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Genetics of seed longevity in soybean

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Summary

Soybean seeds have a short storage life, especially in humid, tropical environments. However, few varieties have been identified to have superior seed longevity. This investigation was conducted to study the genetics of seed longevity/storability with the ultimate aim to improve this trait through breeding programme.

Parental, F_1, F_2, F_3 generations of Kalitur× PK 416, Kalitur× PK 472 and PK 515× Ankur crosses were evaluated for seed longevity after 8 months of ambient storage (December- July). Of the parental lines, Kalitur and Ankur were of superior seed longevity while PK 416, PK 472 and PK515 were of poor seed longevity. Seeds from F_1 plants (F_2 seeds) showed low storability to be dominant over high storability. Segregation pattern in F_2 was 3∶1 in Kalitur× PK472 and 15∶1 in Kalitur× PK 416 and PK 515× Ankur (low vs high longevity) suggesting that the trait was governed by 1 and 2 major genes, respectively. This ratio was supported by 5∶3 and 55∶9 ratio in the F_3 (bulk) of the respective crosses. This could also be confirmed by observing the F_3 rows of true breeding for recessive phenotype i. e. high seed longevity whose number was as per expectation in each cross.

Key words Soybean; Seed longevity; Storability

Introduction

The problem of poor soybean stand establishment is very common in the tropical countries where seed deterioration is accelerated by high temperature and relative humidity. Seed deteriorates even prior to harvest, it begins when seed reaches physiological maturity and it continues until seed is harvested. Pathogens are believed to play an important role in this "field weathering" process (Wilcox, Laviolette and Athow, 1974 and Ndimande, Wien and Kueneman, 1981). Soybean seeds also deteriorate rapidly in storage if seed moisture content

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is high.

Genotypic difference in resistance to field westhering (Green and Pinnell, 1968 a, b; Lanyon, 1970; Paschal& Ellgs, 1978; Potts, Duanpatra, Hairston and Delouche, 1978, I-ITA, 1981 and Ndimande et al., 1981) and for resistance to deterioration during storage (Minor and Paschal, 1982 and Singh and Ram, 1986) have been identified. The inheritance of resistance to field weathering was studied by Green and Pinnell (1968 a, b) who reported low heritabilities. Lanyon (1970) reported that varietal difference in soybean for emergence were due to one major gene and several modifiers. Kueneman (1982) observed that longevity of seeds in segregating populations is governed by genotype of the mother plant from which the seed is derived. Kueneman (1983), Singh and Ram (1986) and Verma and Ram (1987) suggested that material plant genome can influence the longevity of soybean seed. The segregation pattern in F_2 and F_3 generations indicated the involvement of 1- 4 genes for germinability of soybean (Singh and Ram, 1986 and Verma and Ram, 1987).

In view of meagre and variable information on inheritence of seed longevity in soybean, the present investigation was undertaken in three crosses of soybean involving F_1, F_2 and F_3 generations.

Materlals and methods

The experimental material comprised of 5 parental cultivars viz. Kalitur, Ankur, PK 416, PK 472, PK 515 and F_1, F_2, F_3 generations of Kalitur× PK 416, Kalitur× PK472 and PK 515× Ankur, Kalitur is a black- seeded Indian strain which has excellent seed longevity. Ankur a yellow seeded variety has its origin from US varieties and is characterized by high longevity and resistance to rust. The remaining three parental cultivars viz. PK 416, PK 472 and PK515 the varieties breed at Pantnager had poor seed longevity. The F_2 generetions of three crosses were planted in rainy season 1992. The parents, F_1 and F_3 generations were grown in 1993. The F_3 generations were grown as individual plant progenies tracing back to F_2 plants. 100 F_3 progenies by Kalitur× PK 416 and 90 of each of Kalitur× PK 472 and PK 515× Ankur were available for seed longevity evaluation. Room temperature storage of seeds for 8 months (December- July) was followed by laboratory germination test of parental, F_1, F_2, F_3 generations´seeds. The germination percentage after room temperature storage was divided into% increments and x^2 lests of goodness of pit were conducted.

