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EFFECT OF SEED SIZE ON YIELD CONTRIBUTING AND QUALITY TRAITS IN SOYBEAN

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ABSTRACT

The present investigation was carried out with an aim to identify proper seed size in soybean to obtain high seed quality in relation to seed germination and seedling vigour components, as well as to improve seed quality characters. The seed of four soybean genotypes with four different seed sizes of each genotype with total 16 treatment combinations were grown in the field and harvested at physiological maturity and were tested for yield and yield contributing traits, seed and biochemical traits and laboratory traits. The average performance of all the four genotypes viz., MAUS 71, MAUS 81, MAUS 158 and JS 335 in respect of seed quality parameters was found better as per seed certification standards. However, genotype MUAS 158 performed better than all other genotypes. Germination percentage, vigour index, seed yield, test weight and seedling fresh and dry weight as well as root and shoot length decrease with reduced seed size. Oil content showed negative correlation with protein content while protein content showed positive correlation with germination. It was advised to use bold and medium sized seed for sowing of soybean to increase average productivity of soybean and good germination under field conditions.

Key words : *Seed quality, seed size, soybean, yield, correlation.*

Soybean (*Glycine max* (L). Merril) is an oleagi-nous legume of short cycle that grows on tropical, subtropical and temperate regions (1). Taxonomically, soybean belongs to the genus *Glycine* which is divided into two subgenera, *Glycine* and *Soja*. The cultivated soybean, *G. max* (L.) Merril (2n=40) comes under the subgenus *Soja* (Moench). Soybean (*Glycine max* (L.) Merrill.) is aptly called as "Golden Bean" or "Miracle Crop" of the 20th century and is one of the most important oilseed crop in the world (2). Soybean has been now established as oilseed as well as pulse crop and emerged as cheapest alternate source of high quality protein food and edible oil. Soybean has the highest protein content (30-45%) of all food crops and also contains a considerable oil content (15-24%) comprising high percent of unsaturated fatty acids (3). Soybean is now cultivated throughout east and South East Asia where people depend on it for food, animal feed and medicine (4). In India, the area and production of soybean has extensively increased. Unfortunately, there has been no significant increase in the productivity. As compared to the productivity of United States of America, Brazil, Argentina and China, India's productivity is still very low.

Seed size has been recognized as one of the factors that influence seed vigour, plant growth and ultimately yield of soybean (5). It has been reported that seed size correlates with seed vigor and that large seeds tend to produce more vigorous seedlings and better stand (6). There have been immense studies on seed size in various plant species (7) and some field trials have shown that plants from large seeds had significantly greater yield than those from small seeds (5). Huge losses of seed has been observed during seed processing mostly consisting of small/undersized seed (approximately 10 to 15 %). These processing losses can be prevented by retaining such type of small/under sized seeds during processing, if their effect on germination and productivity were properly studied, but such type of studies are still lacking in case of soybean.

Therefore, the present investigation was undertaken with an objective to study the effect of different seed sizes on yield and seed quality traits in soybean and to study the relationship between seed protein, oil and germination percentage in soybean.

MATERIALS AND METHODS

The experimental material consisted four genotypes *viz.* MAUS 71, MAUS 81, MAUS 158 and JS 335 which were obtained from All India Coordinated Research Project on Soybean, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was conducted at experimental farm of All India Coordinated Research Project on Soybean, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during, *kharif*, 2010 in two replications with Factorial Randomized Block Design (FRBD). The seeds of each genotype were further divided into four different grades of seed sizes *i.e.* small (100 seed wt. less than 9 g), medium (100 seed wt. 9-11 g), bold (100 seed wt. more than 11 g) and ungraded (without grading). All the 16 combinations of genotypes and seed sizes were sown in separate plots having 8 rows of each genotype spaced at 45 cm x 5 cm. All the recommended cultural practices and plant protection measures were followed during the crop growth period.

The harvesting and sampling was done at physiological maturity (90-95% leaves drop) separately.

