAND RACE	44	CUHY-13	C.U DEVELOPED VARIETY
20	IC – 14331	LOCAL LAND RACE	45	CUHY-36	C.U DEVELOPED VARIETY
21	IC – 14053	LOCAL LAND RACE	46	CR-11A	C.U DEVELOPED VARIETY
22	IC – 43033	LOCAL LAND RACE	47	CUHY-45	C.U DEVELOPED VARIETY
23	IC – 204159	LOCAL LAND RACE	48	CUMS-9	C.U DEVELOPED VARIETY
24	IC – 152485	LOCAL LAND RACE	49	CUHY-27	C.U DEVELOPED VARIETY
25	IC – 96230	LOCAL LAND RACE	50	CUMS-11	C.U DEVELOPED VARIETY

Table 2. ANOVA: Analysis of Variance and measures of variability for grain Fe and Zn content and other agronomic traits

SOV	DF	Fe	Zn	DF 50% floweing	1000 seed wt	Seed yield per plant
Season	1(1)	22.3	13.7	10.8	4.1	5148.4
Rep/season	2(2)	25.7	87.3	19.2	2.9	153.6
Progeny	29(23)	503.0**	270.7**	3.1**	7.2**	533.8**
Season*Progeny	29(23)	90.3*	48.1*	0.3	0.5	337.0**
Error	58(46)	43.2	24.5	1.1	1.2	135.2
Mean		46.7	44.6	45	9.6	2.14
Range		29.9-77.2	30.7-63.0	43-47	6.6-11.8	1.36-2.93
Heritability %		63.3	64.8	42.0	60.8	9.08

*significant at 5% level of significance **significant at 1% level of significance

Table 3. Correlation coefficient for micronutrient content with yield and yield related traits

	PH	PB	SB	DF	IL	DM	CP	CL	CB	SW	SYP	Fe	Zn
PH	1												
PB	.392*	1											
SB	-.106	.107	1										
DF	.217	.121	-.004	1									
IL	.266*	.389**	-.263*	.027	1								
DM	.150	.210	.168	.015	.182	1							
CP	.469**	.190	.062	-.033	-.080	.043	1						
CL	-.148	-.046	-.225	-.116	-.016	.061	-.186	1					
CB	.080	.267*	-.198	.322*	.091	-.034	-.129	.292*	1				
SW	.197	.523**	-.142	.038	.214	.195	.194	.061	.355*	1			
SYP	.425**	.124	.077	.146	-.067	-.206	.330*	-.119	.159	.248*	1		
Fe	.195	-.020	-.185	.192	-.029	.008	.055	-.322*	.154	.057	.173	1	
Zn	.214	.012	.057	-.031	.076	-.001	.044	-.141	.085	0.47	.126	.267*	1

PH= Plant height, PB= Primary Branches, SB= Secondary branches, DF = 50% flowering, IL= inter node length, DM = Days to maturity, CP= Capsule/ plant, CL = Capsule length, CB= Capsule breath, SW= 1000 seed wt, SYP = Seed yield per plant, Fe= iron, Zn= Zinc

Table 4. Eigen value and percent of total variation and component matrix for the principal component axes

Parameter	PC1	PC2	PC3	PC4	PC5
PH	.707	-.216	-.026	.006	.083
CP	.694	.526	-.218	.236	.016
SYP	.682	.596	.033	.172	.095
SW	.473	.084	.464	-.130	.213
DM	-.432	.086	.231	.255	.427
ZN	.470	-.695	-.080	.110	.182
FE	.107	-.595	-.238	.377	.406
CL	-.041	.032	.676	-.267	.274
CB	.086	-.118	.638	.245	-.501
PB	-.204	.366	-.419	-.415	.308
SB	.301	-.199	.200	-.637	.250
DF	-.295	.288	.278	.444	.470
Eigen Value	2.319	1.802	1.538	1.228	1.146
Variability (%)	19.321	15.013	12.817	10.231	9.551
Cumulative (%)	19.321	34.33	47.151	57.382	66.934

