

## Effect of Pre-Sowing Seed Treatments on Seed Yield and Quality of Soybean [*Glycine max* (L) Merrill]

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**ABSTRACT:** An investigation was carried out in *kharif* 2021 to evaluate the effect of pre-sowing seed treatments on seed yield and quality of soybean. The experimental materials comprising two factors, varieties ( $V_1$ : GJS 3 and  $V_2$ : JS 335) and pre-sowing seed treatments ( $S_1$ : Control,  $S_2$ : Hydration-dehydration treatment with distilled water for 8 hrs,  $S_3$ : 1.5 %  $\text{CaCl}_2$  for 8 hrs. (15 ml/l),  $S_4$ : 2.0 %  $\text{KH}_2\text{PO}_4$  for 8 hrs. (20 ml/l),  $S_5$ : 1.0 %  $\text{KNO}_3$  for 8 hrs. (10 ml/l),  $S_6$ : 10 % PEG 6000 for 8 hrs. (100 ml/l),  $S_7$ : 10 % *Rhizobium japonicum* culture for 8 hrs. (100 ml/l),  $S_8$ : Seed coating with sweet flag rhizome powder @ 5 g/kg seed,  $S_9$ : Seed coating with cytozyme SDM powder @ 3 g/kg seed and  $S_{10}$ : Seed coating with neem kernel powder @ 5 g/kg seed) was carried out at Junagadh, Gujarat. The observations were recorded on seed yield per plant and its contributing traits in the field. Seed quality parameters were also measured in the laboratory conditions from the fresh seed harvested from filed experiment. Variety JS 335 showed it superiority over GJS 3 recorded higher field emergence, seed yield and its components with lower days to 50 per cent flowering, days to maturity, germination percentage, seedling length, seedling dry weight, seedling vigour index I and seedling vigour index II with low value of seed moisture content and electrical conductivity of seed leachates. Among pre-sowing seed treatments, seed coating with sweet flag rhizome powder @ 5g/kg seed recorded the maximum field emergence, seed yield and its components and quality parameters.

**Keywords:** Pre-sowing seed treatments, Seed coating, Seed quality, Soybean, Yield

### INTRODUCTION

Pre-sowing seed priming treatment offer a cost a cost effective and alternate approach to overcome the adverse effects of abiotic stresses during germination and early vegetative stage (1). Pre-sowing treatments are based on controlled seed hydration in solutions containing organic or inorganic solutes, followed by re-drying that allows pre-germination metabolic activities but prevents radical emergence (2). The primed/hardened treatments proved to be better for vigor improvement than traditional soaking (3). Pre-soaking seeds with optimal concentration of phyto-hormones enhances their germination and growth under stress condition by increasing nutrient reserves mobilization through increased physiological activities and root proliferation (1). Different pre-sowing seed treatments have successfully been integrated for vigor enhancement in soybean resulting in good germination and plant stand establishment in field, faster emergence, better and uniform plant stand, vigorous plant, earlier flowering and other advantages (1). Seed coating is also reported to improve seed handling, germination, plant stand increase the seedling

emergence and protect from diseases and pests in some cases.

The present study was conducted to evaluate effect of diverse type of pre-sowing seed treatments on seed germination and growth parameters of soybean [*Glycine max* (L) Merrill]"

### MATERIALS AND METHODS

The experiment was carried out in *kharif* 2021 at the Sagdividi Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh. The seeds of two soybean varieties ( $V_1$ : GJS 3 and  $V_2$ : JS 335) were treated/coated with different seed invigouration treatments ( $S_1$ : Control,  $S_2$ : Hydration-dehydration treatment with distilled water for 8 hrs,  $S_3$ : 1.5 %  $\text{CaCl}_2$  for 8 hrs. (15 ml/l),  $S_4$ : 2.0 %  $\text{KH}_2\text{PO}_4$  for 8 hrs. (20 ml/l),  $S_5$ : 1.0 %  $\text{KNO}_3$  for 8 hrs. (10 ml/l),  $S_6$ : 10 % PEG 6000 for 8 hrs. (100 ml/l),  $S_7$ : 10 % *Rhizobium japonicum* culture for 8 hrs. (100 ml/l),  $S_8$ : Seed coating with sweet flag rhizome powder @ 5 g/kg seed,  $S_9$ : Seed coating with cytozyme SDM powder @ 3 g/kg seed and  $S_{10}$ : Seed coating with neem kernel powder