The seed samples obtained from sixteen treatment combinations were used for recording of observations on morphological traits *viz.,* days to 50 per cent flowering, days to maturity, plant height (cm) and number of branches per plant; yield and yield contributing traits *viz.,* number of pods per plant, seed yield per plant and test weight (g); seed and biochemical traits *viz.,* seed moisture at harvest (%), processing recovery(%), oil content (%), protein content (%) and laboratory traits *viz.,* seed germination (%), root length (cm), shoot length (cm), seedling fresh weight (g), seedling dry weight (g) and vigor index. Data obtained was analyzed following Factorial Randomized Block Design (Panse and Sukhatme, 1967). Correlation coefficient and path coefficient analysis were analyzed as per method suggested by (8).

RESULTS AND DISCUSSION

Seed size was one of essential components which affects the soybean performance and productivity (9) and Large-sized soybean seeds is desirable trait in tempeh industry to fulfill the community's preference (10). In the present investigation the impact of different seed sizes on plant morphological, yield, seed biochemical and laboratory traits were studied. The results so obtained are briefly discussed under suitable headings.

Morphological traits : Days to 50% flowering differed in different genotypes (Table-1). The genotype JS 335 (35.17 days) exhibited lowest value for days to 50% flowering, whereas MAUS 81 (36.98 days) exhibited highest value for days to 50 % flowering. Days to maturity, plant height and number of branches per plant also showed significant differences among different genotypes. The genotype MAUS 71 (92.98 days) matured earlier than all other genotypes. Highest plant height and number of branches per plant was exhibited by genotype MAUS 158 *i. e.* 52.77 cm and 7.06, respectively. These findings are in agreement with those reported by (11) for plant morphological traits among the varieties.

Progeny obtained from bold seed size expressed significantly lowest value for days to 50% flowering, whereas progeny obtained from small seed size depicted significantly lowest value for days to maturity. Progeny obtained from bold seed size recorded highest plant height (54.93 cm) and number of branches per plant (6.92) than all other seed grades. Whitehead *et al.*, (1980) reported that bold seed size produced more plant height and number of branches per plant.

Yield and yield contributing traits : All the three yields and yield contributing traits differed significantly in different genotypes (Table 1). The genotype MAUS 158 exhibited highest number of pods per plant (46.04) than all the other genotypes. Seed yield per plant was also observed higher in genotype MAUS 158 (21.98 gm). The genotype MAUS 158 with bold size recorded highest number of pods per plant (50.63) and seed yield per plant (25.79 gm). Similar results were reported by (12) in Soybean. (5) observed that when populations were similar, higher yields were obtained from plants originating from large seeds.

Significant differences were observed in different genotypes in respect of test weight. Highest test weight was recorded by bold seed size (15.46 gm). The genotype MAUS 158 with bold seed size depicted significant superiority for all yield contributing traits over rest of the interactions. These results are in agreement with those reported by (13).

Seed and biochemical traits : The seed moisture percentage at harvest did not differ significantly among different varieties. However processing recovery (%), protein content (%) and oil content (%) differed significantly in different genotypes (Table-2).

The genotype MAUS 158 (40.42%) exhibited maximum protein content than all other genotypes, whereas, MAUS 71 (19.63%) recorded highest oil content and processing recovery (96.12%) than all other genotypes. There was variation in oil content in different genotypes due to genetic constitution of the genotypes. The variation in oil (17.3 to 34.3) and protein content (34.6 to 43.9%) in different genotype was also been reported by (14).

The protein and oil content changes in the seeds when they are graded based on seed size. Highest protein content (40.52%) and processing recovery (96.09%) was observed in medium seed size (40.52%). Whereas, highest oil content was observed in bold seed size (19.76 %) while, it was lowest in ungraded seed size (19.35%).