PH= Plant height, PB= Primary Branches, SB= Secondary branches, DF = 50% flowering, IL= inter node length, DM = Days to maturity, CP= Capsule/ plant, CL = Capsule length, CB= Capsule breath, SW= 1000 seed wt, SYP = Seed yield per plant, Fe= iron, Zn= Zinc

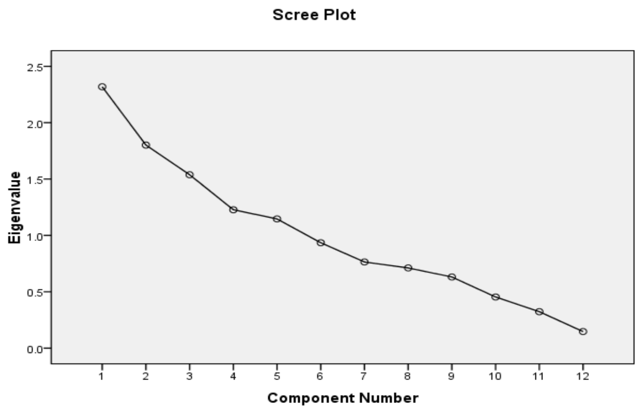

Figure 1. Scree Plot

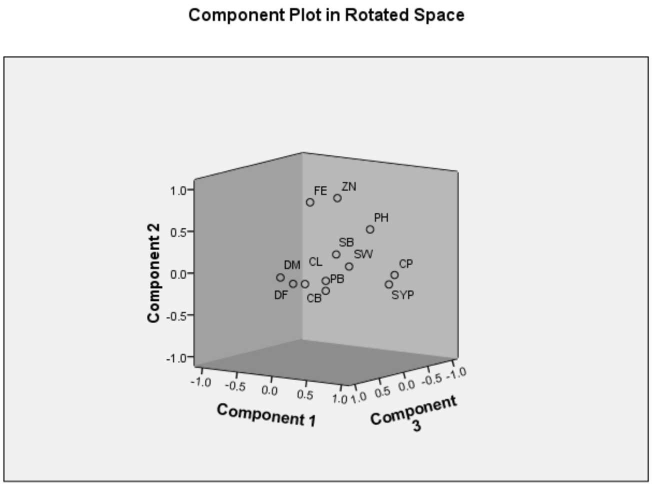

Figure 2. Component plot in rotated space

In rotated plot, (Figure 2), the variables are scattered across different components. The 3D rotation plot describes the variables which are grouped together have cumulative effect on the components.

The statistical properties of this interpretation have been described in detail by some researchers (Dehghani *et al*., 2008; Sabaghnia *et al*., 2011). Increased seed yield potential and micronutrient is an important goal for plant breeders and progress in yield potential results from the progressive accumulation of genes conferring higher yield or elimination of the unfavorable genes through the breeding process. The present investigation revealed that seed yield per plant had a strong relation with capsules per plant and plant height suggesting the need for more emphasis on these components for increasing the seed yield in sesame. Zinc and iron also had a strong relationship. Seed weight and branches had also strong relationship. The PCA may allow the plant breeder more flexibility in finding the number of plants to be evaluated and the plant breeder could use the multivariate methods by first determining the combination of traits that constitute an ideal plant. Here to increase seed yield per plant we have to give preference to capsules per plant and plant height. And to control any micronutrient either iron or zinc, by controlling only one element we can get our desired result. By plotting the PCAs that are considered to be important, plants close to the ideal plant would be selected (Yan and Rajcan, 2002). Thus the results of principal component analysis used in the study have revealed the high level of genetic variation existing in the population panel and explains the traits contributing for this diversity. Hence the results will be of greater benefit to identify parents for improving various morphological traits analyzed in this study. The PCA may be deemed important if their associated coefficients are of relative magnitude with breeding targets and given this apparent potential for using PCA, further work is required to compare multivariate methods for reaching actual gains.

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