@ 5 g/kg seed) were evaluated following Randomized Block Design (Factorial) replicated three times. For seed coating, 5 per cent arabic gum was used as an adhesive. The field observations viz., field emergence (%), days to 50 per cent flowering, days to maturity, plant height (cm), plant stand at maturity, number of clusters per plant, number of pods per plant, number of pods per cluster, number of seeds per pod, number of seeds per plant, biological yield per plant (g), seed yield per plant (g) and harvest index (%) were recorded and analyzed using Randomized Block Design (Factorial) as per the method suggested by Cochran and Cox (4). Seed quality parameters (seed moisture content (%), electrical conductivity of seed leachates (dS/m), germination percentage (%), seedling length (cm), seedling dry weight (mg), seedling vigour index - I, seedling vigour index - II and test weight (g)) were also measured in the laboratory conditions from the fresh seed harvested from filed experiment as per the treatment combinations following Completely Randomized Design (Factorial) (2.4 X 1.8 m) (60 plants/plot) as per the method suggested by Cochran and Cox (4).

## RESULTS AND DISCUSSION

Irrespective of pre-sowing seed treatments, there was significant difference between two varieties for all the characters studied except plant stand at maturity, number of pods per cluster in field condition and seed moisture content in laboratory condition.

The higher field emergence (85.87 %), plant height (57.66 cm), number of clusters per plant (32.87), number of pods per plant (76.14), number of seeds per pod (2.91), number of seeds per plant (221.47), biological yield per plant (29.92 g), seed yield per plant (18.90 g) and harvest index (62.63 %) was recorded in V<sub>2</sub> (JS 335) with lower days to 50 per cent flowering (44.93 days) and days to maturity (84.97 days), while it was lower (81.33 %, 48.97 cm, 28.60, 64.18, 2.62, 168.81, 25.28 g, 13.84 g and 54.42 %, respectively) in V<sub>1</sub> (GJS 3) with more days to 50 per cent flowering (50.47 days) and days to maturity (89.97 days) (Table 1, 2 and 3). The difference observed between two varieties, which might be attributed to its genetic constitution (5 and 6). The results are also in accordance with the findings of Negalur (7), who found that seven months old JS 335 soybean seeds soaked in 2% KH<sub>2</sub>PO<sub>4</sub> for 3 hours and dried to original moisture recorded higher field emergence in comparison to control. Sanjeevakumar (8) also found the same results for

**Table 1.** Effect of pre-sowing seed treatments on field emergence (%), days to 50 per cent flowering, days to maturity and plant height (cm) of soybean

Factor	Field emergence (%)	Days to 50 per cent flowering	Days to maturity	Plant height (cm)
V <sub>1</sub>	81.33	50.47	89.97	48.97
V <sub>2</sub>	85.87	44.93	84.97	57.66
S.Em+	1.08	0.72	1.19	0.75
C.D. at 5%	3.10	2.06	3.40	2.15
S <sub>1</sub>	73.83	53.67	97.83	46.12
S <sub>2</sub>	77.83	49.67	90.83	49.27
S <sub>3</sub>	82.00	47.00	87.17	53.87
S <sub>4</sub>	83.17	44.67	82.83	54.73
S <sub>5</sub>	80.00	49.50	90.67	52.47
S <sub>6</sub>	88.50	49.67	88.50	55.73
S <sub>7</sub>	89.67	46.00	85.00	56.30
S <sub>8</sub>	90.00	47.33	86.67	58.90
S <sub>9</sub>	86.33	44.67	82.33	53.90
S <sub>10</sub>	84.67	44.83	82.83	51.88
S.Em+	2.43	1.61	2.65	1.68
C.D. at 5%	6.94	4.61	7.59	4.82
V <sub>1</sub> S <sub>1</sub>	66.33	57.33	102.67	43.53
V <sub>1</sub> S <sub>2</sub>	77.33	53.67	96.33	47.07
V <sub>1</sub> S <sub>3</sub>	81.00	53.00	96.00	48.87
V <sub>1</sub> S <sub>4</sub>	83.33	50.67	91.00	52.27
V <sub>1</sub> S <sub>5</sub>	77.67	51.67	92.33	51.47
V <sub>1</sub> S <sub>6</sub>	85.67	53.33	90.33	49.87
V <sub>1</sub> S <sub>7</sub>	83.67	44.67	80.00	51.27
V <sub>1</sub> S <sub>8</sub>	83.00	48.67	86.67	54.87
V <sub>1</sub> S <sub>9</sub>	88.67	44.67	80.00	48.87
V <sub>1</sub> S <sub>10</sub>	86.67	47.00	84.33	41.67
V <sub>2</sub> S <sub>1</sub>	81.33	50.00	93.00	48.70
V <sub>2</sub> S <sub>2</sub>	78.33	45.67	85.33	51.47
V <sub>2</sub> S <sub>3</sub>	83.00	41.00	78.33	58.87
V <sub>2</sub> S <sub>4</sub>	83.00	38.67	74.67	57.20
V <sub>2</sub> S <sub>5</sub>	82.33	47.33	89.00	53.47
V <sub>2</sub> S <sub>6</sub>	91.33	46.00	86.67	61.60
V <sub>2</sub> S <sub>7</sub>	95.67	47.33	90.00	61.33
V <sub>2</sub> S <sub>8</sub>	97.00	46.00	86.67	62.93
V <sub>2</sub> S <sub>9</sub>	84.00	44.67	84.67	58.93
V <sub>2</sub> S <sub>10</sub>	82.67	42.67	81.33	62.10
S.Em+	3.43	2.28	3.75	2.38
C.D. at 5%	9.82	6.52	10.74	6.81
CV %	7.11	8.27	7.43	7.73

