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Effect of sowing dates and season on physical seed quality of soybean

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Abstract
The present investigation was undertaken for analyzing the effect of different season and sowing dates on physical seed quality of soybean. Soybean was sown in three season viz. *Kharif*, *Rabi* and summer. The four sowing dates in each season were used as main treatments whereas varieties Phule Agrani (V_1), JS-335 (V_2) and KS-103 (V_3) were used as sub treatments. The present investigation was carried out at Post Graduate Institute, Department of Agricultural Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (M.S.) during 2015-2016.
In the experiment, observations *viz.* seed diameter, area of seed, seed perimeter, length of seed and width of seed were recorded. Results revealed that all the characters were significantly affected by sowing dates, varieties and their interaction effect in *Kharif*, *Rabi* and summer season. The highest values for physical seed quality characters in *Kharif* were recorded in the crop sown on June 1st followed by 15th January in summer and 15th October in *Rabi* season. Variety JS-335 (V_2) had higher physical seed quality in all the three season, irrespective of variety. The most optimum off season date of planting of soybean was January 15th in summer and October 15th in *Rabi* season.

Keywords: Sowing dates, season, seed quality, off-season, soybean

Introduction
Soybean (*Glycine max.* (L.) Merrill) is one of the important pulse and oilseed crop of the world. It has become miracle crop of the twentieth century and designated as "Golden Bean". Soybean seed contains 40-45% protein, 20-22% oil, 20-26% carbohydrate and a high amount of Ca, P and vitamins (Rahman *et al.*, 2011). Soybean *(Glycine max Merrill)* grows in tropical, subtropical and temperate climate where climatic factors such as temperature, photoperiod and moisture stress, exerts a detrimental effect on plant growth and metabolism. In fact crop performance is strongly influenced by weather conditions. The seed yield and seed size of soybean decrease with delay in sowing dates (Adjei and Splittstoesser, 1994) [1]. The variations in seed growth rate depend on the growing conditions during the period between flowering and the beginning of seed filling (Munier and Ney, 1998) [5]. Khalil *et al*. (2001) [4]. Reported that soybean seeds from January, February and March planted crop produced heavier seeds while seeds from the July and August planted crops produced smaller seeds. As the seed quality of Soybean is highly influenced by environmental conditions, the present investigation was undertaken with the main objective to study the effect of season and sowing dates on physical seed quality of Soybean.

Material and Methods
The experimental materials were consisting of three varieties i.e. Phule Agrani (V_1), JS-335 (V_2) and KS-103 (V_3). The experiment was carried out in three season viz. *Kharif* 2015, *Rabi* 2015-2016 and *Summer* 2016 with four sowing dates in each season at Post Graduate Institute farm, Department of Agricultural Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri. The sowing dates *viz.* 1st June, 15th June, 30th June and 15th July in *Kharif* season of the year 2015, 1st October, 15th October, 30th October and 15th November in Rabi season of year 2015-2016 and 1st January, 15th January, 30th January and 15th February in summer season of the year 2016 were used as main treatments whereas, varieties Phule Agrani (V_1), JS-335 (V_2) and KS-103 (V_3) were used as sub treatments. The seeds harvested from each treatment were collected and were analyzed which was done using DeltaT (c) image analysis system by running custom written software "win DIAS". In this mechanical method, seeds are viewed with video camera using transmitted light, so that a binary image of the seed is recorded by the win DIAS. The image of the support is removed by software after image grabbing in the computer that leaves an image of the object consist of five rows and five columns for geometric data measurement. For each treatment, three replications of 20 seeds were taken for measurement.

The data were recorded for characters [*viz.* Seed diameter (mm), Area of seed (mm^2), Seed perimeter (mm), length of seed (mm) and width of seed (mm).]. Analysis was done using Factorial completely Randomized Design (Panse and Sukhatme, 1978) [6].

Results and Discussion

The analysis of variance for all the characters recorded showed that the variance due to the Sowing dates, Varieties and interaction of sowing dates and varieties was found significant.