Laboratory traits : Seed germination and seedling vigour components are the major aspects deciding higher productivity because plant population depends upon healthy and vigorous growth of seedling which is possible mainly by the use of better quality seeds for the sowing purpose. In the present study, it was observed that germination; vigour index, shoot length, root length, seedling fresh weight and seedling dry weight differed significantly due to genotypes (Table 2). The genotypes JS 335 (92.13%) was superior in seed germination. However, all the four genotypes under study maintained seed germination over and above the minimum seed certification standard of above 70 per cent. The genotypes MAUS 158 and MAUS 81 recorded highest vigour index (around 18.50%). Highest root and shoot length was recorded by genotype MAUS 81 *i.e.* 9.48 cm and 11.22 cm, respectively. Highest seedling fresh weight was recorded by genotype MAUS 158 (4.06 gm), whereas, highest seedling dry weight was recorded by

Table-1 : Morphological and yield contributing traits as influenced by genotypes and seed sizes.

Characters	Days to 50% flowering	Days to maturity	Plant Height (cm)	No. of branches Per plant	No. of pods per plant	Seed yield per plant (g)	Test weight (g)
Genotypes (G)							
MAUS 71	35.93	92.98	52.18	6.55	44.03	17.24	14.54
MUAS 81	36.98	95.52	51.89	6.69	43.60	18.14	13.55
MAUS 158	36.12	95.45	52.77	7.06	46.01	21.98	16.32
JS 335	35.17	95.47	52.73	6.09	42.19	17.43	13.05
SE +1	0.20	0.44	0.56	0.11	0.23	0.22	0.19
CD (P=0.05)	0.61	1.35	1.69	0.34	0.77	0.66	0.59
Seed Sizes (S)							
Small size	37.10	93.59	51.70	6.26	40.01	14.96	13.07
Medium size	36.00	95.02	54.17	6.80	43.00	18.04	14.43
Bold size	35.00	94.71	54.93	6.92	47.76	23.31	15.46
Ungraded size	36.10	96.10	48.76	6.40	44.91	18.47	14.50
SE +1	0.20	0.44	0.56	0.11	0.23	0.22	0.19
CD (P=0.05)	0.61	1.35	1.69	0.34	0.77	0.66	0.59
Interaction (GxS)							
SE +1	0.50	1.09	1.37	0.22	0.57	0.44	0.39
CD (P=0.05)	NS	NS	3.34	0.68	1.73	1.33	1.18

Table-2 : Seed, biochemical and Laboratory traits influenced by genotypes x seed sizes.

Characters	Seed moisture at harvest (%)	Processing recovery (%)	Protein content (%)	Oil content (%)	Germination (%)	Vigour Index (%)	Seedling fresh weight (g)	Root length (cm)	Shoot length (cm)
Genotypes (G)									
MAUS 71	29.57	96.12	40.04	19.63	90.92	18.10	3.99	9.21	11.06
MAUS 81	30.14	95.14	39.70	18.28	89.66	18.32	4.01	9.48	11.22
MAUS 158	30.29	95.45	40.42	19.51	91.39	18.55	4.06	9.09	10.98
JS 335	29.79	95.85	40.34	19.40	92.13	18.10	3.94	9.12	10.76
SE 1	0.14	0.30	0.13	0.068	1.11	0.10	0.02	0.09	0.09
CD (P=0.05)	NS	0.91	0.40	0.20	3.34	0.31	0.07	0.27	0.27
Seed sizes (S)									
Small size	30.12	95.48	39.81	19.59	91.00	17.60	3.90	8.73	10.99
Medium size	29.78	96.09	40.52	19.62	91.38	18.29	4.14	9.31	10.38
Bold size	29.83	95.58	40.18	19.76	92.28	19.27	4.08	9.74	11.55
Ungraded size	30.06	95.40	39.98	19.35	88.50	17.92	3.88	9.11	10.77
SE 1	0.14	0.30	0.13	0.068	1.11	0.10	0.02	0.09	0.09
CD (P=0.05)	NS	0.91	0.40	0.20	3.34	0.31	0.07	0.27	0.27
Interaction (G x S)									
SE 1	0.34	0.60	0.32	0.16	2.72	0.25	0.057	0.22	0.22
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

genotype JS 335 (0.44 gm) than rest of the treatments. Differences in total dry matter production due to genotypes have been reported by (15).