KH<sub>2</sub>PO<sub>4</sub>. Muhammad *et al.* (9) reported that seed primed with poly ethylene glycol (PEG) solutions for 6h resulted in faster and improved emergence. Assefa *et al.* (10) reported good field emergence with KH<sub>2</sub>PO<sub>4</sub> (50 ppm). Kujur and Lal (11) showed that osmopriming had significant effect on seed emergence. Meseret (12) observed significantly lower days to 50 per cent flowering in soybean primed with KH<sub>2</sub>PO<sub>4</sub> next to GA<sub>3</sub>. Muhammad

**Table 2.** Effect of pre-sowing seed treatments on plant stand at maturity, number of clusters per plant, number of pods per plant and number of pods per cluster of soybean

Factor	Plant stand at maturity	Number of clusters per plant	Number of pods per plant	Number of pods per cluster
V <sub>1</sub>	47.27	28.60	64.18	2.24
V <sub>2</sub>	51.17	32.87	76.14	2.32
S.Em+	1.41	0.37	0.53	0.03
C.D. at 5%	NS	1.06	1.52	NS
S <sub>1</sub>	45.83	26.67	53.30	1.98
S <sub>2</sub>	43.83	26.91	57.90	2.16
S <sub>3</sub>	52.17	29.27	66.10	2.26
S <sub>4</sub>	47.67	29.79	69.13	2.33
S <sub>5</sub>	44.83	27.89	63.85	2.30
S <sub>6</sub>	52.00	32.53	75.73	2.34
S <sub>7</sub>	55.50	34.14	80.18	2.35
S <sub>8</sub>	56.50	34.80	82.78	2.38
S <sub>9</sub>	47.00	33.43	76.48	2.30
S <sub>10</sub>	46.83	31.91	76.13	2.39
S.Em+	3.16	0.83	1.19	0.08
C.D. at 5%	NS	2.37	3.40	0.22
V <sub>1</sub> S <sub>1</sub>	43.33	22.92	41.27	1.80
V <sub>1</sub> S <sub>2</sub>	42.67	23.12	49.57	2.15
V <sub>1</sub> S <sub>3</sub>	46.33	26.68	60.93	2.28
V <sub>1</sub> S <sub>4</sub>	42.00	26.89	61.93	2.30
V <sub>1</sub> S <sub>5</sub>	38.33	25.52	57.50	2.28
V <sub>1</sub> S <sub>6</sub>	50.00	30.36	69.80	2.30
V <sub>1</sub> S <sub>7</sub>	54.00	33.31	76.37	2.29
V <sub>1</sub> S <sub>8</sub>	61.33	33.44	78.00	2.35
V <sub>1</sub> S <sub>9</sub>	47.00	31.74	73.57	2.32
V <sub>1</sub> S <sub>10</sub>	47.67	31.99	72.83	2.28
V <sub>2</sub> S <sub>1</sub>	48.33	30.41	65.33	2.15
V <sub>2</sub> S <sub>2</sub>	45.00	30.69	66.23	2.17
V <sub>2</sub> S <sub>3</sub>	58.00	31.85	71.27	2.24
V <sub>2</sub> S <sub>4</sub>	53.33	32.68	76.33	2.35
V <sub>2</sub> S <sub>5</sub>	51.33	30.26	70.20	2.33
V <sub>2</sub> S <sub>6</sub>	54.00	34.71	81.67	2.38
V <sub>2</sub> S <sub>7</sub>	57.00	34.97	84.00	2.41
V <sub>2</sub> S <sub>8</sub>	51.67	36.16	87.57	2.42
V <sub>2</sub> S <sub>9</sub>	47.00	35.12	79.40	2.27
V <sub>2</sub> S <sub>10</sub>	46.00	31.83	79.43	2.49
S.Em+	4.46	1.17	1.68	0.11
C.D. at 5%	NS	3.36	4.81	NS
CV %	15.71	6.61	6.29	8.15