Among the seeds harvested from *Kharif* season, the highest seed diameter (5.732 mm), area of seed (36.98 mm^2), seed perimeter (29.54 mm), length of seed (7.215 mm) and width of seed (5.853 mm) was observed for sowing date of 1st June, irrespective of varieties whereas irrespective of sowing dates, variety JS-335 (V_2) recorded the highest seed diameter (5.768 mm), area of seed (37.75 mm^2), seed perimeter (28.96 mm), length of seed (7.40 mm) and width of seed (5.827 mm). The highest seed diameter (5.904 mm), area of seed (38.73 mm^2), seed perimeter (30.26 mm), length of seed (7.523 mm) and width of seed (5.99 mm) from interaction of sowing date and varieties was recorded at 1st June sowing for variety JS-335 i.e. S_1V_2. (Table 1).

Among the seeds harvested from *Rabi* season, the highest seed diameter (5.034 mm), area of seed (30.60 mm^2), seed perimeter (25.39 mm), length of seed (6.388 mm) and width of seed (5.145 mm) was observed for sowing date of 15th October, irrespective of varieties whereas irrespective of sowing dates, variety JS-335 (V_2) recorded the highest seed diameter (4.951 mm), area of seed (30.51 mm^2), seed perimeter (25.11 mm), length of seed (6.178 mm) and width of seed (5.254 mm). The highest seed diameter (5.259 mm), area of seed (32.40 mm^2), seed perimeter (26.22 mm), length of seed (6.54 mm) and width of seed (5.427 mm) from interaction of sowing date and varieties was recorded at 15th October sowing for variety JS-335 i.e. S_2V_2. (Table 1).

For the seeds harvested from *summer* season, the highest seed diameter (5.42 mm), area of seed (33.71 mm^2), seed perimeter (27.33 mm), length of seed (6.711 mm) and width of seed (5.601 mm) was observed for sowing date of 15th January, irrespective of varieties whereas irrespective of sowing dates, variety JS-335 (V_2) recorded the highest seed diameter (5.256 mm), area of seed (32.13 mm^2), seed perimeter (25.91 mm), length of seed (6.585 mm) and width of seed (5.384 mm). The highest seed diameter (5.566 mm), area of seed (34.51 mm^2), seed perimeter (28.21 mm), length of seed (6.83 mm) and width of seed (5.728 mm) from interaction of sowing date and varieties was recorded at 15th January sowing for variety JS-335 i.e. S_2V_2. (Table 1). The lowest physical seed quality characters were recorded for the last sowing dates i.e. 15th July, 15th November and 15th February in *Kharif*, *Rabi* and summer season, respectively.

In the present investigation, it was observed that the physical seed quality characters were highest in *kharif* season followed by summer season whereas the lowest values were recorded for *Rabi* season.

Reduction in seed size with delayed planting dates might be due to higher temperatures during reproductive growth stages and shortened time for seed to develop fully before maturity resulting in a decrease in seed size of soybean (Duthion and Pigeaire, 1991) [3]. Moreover, high temperature stress during reproductive development may negatively affect the cell expansion, cotyledon cell number and thus seed filling rate, resulting in reduced seed size (Munier and Ney, 1998) [5]. Seeds have a highly regulated capacity to achieve a uniform size but high temperature stress imposed during the mid-reproductive stage prevented seed filling capacity to full potential size (Duthion and Pigeaire, 1991) [3]. These results are in accordance with the findings of Ball *et al.* (2000) [2]. And Khalil *et al.* (2001) [4]. Who reported that early sowings produced bold seeds and delayed sowings produced smaller seeds.

On the basis of above study, it is concluded that early sowings in all the three season viz. *Kharif*, *Rabi* and summer produced the larger seeds which ultimately resulted in higher yield whereas the seeds harvested from delayed sowing dates produced smaller seeds. Among the seasons, seeds harvested from *Kharif* season produced seeds with higher seed size compared to seeds produced in off season i.e. *Rabi* and summer.

Table 1: Effect of sowing dates (S), varieties (V) and their interactions (S×V) on physical seed quality of soybean

