The Pharma Innovation Journal 2022; 11(6): 2061-2063

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 2061-2063

www.thepharmajournal.com
Received: 08-04-2022
Accepted: 19-05-2022

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Influence of seed invigouration treatments on seed quality parameters of soybean [*Glycine max* (L.) Merill]

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Abstract
The present investigation entitled "Influence of seed invigouration treatments on seed quality parameters of soybean [*Glycine max* (L) Merill] was carried out in *kharif* 2020 at the Seed Testing Laboratory, 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 8hrs, S_3: 1.5% $CaCl_2$ for 8 hrs. (15 ml/l), S_4: 2.0% KH_2PO_4 for 8 hrs. (20 ml/l), S_5: 1.0% 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) repeated thrice and evaluated for seed quality parameters *viz*., germination percentage, seedling length (cm), seedling dry weight (mg), seedling vigour index - I and seedling vigour index – II using Completely Randomized Design (Factorial) as per the method suggested by Cochran and Cox (1957). Among the varieties, JS 335 and among the seed invigouration treatments, seed coating with sweet flag rhizome powder @ 5g/kg seed recorded the maximum germination percentage, seedling length, seedling dry weight, seedling vigour index I and seedling vigour index II.

Keywords: Invigouration, seed coating, seed treatments, soybean

Introduction
Soybean [(*Glycine max* (L.) Merill] is known as "Golden bean" and "Miracle crop", of the 20th century, because of its multiple uses (Kumar *et al*., 2013) [9], and often designated as "Wonder crop" and "Gold of soil". Soybean belongs to the family *Fabaceae* and sub family *Papilionaceae* with chromosome number 2n=20. Soybean contains more protein (about 40-42%) than other pulses and a much higher content of edible oil (about 20%) (Gopalan *et al.*, 1989) [3]. Soybean protein is also rich in valuable amino acid "lysine" (5%), which is deficient in most of the cereals (Hammond *et al.*, 2005) [4].

The primed/hardened treatments proved to be better for vigor improvement than traditional soaking (Manjunath and Dhanoji, 2011) [11]. Seed priming/ hardening treatments enhances seeds vigor by protecting structure of the plasma membrane against injury during stress environment (JunMin *et al*., 2000) [7]. Pre-soaking seeds with optimal concentration of phyto-hormones enhance their germination, growth and yield under stress condition by increasing nutrient reserves mobilization through increased physiological activities and root proliferation (Khan *et al.*, 2016) [8].

In recent years, importance of soybean has increased and large number of farmers cultivating it. Seed industry is playing an important role in production and supply of quality seeds to farmers. Despite its great food value, it is known to have poor field emergence compared to seeds of other *kharif* oilseeds/pulse crops due to its inherent seed structure and composition.

Keeping this in view, the present study was planned in laboratory condition to know the effect of different seed invigouration treatments on seed quality parameters in soybean.

Materials and Methods
The experiment was carried out in *kharif* 2020 at the Seed Testing Laboratory, 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 8hrs, S_3: 1.5% $CaCl_2$ for 8 hrs. (15 ml/l), S_4: 2.0% KH_2PO_4 for 8 hrs.

(20 ml/l), S_5: 1.0% 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) repeated thrice and evaluated for seed quality parameters *viz*., germination percentage, seedling length (cm), seedling dry weight (mg), seedling vigour index - I and seedling vigour index – II using Completely Randomized Design (Factorial) as per the method suggested by Cochran and Cox (1957) [2]. The observations *viz.,* germination percentage (%), seedling length (cm), and seedling dry weight (mg) were determined following standard procedure, while seedling vigour index I and seedling vigour index II were determined as per formulae given by Abdul-Baki and Anderson (1973) [1]. For seed coating, 5 per cent arabic gum was used as an adhesive.

Results and Discussion

There was significant difference was noted between varieties, seed invigouration treatments and their interaction for all the seed quality parameters recorded *viz*., germination percentage, seedling length (cm), seedling dry weight (mg), seedling vigour index I and seedling vigour index II.

The higher germination (79.60%), seedling length (20.13 cm), seedling dry weight (31.80 mg), seedling vigour index I (1623.90) and seedling vigour index II (2599.95) was recorded in V_2 (JS 335), while it was lower (76.23%, 18.35 cm, 27.03 mg, 1412.88 and 2098.56, respectively) in V_1 (GJS 3) (Table 1).