et al. (13) confirmed that priming of cultivar NARC 2 with 0.5% KNO<sub>3</sub> solution produced the highest number of pods per plant.

Similarly, germination percentage (84.63 %), seedling length (14.93 cm), seedling dry weight (27.24 mg), seedling vigour index I (1267.78), seedling vigour index II (2313.29) and test weight (8.72 g) was also noted higher in V<sub>2</sub> (JS 335) and were lower (83.33 %, 14.56 cm, 26.46

mg, 1214.97, 2209.22 and 8.49 g, respectively) in V<sub>1</sub> (GJS 3). The highest and lowest electrical conductivity of seed leachates (0.63 dS/m and 0.61 dS/m) and seed moisture content (8.26 % and 8.12 %) was recorded in V<sub>1</sub> (GJS 3) and V<sub>2</sub> (JS 335), respectively (Table 4 and 5).

Irrespective of varieties, the effect of different pre-sowing seed treatments on plant stand at maturity and number of seeds per pod was non-significant. Irrespective of varieties, significantly the highest field emergence in percentage (90.00%), plant height (58.90 cm), number of clusters per plant (34.80), number of pods per plant (82.78), number of pods per cluster (2.38), number of seeds per plant (231.39), biological yield per plant (35.47 g) and seed yield per plant (24.52 g) was recorded in S<sub>8</sub> (Seed coating with sweet flag rhizome powder @ 5g/kg seed), while they were the lowest (73.83 %, 46.12 cm, 26.67, 53.30, 1.98, 149.69, 17.78 g and 7.62 g, respectively) in S<sub>1</sub> (untreated seed) (Table 1 to 3). Significantly the highest and lowest days to 50 per cent flowering (53.67 days and 44.67 days) was recorded in control (S<sub>1</sub>) and seeds treated with 2.0% KH<sub>2</sub>PO<sub>4</sub> for 8 hrs. (20 ml/l) (S<sub>4</sub>), respectively. Seed coating with cytozyme SDM powder @ 3g/kg (S<sub>9</sub>) also taken 44.67 days for 50 per cent flowering (Table 1). Significantly the highest and lowest days to maturity (97.83 days and 82.33 days) was recorded in control (S<sub>1</sub>) and seed coating with cytozyme SDM powder @ 3g/kg (S<sub>9</sub>), respectively (Table 1). Significantly the maximum and minimum harvest index (70.09 % and 43.13 %) was recorded in seeds primed with 10% *Rhizobium japonicum* culture for 8 hrs. (100 ml/l) (S<sub>7</sub>) and control (S<sub>1</sub>), respectively (Table 3). The results are in accordance with the findings of Negalur (7), who found that seven months old JS 335 soybean seeds soaked in 2% KH<sub>2</sub>PO<sub>4</sub> for 3 hours and dried to original moisture recorded higher field emergence in comparison to control. Muhammad et al. (9) reported that seed primed with poly ethylene glycol (PEG) solutions for 6h resulted in faster and improved emergence. Assefa et al. (10) also reported good field emergence with KH<sub>2</sub>PO<sub>4</sub> (50 ppm). Kujur and Lal (11) showed that osmopriming had significant effect on seed emergence. Meseret (12) observed significantly lower days to 50 per cent flowering in soybean primed with KH<sub>2</sub>PO<sub>4</sub> next to GA<sub>3</sub>. Earlier flowering produced the pods more rapidly and the results of earlier pod formation relative to seed treatments results in to early maturity in comparison to untreated seeds (6). They also reported that reported that hydration inoculation, on-farm priming and hydropriming treatments ensured higher plant height