Treatments	Seed diameter (mm)			Area of seed (mm^2)			Seed perimeter (mm)			Length of seed (mm)			Width of seed (mm)		
Sowing dates	***Kharif***	***Rabi***	***Summer***	***Kharif***	***Rabi***	***Summer***	***Kharif***	***Rabi***	***Summer***	***Kharif***	***Rabi***	***Summer***	***Kharif***	***Rabi***	***Summer***
S_1	5.732	4.803	5.241	36.98	29.90	31.66	29.54	25.09	25.72	7.215	6.106	6.587	5.853	4.995	5.362
S_2	5.616	5.034	5.420	36.08	30.60	33.71	28.96	25.39	27.33	7.177	6.388	6.711	5.715	5.145	5.601
S_3	5.524	4.605	5.177	35.59	28.79	30.81	27.94	24.05	25.29	6.990	5.869	6.446	5.618	4.959	5.263
S_4	5.418	4.520	4.598	34.74	24.93	26.67	27.05	22.60	23.49	6.848	5.614	5.776	5.525	4.873	4.671
SE (m) ±	0.019	0.009	0.009	0.132	0.217	0.255	0.089	0.104	0.100	0.023	0.019	0.020	0.020	0.018	0.018
CD at 5%	0.054	0.026	0.025	0.387	0.633	0.743	0.261	0.304	0.293	0.066	0.055	0.057	0.059	0.054	0.051
Variety															
V_1 (Phule Agrani)	5.282	4.509	4.941	32.64	26.03	28.90	27.68	23.36	24.99	6.633	5.751	6.172	5.414	4.715	5.059
V_2 (JS-335)	5.768	4.951	5.256	37.75	30.51	32.13	28.96	25.11	25.91	7.400	6.178	6.585	5.827	5.254	5.384
V_3 (KS-103)	5.667	4.763	5.130	37.15	29.12	31.11	28.48	24.38	25.49	7.139	6.054	6.382	5.792	5.009	5.229
SE (m) ±	0.016	0.008	0.008	0.115	0.188	0.221	0.077	0.090	0.087	0.019	0.016	0.017	0.017	0.016	0.015
CD at 5%	0.047	0.023	0.022	0.335	0.548	0.644	0.226	0.263	0.254	0.057	0.048	0.049	0.051	0.046	0.044
S x V Interaction															
S_1V_1	5.446	4.545	5.080	33.51	26.99	28.89	28.90	23.91	25.60	6.756	5.849	6.367	5.619	4.730	5.128
S_1V_2	5.904	4.967	5.397	38.73	31.71	33.56	30.26	26.13	25.79	7.523	6.240	6.792	5.990	5.215	5.592
S_1V_3	5.846	4.897	5.245	38.70	31.00	32.51	29.45	25.25	25.77	7.366	6.230	6.602	5.950	5.038	5.366
S_2V_1	5.337	4.705	5.239	32.82	27.51	32.86	28.15	24.57	26.40	6.750	6.090	6.513	5.489	4.814	5.459
S_2V_2	5.760	5.259	5.566	37.91	32.40	34.51	29.75	26.22	28.21	7.420	6.540	6.830	5.826	5.427	5.728
S_2V_3	5.750	5.139	5.454	37.51	31.90	33.75	28.98	25.38	27.39	7.360	6.534	6.790	5.830	5.194	5.615
S_3V_1	5.284	4.459	5.001	32.37	26.01	28.41	27.48	22.89	25.00	6.672	5.699	6.221	5.386	4.659	5.083
S_3V_2	5.739	4.887	5.351	37.97	31.85	32.93	28.32	25.21	25.48	7.364	6.138	6.758	5.769	5.222	5.442

S_3V_3	5.549	4.469	5.180	36.42	28.53	31.10	28.02	24.05	25.40	6.933	5.769	6.358	5.700	4.996	5.265
S_4V_1	5.060	4.326	4.444	31.86	23.63	25.43	26.17	22.07	22.94	6.354	5.367	5.589	5.162	4.656	4.566
S_4V_2	5.671	4.690	4.710	36.39	26.07	27.50	27.51	22.89	24.15	7.293	5.792	5.960	5.724	5.154	4.775
S_4V_3	5.524	4.545	4.640	35.96	25.08	27.09	27.48	22.83	23.40	6.896	5.681	5.780	5.689	4.809	4.670
SE (m) ±	0.032	0.016	0.015	0.229	0.375	0.441	0.155	0.180	0.174	0.039	0.033	0.034	0.035	0.032	0.030
CD at 5%	0.094	0.045	0.044	0.670	1.096	1.288	0.452	0.526	0.507	0.114	0.096	0.099	0.102	0.093	0.089
General mean	5.572	4.741	5.109	35.85	28.56	30.71	28.37	24.28	25.46	7.057	5.994	6.380	5.678	4.993	5.224

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