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Seed quality variation in relation to pod and seed position on the mother plant of soybean [*Glycine max.* (L.) Merrill] seed lot

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ABSTRACT

Heterogeneity in seed quality due to pod position on the mother plant and ovule position within the pod were studied as a possible plant components contributing to variation in respected quality of seeds within lots of soybean [Glycine max. (L.) Merrill] cultivar PRS-1. Plants were grown in two consecutive years at 2100 m ASL under mid hills of Uttarakhand during kharif, 2008 and 2009. The seed quality and subsequent seedling vigour were assessed with in plant for different stem type and pod section. The heaviest seeds were produced on main stem position on the mother plant where the earliest pods were formed whereas within the pod distal position has greater seed weight. Seed germination per cent was greatly influenced by different stem type and seed position within the pod on the mother plant and significantly higher germination per cent was recorded for main stem type over primary and secondary branches while seed attached to distal end within the pod had greater germination per cent over middle and proximal location under pod section. The subsequent seed and seedling vigour in terms of seedling length, fresh and dry weight of seeding, vigour index, relative growth index (RGI) and early germination as indicated by lower value of mean germination time (MGT) and time to 50% germination (T_{50}) as well as electrical conductivity of seed leactates varied in different stem type and pod section. On the basis of these parameters, the seeds obtained from main stem exhibited greater vigour over primary and secondary branches respectively. However, in pod section the seed attached to distal end with in the pod reflected higher seedling vigour than middle and proximal end of the pod section. The results suggest that the seeds produced with in a plant even within pod might differ in their vigour.

Key words: Seed lot, seed quality, soybean, stem and ovule position and variation

A considerable degree of heterogeneity in seed quality is regularly observed within and between soybean seed lots. The heterogeneity with in a seed lot has been arising mainly from variations between and within mother plants in the crop producing the seeds. Pod and seed position on the mother plant is one of the components of within plant heterogeneity that may account for part of the heterogeneity in physical or physiological seed attributes. The top main stem seeds were heavier than seeds from bottom main stem or branches and performed better in conductivity and germination tests (Ramseur *et al.*, 1984). Thus position of the pod affects seed quality attributes both directly and indirectly through its association with time to pod set. Differences in seed maturity or in time left for seed ageing on the mother plant and position of seed in the pod may be responsible for variation in physiological seed attributes. Seed maturity is an important factor explaining seed position effects but little is known about the relations between the duration of pod growth, development, maturation and ageing and physiological seed quality attributes for individual seeds (Keigley and Mullen, 1986). External conditions around the pod i.e. light, temperature and relative humidity and internal factors *i.e.* local sink-source relation may contribute to response on physiological seed attributes. Here we hypothesize that both the variation in time of individual pod growth, development, maturation and ageing until harvest and the pod and seed position on the mother plant significantly contribute to the heterogeneity in physical and physiological quality attributes of seeds harvested from a soybean crop.

Therefore, the present study was carried out with the main aim to examine the response for pod position at different stem on the mother plants and seed position within the pod and physical or physiological quality attributes of individual seeds harvested from soybean crops.

MATERIALS AND METHODS

Soybean seed variety PRS-1 was used in the present study and experiment was conducted at GBPUA&T, Hill Campus, Ranichauri during Kharif season 2008. The seeds were sown in field with three replications and each replication had 24 rows of 3 meters length with 40 x 10 cm of plant geometry. Standard cultural practices were adopted to raise normal healthy crop. Twenty four plants were randomly selected from each replications (*i.e.* one plant in each row) for the pod and seed position on the mother plant used for each classification of seed i.e. stem type and pod section.

For stem type, plants were divided into three groups i.e. main stem, primary and secondary branch.

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However, for position of seed from pods, three seeded well matured robust pods were selected. The first, second and third seed from attachment side was considered as proximal, middle and distal position respectively. The individual pods were thrashed manually and seeds were subjected to laboratory test for assessment of germination, seedling vigour and other seed quality parameters from completely randomized block design (CRD) in experiment. 100-seed weight was noted down by random sampling with three replications for each treatment with the help on an electronic balance. Under laboratory, 100 seeds of three replications for each treatment were used for germination test. The seeds were kept in between paper (BP method) and then placed in seed germinator at 25^{0}C. After 192 hours of incubation, seed which produced normal seedlings were considered as germination percentage. After the germination count, 20 normal seedlings from every replication of each treatment were used to measure the seedling length (total length of hypocotyls + root), fresh and dry weight of seedlings (ISTA 1985). Seedling dry weight was measured after subjecting the samples in an hot air oven at 80^{0}C for 24 h. Vigour index I was computed as a product of germination and seedling length, however, vigour index II was worked out by multiplying germination per cent with seedling dry weight (Abdul- Baki and Anderson 1973).

To measure the electrical conductivity 5 g seeds were surface sterilized with 0.10 per cent mercuric chloride solution in three replications of each treatment. Seeds were then washed thoroughly with distilled water and soaked in 25 ml of distilled water for 24 h. The leachates were measured for electrical conductivity with the help of electrical conductivity (EC) meter at room temperature.