Seed germination found to be decreased with decrease in seed size. The germination, vigour index, root length and shoot length were found high in bold seed size as compared to other seed sizes. Whereas, higher seedling fresh weight and seedling dry weight were recorded in medium seed size, (92.28% germination, 19.27 vigour index, 9.74 cm root length and 11.55 cm shoot length)s. High seedling fresh weight 4.14 gm and seedling dry weight 0.44 gm were recorded in medium seed size. These findings are in agreement with (16), while (17) detected that the highest and the lowest amounts of seedling dry weight of soybean seeds were detected by medium and small seeds.

Table-3 : Correlation coefficient among different characters during various stages of seed harvest.

Characters	Seed moisture (%)	Processing recovery (%)	Oil content (%)	Protein content (%)	Test weight (g)	Seed yield per plant (g)	Germination (%)
Seed moisture (%)	1.000	-0.350*	-0.250	-0.234	0.093	0.045	-0.227
Processing recovery (%)		1.000	-0.178	0.117	0.170	0.093	0.240
Oil content (%)			1.000	-0.089	-0.152	-0.250	-0.039
Protein content (%)				1.000	0.329	0.255	0.354*
Test weight (g)					1.000	0.737**	0.141
Seed yield per plant (g)						1.000	0.084

** Significant at 1% (P=0.01) *Significant at 5% (P=0.01)

Table-4 : Path analysis showing direct (diagonal) and indirect (off diagonal) effect of different Characters on germinatiomn.

Characters	Seed moisture (%)	Processing recovery (%)	Oil content (%)	Protein content (%)	Test weight (g)	Seed yield per plant (g)	Germination (%)
Seed moisture (%)	-0.108	0.0378	0.0270	0.025	-0.010	-0.004	0.2269
Processing recovery (%)	-0.055	0.1585	-0.0283	0.018	0.027	0.014	0.2398
Oil content (%)	0.003	0.0027	-0.0152	0.001	0.002	0.003	-0.0395
Protein content (%)	-0.070	0.0353	-0.026	0.301	0.099	0.077	0.3538
Test weight (gm)	0.005	0.0105	-0.0093	0.020	0.061	0.045	0.1412
Seed yield per plant (gm)	-0.002	-0.0049	0.013	-0.0134	-0.038	-0.052	0.0836

It was further observed that the seed germination, vigour index, seedling fresh weight, seedling dry weight, root length and shoot length were significantly reduced with reduction in seed size. This may be due to lack of endospermic material available at the time of germination as well as initial seedling development period. Similar results were also reported by (18). The soybean seed attains maximum seed weight and full germination potential in bold seed size followed by medium than other seed sizes. These results were also reported by (19).

Correlation and path analysis : The germination percentage of seed being dependent upon its important components *viz.,* moisture content, processing recovery, oil content, protein content, test weight and seed yield per plant. A better picture of the contribution of reach component in building up total genetic architecture of complete character may be obtained through the study of correlation of components and their direct and indirect effect. In present investigation most of the components *viz.,* processing recovery, protein content, test weight and seed yield per plant were positively correlated with germination while, seed moisture and oil content were negatively correlated with germination (Table 3). Oil content was negatively correlated with all the characters, where as protein content, test weight and seed yield per plant were positively correlated with all other characters. Oil content showed negative correlation with protein content, while protein content showed positive correlation with germination. The present findings are agreement with the finding of (20). On the contrary, protein percentage showed negative association with seed oil percentage. Similar results were reported earlier by (21). Test weight was highly significant and positively correlated with seed yield per plant. Similar results were reported by (22).

The path coefficient analysis revealed that moisture content (-0.108) recorded negative correlation with germination percentage (Table-4). Oil content exerted highest negative direct effect on seed germination percentage. Protein content showed significant and positive direct effect on seed moisture, processing recovery, test weight and seed yield per plant whereas, positive direct effect on seed germination percentage.

From the present study it is advised to use bold (More than 11 gm per 100 seed weight) and medium (9 to 11 gm per 100 seed weight) size for sowing of soybean to increase average productivity of soybean and good germination under field conditions.

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