Irrespective of varieties, among seed invigouration treatments, seed coating with sweet flag rhizome powder @ 5g/kg seed (S_8) recorded significantly the highest germination percentage (91.83%) and seedling length (23.27 cm), it was remained at par with seed treated with 10% *Rhizobium japonicum* culture for 8 hrs. (100 ml/l) (S_7) noted germination of 89.00 per cent and seedling length of 22.14 cm. Seed coated with sweet flag rhizome powder @ 5g/kg seed (S_8) recorded significantly the highest seedling dry weight (40.30 mg), seedling vigour index I (2140.66) and seedling vigour index II (3714.20) and it was followed by seed treated with 10% *Rhizobium japonicum* culture for 8 hrs. (100 ml/l) (S_7), 10% PEG 6000 for 8 hrs. (100 ml/l) (S_6) and seed coating with cytozyme SDM powder @ 3 g/kg seed (S_9) with seedling dry weight (38.60 mg, 34.92 mg and 33.22 mg, respectively), seedling vigour index I (1972.04, 1765.75 and 1670.08, respectively) and seedling vigour index II (3448.83, 2956.70 and 2735.93, respectively). Untreated/uncoated seeds recorded significantly the lowest germination (68.17%) seed ling length (15.91 cm), seedling dry weight (20.95 mg), seedling vigour index I (1084.47) and seedling vigour index II (1428.23) (Table 1). The results are in accordance with the findings of Mahesh and Ravi (2008) [10], 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. Hossein *et al.* (2011) [6] and Hemasruthi *et al.* (2020) [5] reported that PEG 6000 enhanced the germination percentage, seedling length, seedling dry weight, seedling vigour index I and seedling vigour index II of soybean seeds.

Irrespective of varieties and seed invigouration treatments, among the interactions, significantly the highest germination (95.33%), seedling length (24.51 cm), seedling dry weight (44.03 mg), seedling vigour index I (2336.48) and seedling vigour index II (4198.23) was recorded in seeds of JS 335 coated with sweet flag rhizome powder @ 5g/kg seed (V_2S_8) and it was followed by seeds of JS 335 treated with 10% *Rhizobium japonicum* culture for 8 hrs. (100 ml/l) (V_2S_7) with germination of 92.00 per cent, seedling length of 22.90 cm, seedling dry weight of 43.50 mg, seedling vigour index I of 2105.79 and seedling vigour index II of 3998.27. Significantly the lowest germination percentage (68.00%), seedling length (15.22 cm), Seedling dry weight (20.47 mg), seedling vigour index I (1034.90) and seedling vigour index II (1391.53) was noted in untreated seeds of GJS 3 (V_1S_1) (Table 1).

Table 1: Effect of seed invigouration treatments on different seed quality parameters of soybean seeds

Factor	Germination%	Seedling length (cm)	Seedling dry weight (mg)	Seedling vigour index I	Seedling vigour index II
V_1	76.23	18.35	27.03	1412.88	2098.56
V_2	79.60	20.13	31.80	1623.90	2599.95
S.Em+	0.45	0.08	0.23	10.67	23.30
C.D. at 5%	1.27	0.23	0.67	30.50	66.60
S_1	68.17	15.91	20.95	1084.47	1428.23
S_2	70.17	16.65	22.05	1167.75	1547.10
S_3	72.50	18.09	24.75	1312.25	1797.00
S_4	73.50	18.64	26.00	1370.26	1911.70
S_5	71.00	17.25	24.15	1224.07	1717.08
S_6	84.33	20.89	34.92	1765.75	2956.70
S_7	89.00	22.14	38.60	1972.04	3448.83
S_8	91.83	23.27	40.30	2140.66	3714.20
S_9	82.33	20.27	33.22	1670.08	2735.93
S_{10}	76.33	19.30	29.23	1476.54	2235.78
S.Em+	1.00	0.18	0.52	23.86	52.11
C.D. at 5%	2.85	0.52	1.49	68.20	148.93
V x S					
V_1S_1	68.00	15.22	20.47	1034.90	1391.53
V_1S_2	70.33	15.91	20.77	1118.21	1460.93
V_1S_3	71.67	17.23	22.03	1235.11	1580.20
V_1S_4	73.00	17.35	23.63	1266.30	1724.00
V_1S_5	70.33	16.75	21.47	1176.79	1511.20
V_1S_6	80.33	19.68	31.97	1580.23	2569.07

V_1S_7	86.00	21.37	33.70	1838.29	2899.40
V_1S_8	88.33	22.02	36.57	1944.85	3230.17
V_1S_9	81.33	19.51	31.30	1586.96	2545.60
V_1S_{10}	73.00	18.45	28.40	1347.14	2073.53
V_2S_1	68.33	16.59	21.43	1134.05	1464.93
V_2S_2	70.00	17.39	23.33	1217.29	1633.27
V_2S_3	73.33	18.94	27.47	1389.40	2013.80
V_2S_4	74.00	19.92	28.37	1474.22	2099.40
V_2S_5	71.67	17.74	26.83	1271.36	1922.97
V_2S_6	88.33	22.09	37.87	1951.27	3344.33
V_2S_7	92.00	22.90	43.50	2105.79	3998.27
V_2S_8	95.33	24.51	44.03	2336.48	4198.23
V_2S_9	83.33	21.02	35.13	1753.21	2926.27
V_2S_{10}	79.67	20.15	30.07	1605.94	2398.03
S.Em+	1.41	0.26	0.74	33.75	73.69
C.D. at 5%	4.03	0.74	2.11	96.45	210.62
CV%	3.13	2.32	4.34	3.85	5.43

Conclusion

Among the varieties, variety JS 335 was found its superiority over GJS 3, which might be attributed to its genetic variability. Among the seed invigouration treatments, seed coating with sweet flag rhizome powder @ 5g/kg seed recorded the maximum germination, seedling length, seedling dry weight, seedling vigour index I and seedling vigour index II was found the best treatment for improving the seed quality.

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