**Table 3.** Effect of pre-sowing seed treatments on number of seeds per pod, number of seeds per plant, biological yield per plant (g), seed yield per plant (g) and harvest index (%) of soybean

Factor	Number of seeds per pod	Number of seeds per plant	Biological yield per plant (g)	Seed yield per plant (g)	Harvest index (%)
V <sub>1</sub>	2.62	168.81	25.28	13.84	54.42
V <sub>2</sub>	2.91	221.47	29.92	18.90	62.63
S.Em+	0.05	3.74	0.45	0.25	1.25
C.D. at 5%	0.14	10.72	1.29	0.72	3.58
S <sub>1</sub>	2.75	149.69	17.78	7.62	43.13
S <sub>2</sub>	2.67	155.90	24.78	11.60	47.17
S <sub>3</sub>	2.72	181.14	26.75	14.83	55.64
S <sub>4</sub>	2.83	197.91	27.30	16.37	59.77
S <sub>5</sub>	2.80	180.19	26.63	14.55	54.38
S <sub>6</sub>	2.77	209.91	30.07	18.75	62.64
S <sub>7</sub>	2.82	225.79	31.35	21.42	70.09
S <sub>8</sub>	2.78	231.39	35.47	24.52	70.07
S <sub>9</sub>	2.62	199.64	28.08	17.02	61.01
S <sub>10</sub>	2.90	219.84	27.78	17.03	61.36
S.Em+	0.11	8.37	1.01	0.56	2.80
C.D. at 5%	NS	23.96	2.88	1.61	8.01
V <sub>1</sub> S <sub>1</sub>	2.60	106.69	14.10	6.27	44.50
V <sub>1</sub> S <sub>2</sub>	2.53	125.11	23.43	11.27	48.50
V <sub>1</sub> S <sub>3</sub>	2.47	149.85	24.13	13.37	55.57
V <sub>1</sub> S <sub>4</sub>	2.63	161.68	26.80	10.93	40.86
V <sub>1</sub> S <sub>5</sub>	2.60	148.66	22.83	11.47	50.58
V <sub>1</sub> S <sub>6</sub>	2.63	183.89	31.23	18.83	60.66
V <sub>1</sub> S <sub>7</sub>	2.70	207.81	33.40	19.47	58.78
V <sub>1</sub> S <sub>8</sub>	2.57	198.98	25.67	18.27	71.82
V <sub>1</sub> S <sub>9</sub>	2.63	198.74	28.80	14.83	51.65
V <sub>1</sub> S <sub>10</sub>	2.80	206.68	22.40	13.70	61.32
V <sub>2</sub> S <sub>1</sub>	2.90	192.68	21.47	8.97	41.77
V <sub>2</sub> S <sub>2</sub>	2.80	186.70	26.13	11.93	45.83
V <sub>2</sub> S <sub>3</sub>	2.97	212.42	29.37	16.30	55.71
V <sub>2</sub> S <sub>4</sub>	3.03	234.13	27.80	21.80	78.68
V <sub>2</sub> S <sub>5</sub>	3.00	211.72	30.43	17.63	58.18
V <sub>2</sub> S <sub>6</sub>	2.90	235.94	28.90	18.67	64.62
V <sub>2</sub> S <sub>7</sub>	2.93	243.77	29.30	23.37	81.40
V <sub>2</sub> S <sub>8</sub>	3.00	263.79	45.27	30.77	68.31
V <sub>2</sub> S <sub>9</sub>	2.60	200.53	27.37	19.20	70.37
V <sub>2</sub> S <sub>10</sub>	3.00	233.00	33.17	20.37	61.41
S.Em+	0.16	11.84	1.42	0.79	3.96
C.D. at 5%	NS	33.88	4.07	2.27	11.32
CV %	9.89	10.51	8.92	8.40	11.71