Other same tests of 100 seeds in three replications for each treatment were designated to asses the germination rate as indicated by mean germination time (MGT) and time to take 50% germination (T_{50}). For rate of germination, when the seed has begun to germinate, checked daily and counted from the test when they reach a predetermined size till the date of first germination of seed that were capable of producing normal seedling. Mean Germination Time (MGT) was calculated as: MGT = (n x d)/N

Where, n= number of seeds which germinated after each period of incubation in days 'D' and N= Total number of seeds germinated at the end of the test period

$$\text{RGI} = \frac{\text{Number of seeds germinated at first count}}{\text{Number of seeds germinated at final count}} \times 100$$

(Hartmann *et al.*, 1989).

While the time to 50% germination (T_{50}) was calculated to the following formula of (Coolbear *et al.*, 1984) and modified by (Farooq *et al.*,2005) as under:

$$T_{50} = \mathrm{t_i} + \frac{[N/2 - n_i]}{N_j - \mathrm{n_i}}$$

where 'N' is the final number of germination and n_i and n_j are cumulative number of seeds germinated by adjacent counts at times t_i and t_j when $n_i < n/2 < n_j$

While critically analyzing Maguire's germination rate index (Brown and Mayer 1986) suggested total germination at two separate times i.e. at the end of the experiment (final count) and at some other relevant time such as (first count) to be more informative. To compare the treatments, however, it is necessary to have a single index. Therefore, following formula were used to estimate the rate of germination (RG) index.

The observations for soybean seed quality with respect to different physical and physiological attributes used for statistical difference between the treatments variance analysis and least significant difference (LSD) at P =0.05 tests by following the methods of Snedecor and Cochran (1989)

RESULTS AND DISCUSSION

Stem type

Heterogeneity in seed quality from pod position in different stem type on the mother plant is depicted in table 1. The seed produced from different stem type i.e. main stem, primary branch and secondary branch statistically differed from each other in 100-seed weight and the highest value (13.95 g) was obtained from seed obtained from main stem followed by primary branch (12.72 g), while least 100-seed weight (12.32 g) was noted for seed obtained from secondary branch. These findings were also supported by Illipronti *et al.*, (2000). The seed germination and seedling length also varied with pod position in stem type on mother plant and results showed that seed produced from the main stem pod had significantly higher germination (86.00%) at par with primary branches (84.50%), while least germination (82.50%) was recorded for seed produced from secondary branches. However, significantly greater seedling length (32.95 cm) were recorded also from main stem attached pod's seed and least seedling length (30.67 cm) had noticed from seed produced from secondary branches. In terms of biomass production, as indicated by fresh and dry weight of seedling, main stem seeds produced more fresh and dry weight (16.25 and 1.90 g) over primary (15.40 and 1.77 g) and secondary branches (14.45 and 1.47 g) respectively. Vigour index is a mirror that images the quality spectrum of a particular seed/

seed lot by multiplying criteria and maximum vigour index I and II (2833.85 and 163.45) respectively were calculated also for main stem seeds, results were at par (2730.97 and 152.29) with primary branches seeds, while significantly lowest value (2637.62 and 126.63) were calculated for seed produced from pod attached to secondary branches of the mother plant respectively for both the vigour index.

Deterioration in seed is judged by the electric current of the seed leachates and seed vigour is inversely proportional to the electrical conductivity and seed obtained in respective of main stem, primary branch and secondary branch differed from each other and found significantly maximum (2.44 mmhos.cm^{-2}) electric conductivity for secondary branches and lowest (1.58 mmhos.cm^{-2}) for main stem seeds. While, electric conductivity of seed leachets of primary branch was 2.10 mmhos.cm^{-2}.

A faster germination rate will facilitate early seedling establishment, a clear advantage in soybean crop. Germination rate index in terms of relative growth index (RGI) was significantly higher in seed produced from main stem (69.37), results at par with seed produced from primary branch (69.02), while minimum RGI value (65.97) was recorded from seeds obtained from secondary branch.

The response of seed quality as earlier germination to the pod position on the mother plant for soybean was recorded as indicated by lower values of mean germination time (MGT) and time to 50 per cent germination (T_{50}). A significant (LSD<0.05) effect of pod position was seen on the MGT and T_{50}. A significantly earlier and more uniform germination and emergence were observed in seeds produced from main stem as indicated by lesser MGT (4.40 days) and T_{50} (3.92 days) and result did not differ in T_{50} (4.05 days) for primary branch seeds while higher MGT (5.26 days) and T_{50} (4.42 days) were recorded for seed produced from secondary branches (Table- 1). The larger weight and quality of seed in main stem might be directly associated with significant amounts of assimilates translocated downwards in the plants during the pod filling period (Blomquist and Kust, 1971) and indirectly with main stem seeds being more frequent in higher main stem sections.

Pod Section

Differentiation in seed quality by means of attachment position of seed with in the pod is shown in Table 2. Seed produced in the proximal section of the pods were lighter and smaller than seeds produced in the middle and distal section. This was found when positions were compared with in pods containing three seeds.