Results

Out of five parental cultivars, Kalitur, and Ankur had good longevity with germination percentage 84.20 and 76.60%, respectively, while PK 416, PK 472 and PK 515 had poor longevity with germination percentage 16.11m 8.76 and 8.7%, respectively after 8 months of room temperature storage. The mid parental value of Kalitur× PK 416 was 49.65, Kalitur× PK 472 was 46.48%, and PK 515× Ankur was 47.35%. The germination percentage of F_1 generation in all the three crosses was towards low parent (28% in Kalitur × PK 416, 20.60% in Kalitur× PK 472 and 8.70% in PK 515× Ankur) indicating dominance of low over higher longevity. The F_2 frequency distribution curves (Fig°1) were skewed towards low germination in all three crosses demonstrating domimance of low seed longevity over high one. Further, the curves did not show normal distribution. The data of F_1, F_2 and F_3 generations were subjected to Mendelian genetic analysis. The value of x^2 of the F_2 and F_3 generations (bulk basis) gave a goodness of fit to a ratio of 15∶1 and 55∶9 (low vs high), respectively (Table l) in two crosses Kalitur× PK 416 and PK 515× Ankur, and a ratio of 3∶1 and 5∶3 (low vs high), respectively in Kalitur× PK 472. The results were in conformity with the assumption of two recessive genes for high seed longevity in Kalitur× PK 416, PK 515× Ankur and one recessive gene in Kalitur× PK 472.

Table 1 The Chi- square values in various crosses

Crosses	Phenotype	Observed	Expected	Computed x^2	Tabular value of x^2 at P= 0.05
Kalitur× PK 416	F_2 generation	(15∶1)			
	Low germination	239	234.375	1.46	3.84
	High germination	11	15.625		
	F_3 generation	(Bulk basis) (55∶9)			
	Low germination	1213	1237.500	3.69	
	High germination	228	202.500		
Kalitur× PK 472	F_2 generation	(3∶1)			
	Low germination	180	187.5	12.0	
	High germination	70	62.5		
	F_3 generation	(Bulk basis) (5∶3)			
	Low germination	857	832.5	1.92	
	High germination	475	499.5		
PK 515× Ankur	F_2 generation	(15∶1)			
	Low germination	183	187.5	1.73	
	High germination	17	12.5		
	F_3 generation	(Bulk basis) (55∶9)			
	Low germination	1166	1155.85	0.63	
	High germination	179	189.15		

Although individual plants within F_3 rows were ovaluated, segregation pattern within F_3 rows was not taken into account due to the fact that there were not enough plants (about 15 plants/family) to give a/valid fit for various genetic ratios sasuming one/two gene differ– ences. However, 1/16 and 1/4 F_3 families were expected to be true breeding for high longevity in Kalitur× PK 416, PK 515× Ankur and Kalitur× PK 472 respectively. Thus, out of 100 F_3 rows (Kalitur× PK 416) and 90 F_3 rows (in Kalitur× PK 472, PK 515× Ankur), 6.25 rows (in Kalitur× PK 416), 5.625 rows (in PK 515× Ankur) and 22.5 rows (in Kalitur× PK 472) were expected to be true breeding for high seed longevity. The corresponding actual numbers of such lines observed were five, six and nineteen and there was no significant difference between the observed numbers and the expected numbers of F_3 rows trus breeding for high seed longevity (Table 2). The also aupported the results of F_2 generations.

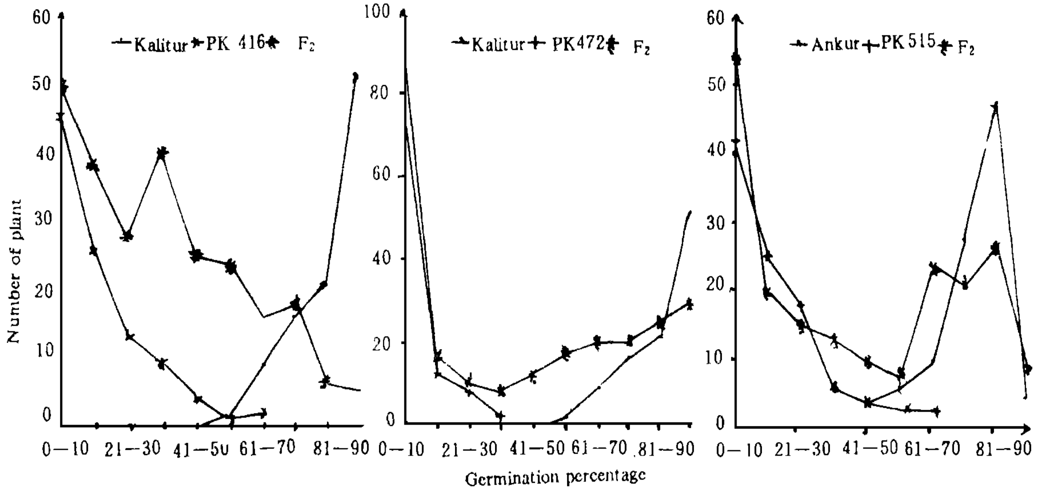

Fig. 1 Frequency distribution of parental and F_2 generaticn palnts fot seed germination percentage