when compared with control and osmopriming in soybean. Oad *et al.* (14) reported that *Rhizobium japonicum* exhibited the positive change in terms of enhanced growth and seed yield. The satisfactory results would be achieved, if the soybean seed treated with 25 ml of *Rhizobium japonicum* inoculums. Syaiful *et al.* (15) reported that seed priming with PEG can improve plant growth in soybean by conferring more resistant seedlings to drought stress with higher seed yield. Paudel *et al.* (5)

reported the maximum seed yield per plant under boron application, which was statistically at par with combined application of boron and *rhizobium* and separate application of *rhizobium*. Chavan *et al.* (16) observed significant interaction effect in plant height raised from the Phule Kalyani seeds treated with CaCl<sub>2</sub>.2H<sub>2</sub>O (0.5%). Thawale *et al.* (17), Anitha *et al.* (18) and Jadhav *et al.* (19) reported that all invigoration treatments with fresh seed lot recorded more number of pods per plant with

higher seed yield in soybean. Muhammad *et al.* (13) confirmed that priming of cultivar NARC 2 with 0.5% KNO<sub>3</sub> solution produced the highest number of pods per plant.

Significantly the maximum and minimum seedling length (15.83 cm and 13.55 cm) and seedling vigour index I (1410.05 and 1044.87) was recorded in seeds primed with 10% *Rhizobium japonicum* culture for 8 hrs. (100 ml/l) (S<sub>7</sub>) and control (S<sub>1</sub>), respectively (Table 4 and 5). Similarly, germination (90.00 %), seedling dry weight (29.33 mg), seedling vigour index II (2644.92) and test weight (9.44 g) were also recorded the highest in S<sub>8</sub> (Seed coating with sweet flag rhizome powder @ 5g/kg seed) and the lowest (77.17 %, 24.07 mg, 1853.35 and 8.10 g, respectively) in S<sub>1</sub> (control). Significantly the maximum electrical conductivity of seed leachates (0.77 dS/m) and seed moisture content (8.97 %) was noted in control (S<sub>1</sub>), while they were significantly the minimum (0.51 dS/m and 7.47 %) in seed coated with sweet flag rhizome powder @ 5g/kg seed (S<sub>8</sub>). The results are in accordance with the findings of Mahesh and Ravi (20), who observed higher germination percentage, seedling length, seedling dry weight, seedling vigour index I and seedling vigour index II in soybean with seed treatment of sweet flag rhizome powder @ 10 g / kg of seed.

The plant stand at maturity, number of pods per cluster, number of seeds per pod, seed moisture content and electrical conductivity of seed leachates exerted non-significant difference due to interaction of varieties and different pre-sowing seed treatments. Significantly the lowest days to 50 per cent flowering and days to maturity (38.67 days and 74.67 days) was recorded in seeds of JS 335 primed with 2.0 % KH<sub>2</sub>PO<sub>4</sub> for 8 hrs. (20 ml/l) (V<sub>2</sub>S<sub>4</sub>) and the highest (57.33 days and 102.67 days) in V<sub>1</sub>S<sub>1</sub> (untreated seeds of GJS 3). Significantly the lowest plant height (41.67 cm) was recorded in seeds of JS 335 coated with neem kernel powder @ 5 g/kg seed (V<sub>1</sub>S<sub>10</sub>) and the highest (62.93 cm) in V<sub>2</sub>S<sub>8</sub> (seeds of JS 335 coated with sweet flag rhizome powder @ 5g/kg seed). Significantly the highest and lowest field emergence (97.00 % and 66.33 %), number of clusters per plant (36.16 and 22.92), number of pods per plant (87.57 and 41.27), number of seeds per plant (263.79 and 106.69), biological yield per plant (45.27 g and 14.10 g), seed yield per plant (30.77 g and 6.27 g), germination (95.33 % and 77.67 %), seedling length (16.60 cm and 13.40 cm), seedling dry weight (30.30 mg and 22.17 mg), seedling vigour index I (1582.47 and 1039.40), seedling vigour index II (2889.00 and 1716.37) and test weight

**Table 4.** Effect of pre-sowing seed treatments on seed moisture content (%), electrical conductivity of seed leachates (dS/m), germination (%) and seedling length (cm) of soybean seeds