With regards to 100-seeds weight each pod section seeds varied significantly and maximum (14.97 g) was found for seed produced from distal end, while minimum (14.15 g) was noted for proximal section of pod. The observation that the heavier and larger seeds in a seed lot of soybean originated from more distal position in a pod are in accordance with results of Egli *et al.* (1978) on position in the pod. The maximum seed germination (87.00%) was recorded also for distal position seed of pod section while minimum (82.75%) was noted for seed attached to proximal position of pod section, whereas the result of middle section did not significantly vary with proximal or either distal section. However, length of normal seedlings significantly varied with each seed lot originates from different pod section and more length (32.92 cm) was measured for distal section followed by middle (31.87 cm), whereas minimum length (30.60 cm) was observed for proximal section. The total seedling biomass as indicated by fresh and dry weight of seedling investigated for seeds at different position in 3-seeded soybean pods showed that middle and proximal seeds were similar, but inferior to the distal seeds (Table 2). However, vigour parameter as vigour index-I explained significant differences for every three pod sections seed and greater value (2863.92) was recorded for distal section than the proximal (2532.46). Whereas, in vigour index II seed produced from proximal as well as middle section of pod were similar but inferior to distal section (Table 2). The physiological attributes of seed vigour in terms of leachate electrical conductivity also stratified the seed lot obtained from different pod section and least electrical, conductivity (1.62 mmhose/cm^2) reflected as most vigorous lot was noted for seed attached to distal position in the pod followed by middle (2.14 mmhose/cm^2) whereas highest reading (2.45 mmhose/cm^2) was observed for proximal sections that indicated lesser in seed quality. Seed investigated at different position in 3-seeded pods exhibited that the middle and distal seeds were similar (69.05 and 69.72), but superior to the proximal seeds (65.67) in RGI, express the power to faster germination and germination spread over the time (Table 2).

Table 1: Soybean seed quality response to pod position in different stem type on the mother plant

Stem type	Quality parameter										
	100-seed weight (g)	Germination (%)	Seedling length (cm)	Fresh weight of seedlings (g)	Dry weight of seedling (g)	Vigour index I	Vigour index II	Electrical conductivity mmhos.cm^{-2}	RGI	MGT (days)	T_{50} (days)
Main Stem	13.95	86.00	32.95	16.25	1.90	2833.85	163.45	1.58	69.37	4.40	3.92
Primary branch	12.72	84.50	31.75	15.40	1.77	2730.97	152.29	2.10	69.02	4.69	4.05
Secondary branch	12.32	82.50	30.67	14.45	1.47	2637.62	126.63	2.44	65.97	5.26	4.42
GM	13.00	84.33	31.79	15.36	1.71	2734.15	147.46	2.04	68.12	4.78	4.13
SEm (±)	**0.10**	**0.85**	**0.21**	**0.16**	**0.04**	**34.16**	**5.22**	**0.04**	**0.67**	**0.07**	**0.06**
LSD(0.05)	**0.34**	**2.71**	**0.70**	**0.52**	**0.12**	**109.26**	**13.75**	**0.12**	**2.16**	**0.24**	**0.18**
CV(%)	**1.67**	**2.01**	**1.37**	**2.12**	**4.67**	**2.49**	**7.51**	**3.92**	**1.99**	**3.20**	**2.83**

Table 2: Soybean seed quality response to seed position under different pod section on the mother plant

Pod Section	Quality parameter										
	100-seed weight (g)	Germination (%)	Seedling length (cm)	Fresh weight of seedlings (g)	Dry weight of seedling (g)	Vigour index I	Vigour index II	Electrical conductivity mmhos.cm^{-2}	RGI	MGT (days)	T_{50} (days)
Proximal	14.15	82.75	30.60	14.95	1.47	2532.46	121.95	2.45	65.67	5.18	4.42
Middle	14.65	84.50	31.87	15.10	1.59	2693.32	134.52	2.14	69.05	4.71	4.10
Distal	14.97	87.00	32.92	15.87	1.95	2863.92	169.52	1.62	69.72	4.40	3.85
GM	14.59	84.75	31.79	15.30	1.67	2696.57	142.00	2.07	68.15	4.76	4.12
SEm (±)	0.09	0.96	0.13	0.10	0.06	33.85	5.14	0.03	0.46	0.08	0.07
LSD(0.05)	0.28	3.09	0.43	0.31	0.19	107.14	16.45	0.11	1.47	0.25	0.21
CV(%)	1.22	2.28	0.85	1.30	7.29	2.56	7.24	3.34	1.35	3.36	3.20

All components of plant variation together (Stem section, stem type and pod section) explained heterogeneity in soybean seed lot. Variation in physical and physiological seed attributes within a soybean seed lot have also been demonstrated by Illipronti *et al.* (1997).

However, heterogeneity in soybean seed lot for seed vigour differences resulting from different pod position and ovule position with in the pod on the mother plant did not show exact linear differences for each and every parameter of seed vigour among different position. The result generated from the present experiment provides some evidence that difference in seed vigour with in the soybean seed lot is associated with pod position and ovule position with in the pod on the mother plant.

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