Table 2 Behaviour of F_3 rows with respect to segregation for seed longevity

Grosses	F_2 ratio	F_3 rows: Segregation /true breeding for low longevity	F_3 rows: True breeding for recessive phenotype (high seed longevity)	Computed x^2
Kalitur× PK 416	15∶1	95	5	0.27
Kalitur× PK 472	3∶1	71	19	0.72
PK 515× Ankur	15∶1	84	6	0.03

Discussion

The seed longevity of F_1'S of crosses studied (Kalltur× PK 416, Kalitur× PK 472, PK 515× Ankur) was close to low longevity parent suggesting dominance of low seed longevity over high longevity. The results of Green and Pinnell (1968 a) on normal seedlings at 5 days in laboratory germination test and those of Verma and Ram (1987) were in agreement with this finding. However, Green and Pinnell (1968 a) noted that the F_1 mean field emergence percentage equalled or exceeded those of the high parent in three of the six crosses. Similarly, Singh and Ram (1986) also reported dominance of high over low germinability in two crosses (bragg× T 49 and Kalitur× Alankar).

The germination percentage in F_2 generantion of Kalitur× PK 416, PK 515× Ankur segregated in a ratio of 15 low : 1 high and of Kalitur× PK 472 segregated in a ratio of 3 low : 1 high (Table l) supporting the dominance observed for low germination in the F_1 generation. The segregation pattern in F_2 generation indicated involvement of 2 recessive genes in Kalitur× PK 416 and PK 515× Ankur and one recessive gene in Kalitur× PK 472 for high longevity. On the F_3 bulk basis, the ratio of 55 low : 9 high longevity in Kalitur× PK 416 and PK 515× Ankur and 5 low: 3 high longevity in Kalitur× PK 472 were obtained confirming the segregation ratios detected in F_2 generation. These results was further confirmed by seeing the number of F_3 rows true breeding for high geed longevity where there was a good agreement between the observed and expected F_3 rows based on 90 – 100 F_3 rows/cross.

In conformity to these results, Lanyon (1970) proposed that emergence characteristics in soybean may be determined by one major gene and several modifiers. Singh and Ram (1986) reported the involvement of one major gene and Verma and Ram (1987) found the involvement of 2– 4 genes for germinability of soybean. Therefore, in view of our results and available information, it seeme that longevity in soybean is simply, qualitatively inherited trait conditioned by a few major genes. Therefore, it should be possible to improve longevity through hybridization followed by effective individual plant section. Since maternal plant influence is great (Kueneman, 1983; Singh and Ram, 1986, and Verma and Ram, 1987), the expression of segregation is dolayed one generation consequently, selection for seed longevity should be practiced on F_3 seeds (F_2 generation).

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大豆种子寿命的遗传

摘　　要

大豆种子的储存寿命较短,在潮湿、酷热的环境里更是如此。然而,已经筛选出几个种子寿命较长的品种。本研究旨在了解大豆种子寿命(或耐贮性)的遗传,以便通过育种程序来改良该性状。

组合 Kalitur× PK416、Kalitur× PK472和 PK515× Ankur的亲本、F_1、F_2和 F_3代的种子在自然条件下贮藏 8个月后进行寿命鉴定。在所用的几个亲本中,Kalitur和 Ankur的耐贮性优于 PK416、PK472和 PK515。从 F_1植株上收获的种子(F_2种子)的鉴定结果表明不耐贮为显性。F_2代的分离模式在 Kalitur× PK472组合中为 3∶1,在 Kalitur× PK416和 PK515× Ankar组合中为 15∶1(不耐贮∶耐贮),表明该性状分别由 1对和 2对主基因控制。这个分离比率被相应组合的 F_3代大群体的比率(5∶3和 55∶9)所证实也被育种实践所证实,因为在每个组合中,F_3代出现稳定的隐性(耐贮)表现型株行出现数量与每组合的理论值一致。

关键词　大豆;种子寿命;耐贮性