Factor	Seed moisture content (%)	Electrical conductivity of seed leachates (dS/m)	Germination (%)	Seedling length (cm)
V <sub>1</sub>	8.26	0.63	83.33	14.56
V <sub>2</sub>	8.12	0.61	84.63	14.93
S.Em+	0.07	0.002	0.34	0.11
C.D. at 5%	NS	0.01	0.99	0.31
S <sub>1</sub>	8.97	0.77	77.17	13.55
S <sub>2</sub>	8.60	0.71	79.50	14.18
S <sub>3</sub>	8.35	0.64	82.83	14.58
S <sub>4</sub>	8.30	0.61	84.17	14.75
S <sub>5</sub>	8.47	0.65	81.83	14.35
S <sub>6</sub>	7.86	0.57	87.50	15.07
S <sub>7</sub>	7.70	0.54	89.00	15.83
S <sub>8</sub>	7.47	0.51	90.00	15.47
S <sub>9</sub>	8.00	0.60	84.00	14.92
S <sub>10</sub>	8.20	0.61	83.83	14.78
S.Em+	0.16	0.01	0.77	0.25
C.D. at 5%	0.45	0.02	2.20	0.70
V <sub>1</sub> S <sub>1</sub>	9.04	0.79	77.67	13.40
V <sub>1</sub> S <sub>2</sub>	8.68	0.74	78.33	14.30
V <sub>1</sub> S <sub>3</sub>	8.35	0.65	80.67	14.50
V <sub>1</sub> S <sub>4</sub>	8.31	0.62	85.00	14.77
V <sub>1</sub> S <sub>5</sub>	8.58	0.66	83.00	14.23
V <sub>1</sub> S <sub>6</sub>	7.91	0.57	87.67	15.10
V <sub>1</sub> S <sub>7</sub>	7.73	0.55	87.00	15.57
V <sub>1</sub> S <sub>8</sub>	7.70	0.53	84.67	14.33
V <sub>1</sub> S <sub>9</sub>	8.04	0.60	85.00	14.47
V <sub>1</sub> S <sub>10</sub>	8.26	0.61	84.33	14.97
V <sub>2</sub> S <sub>1</sub>	8.89	0.75	76.67	13.70
V <sub>2</sub> S <sub>2</sub>	8.51	0.68	80.67	14.07
V <sub>2</sub> S <sub>3</sub>	8.34	0.62	85.00	14.67
V <sub>2</sub> S <sub>4</sub>	8.28	0.61	83.33	14.73
V <sub>2</sub> S <sub>5</sub>	8.36	0.65	80.67	14.47
V <sub>2</sub> S <sub>6</sub>	7.81	0.57	87.33	15.03
V <sub>2</sub> S <sub>7</sub>	7.68	0.53	91.00	16.10
V <sub>2</sub> S <sub>8</sub>	7.23	0.50	95.33	16.60
V <sub>2</sub> S <sub>9</sub>	7.96	0.59	83.00	15.37
V <sub>2</sub> S <sub>10</sub>	8.13	0.60	83.33	14.60
S.Em+	0.22	0.01	1.09	0.35
C.D. at 5%	NS	NS	3.12	0.99
CV %	4.73	2.56	2.25	4.08

(9.88 g and 7.69 g) was recorded in V<sub>2</sub>S<sub>8</sub> (seeds of JS 335 coated with sweet flag rhizome powder @ 5g/kg seed) and V<sub>1</sub>S<sub>1</sub> (untreated seeds of GJS 3). Seeds of JS 335 treated with 10 % *Rhizobium japonicum* culture for 8 hrs. (100 ml/l) (V<sub>2</sub>S<sub>7</sub>) was the next best treatment for these traits. Significantly the highest harvest index (81.40%) was observed in V<sub>2</sub>S<sub>7</sub> (seeds of JS 335 treated with 10

**Table 5.** Effect of pre-sowing seed treatments on seedling dry weight (mg), seedling vigour Index I, seedling vigour Index II and test weight (g) of soybean seeds

Factor	Seedling dry weight (mg)	Seedling vigour index I	Seedling vigour index II	Test weight (g)
V <sub>1</sub>	26.46	1214.97	2209.22	8.49
V <sub>2</sub>	27.24	1267.78	2313.29	8.72
S.Em+	0.24	9.61	22.77	0.07
C.D. at 5%	0.70	27.47	65.08	0.20
S <sub>1</sub>	24.07	1044.87	1853.35	8.10
S <sub>2</sub>	24.98	1128.07	1985.60	8.36
S <sub>3</sub>	26.32	1208.23	2182.48	8.46
S <sub>4</sub>	26.98	1241.58	2271.82	8.51
S <sub>5</sub>	25.70	1173.58	2102.30	8.43
S <sub>6</sub>	27.82	1318.12	2433.92	8.71
S <sub>7</sub>	28.67	1410.05	2552.85	8.87
S <sub>8</sub>	29.33	1397.63	2644.92	9.44
S <sub>9</sub>	27.48	1252.30	2310.45	8.68
S <sub>10</sub>	27.13	1239.33	2274.90	8.53
S.Em+	0.54	21.49	50.91	0.15
C.D. at 5%	1.56	61.42	145.52	0.44
V x S				
V <sub>1</sub> S <sub>1</sub>	22.17	1039.40	1716.37	7.69
V <sub>1</sub> S <sub>2</sub>	25.67	1121.50	2009.67	8.02
V <sub>1</sub> S <sub>3</sub>	25.60	1169.83	2065.63	8.61
V <sub>1</sub> S <sub>4</sub>	27.70	1255.23	2353.90	8.54
V <sub>1</sub> S <sub>5</sub>	25.00	1181.33	2075.00	8.49
V <sub>1</sub> S <sub>6</sub>	27.77	1323.37	2434.17	8.47
V <sub>1</sub> S <sub>7</sub>	27.77	1354.97	2415.70	8.91
V <sub>1</sub> S <sub>8</sub>	28.37	1212.80	2400.83	9.01
V <sub>1</sub> S <sub>9</sub>	27.47	1229.43	2335.53	8.57
V <sub>1</sub> S <sub>10</sub>	27.10	1261.87	2285.43	8.64
V <sub>2</sub> S <sub>1</sub>	25.97	1050.33	1990.33	8.52
V <sub>2</sub> S <sub>2</sub>	24.30	1134.63	1961.53	8.70
V <sub>2</sub> S <sub>3</sub>	27.03	1246.63	2299.33	8.32
V <sub>2</sub> S <sub>4</sub>	26.27	1227.93	2189.73	8.47
V <sub>2</sub> S <sub>5</sub>	26.40	1165.83	2129.60	8.36
V <sub>2</sub> S <sub>6</sub>	27.87	1312.87	2433.67	8.95
V <sub>2</sub> S <sub>7</sub>	29.57	1465.13	2690.00	8.83
V <sub>2</sub> S <sub>8</sub>	30.30	1582.47	2889.00	9.88
V <sub>2</sub> S <sub>9</sub>	27.50	1275.17	2285.37	8.80
V <sub>2</sub> S <sub>10</sub>	27.17	1216.80	2264.37	8.41
S.Em+	0.77	30.39	72.00	0.22
C.D. at 5%	2.20	86.86	205.79	0.62
CV %	4.97	4.24	5.51	4.36

% *Rhizobium japonicum* culture for 8 hrs. (100 ml/l)) and the lowest (40.86 %) was recorded in V<sub>1</sub>S<sub>4</sub> (seeds of GJS 3 treated with 2.0 % KH<sub>2</sub>PO<sub>4</sub> for 8 hrs. (20 ml/l)) (Table 1 to 5).

## CONCLUSION

From the results, it can be seen that, in the field performance, variety JS 335 showed its superiority over

GJS 3 recorded higher field emergence, plant height, number of clusters per plant, number of pods per plant, number of seeds per pod, number of seeds per plant, biological yield per plant, seed yield per plant and harvest index with lower days to 50 per cent flowering and days to maturity. Among seed invigoration treatments, seed coating with sweet flag rhizome powder @ 5g/kg seed recorded the maximum field emergence, plant height, number of clusters per plant, number of pods per plant, number of pods per cluster, number of seeds per plant, biological yield per plant, seed yield per plant and test weight. The results of seed quality parameters measured from seed harvested from field trials, variety JS 335 was found superior over GJS 3 recorded the maximum germination percentage, seedling length, seedling dry weight, seedling vigour index I and seedling vigour index II with low value of seed moisture content and electrical conductivity of seed leachates. Similarly, seed coating with sweet flag rhizome powder @ 5g/kg seed recorded the maximum germination percentage, seedling length, seedling dry weight and seedling vigour index II with low value of seed moisture content and electrical conductivity of seed leachates.

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