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EFFECT OF SEED PRIMING ON CROP GROWTH AND SEED YIELD OF SOYBEAN [*GLYCINE MAX* (L.) MERILL]

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ABSTRACT

The results exhibited that seeds primed with GA_3 @ 100 ppm (T_4), 0.5 % KNO_3 (T_5) recorded significantly higher germination percentage i.e. 87.33%) and 87.00 % respectively over the untreated control T_1(83.00%). The treatments (T_4) GA_3 100 ppm 12 hr (77.19), (T_8) Hydration with IAA @ 80 ppm 12hr (76.55) and (T_3) Hydration with $CaCl_2$ (2.0%) 12 hr (76.22) maintained the optimum plant stand at harvest over untreated control (T_1). This may likely contributed for boosting up economic yield in soybean cultivar, JS- 9305. The seed priming significantly influenced the seed yield and yield contributing characters of soybean. The seed priming treatments (T_4) GA_3 100 ppm 12 hr, (T_7) hydration with water + Bavistin 3.0 g/kg found effective for improvement in dry matter content of seedling (g) in soybean variety JS- 9305. The treatments (T_4) 100 ppm GA_3 12 hr (2078.00 g/plot), (T_8) hydration with IAA 80 ppm 12 hr (2008.67 g/plot), (T_5) Hydration with 0.5 per cent KNO_3 12 hr (1991.00g/plant) seed yield per plot respectively over the untreated control T_1 (1647.67g/plot) showing to the corresponding favourable improvement in number of pods per plant, number of seeds per pod, test weight (g), seed yield per plot (gm), seed yield per Ha (q), biological yield (g) and numerical harvest index (%).

INTRODUCTION

The improvement in seed quality in Soybean (*Glysine max* L. Merril) by priming treatments is attributed to primary reduction of lipid peroxidation and quantitative changes in biochemical activities inducing greater amylase activity increasing per cent sugar during seed germination. Availability of good quality seed is the first and foremost requirement to achieve impact of high yielding variety. Rapid germination and emergence is an important factor of successful establishment. It is reported that the seed priming is one of the most important developments to help rapid and uniform germination and emergence of seeds and to increase seed tolerance to adverse environmental conditions (Heydecker *et al.*, 1973, 1975; Harris *et al.*, 1999). Seed priming has presented promising and even surprising results, for many seeds including the legume seeds (Bradford, 1986).

The advantage of seed priming in reducing the germination time and improving emergence uniformity is well established under laboratory conditions.The direct benefits of seed priming in all crops included: faster emergence, better, more and uniform stands, less need to re-sow, more vigorous plants, better drought tolerance, earlier flowering, earlier harvest and higher grain yield. The indirect benefits reported were: earlier sowing of crops, earlier harvesting of crops and increased willingness to use of fertilizer because of reduce risk of crop failure.Park *et al.* (1997) reported that priming aged seeds of soybean resulted in good germination and stand establishment in the field trials.Seed pretreatment with PEG-6000 increased seed germination and vigour index (Gong Ping, *et al.*, 2000; Finch-Savage *et al.*, 2004).This crop is therefore exposed many times to moisture and nutrient stresses during or immediately after germination. Considering the beneficial effects of seed priming on moisture use efficiency and seed quality parameters like, germination and vigour which help in maintenance of optimum plant population and to obtain expected yield level the present study was undertaken with the objectives as to study the effect of seed priming on field emergence of soybean and to find out the effect of seed priming on crop growth, yield contributing character and yield of soybean.

MATERIALS AND METHODS

The present investigation was carried out at PGI farm, Department of Agricultural Botany and Seed Technology Research Unit (STRU), Mahatma Phule Krishi Vidyapeeth, Rahuri in *Kharif* 2012 with spacing 30cm×10cm.The experiment was laid out in a Randomized Block Design (RBD) with eight treatments and three replications.Freshly harvested seeds of soybean variety JS-9305 were obtained from Seed Technology Research Unit, M.P.K.V., Rahuri.The collected soybean seeds of variety JS- 9305 were treated with growth regulators and chemicals as detailed below

Treatments

T_1 : Untreated (control)

T_2 : Hydration with water (distilled water) for 12 hr and surface drying at room temperature (below 25ºC).

T_3 : Hydration with $CaCl_2$ (2.0 %) for 12 hr and surface drying at room temperature

T_4 : Hydration with 100 ppm GA_3 for 12 hr and surface drying at room temperature

T_5 : Hydration with 0.5 per cent KNO_3 for 12 hr and surface drying at room temperature

T_6 : Hydration with KCl (0.5%) for 12 hr and surface drying at room temperature

T_7 : Hydration with water (distilled water) - 12 hr + Bavistin @ 3.0 g/kg of seed.

T_8 : Hydration with IAA @ 80 ppm for 12 hr and surface drying at room temperature

The data collected from the experiment were analyzed statistically by Randomized Block Design as per procedure given by Panse and Sukhatme (1967) and Sundararajan *et al.* (1972).

RESULTS AND DISCUSSION

During present study seed priming with T_4 (hydration with GA_3 100 ppm 12 hr) and T_5 (hydration with 0.5 % KNO_3 12 hr) exhibited higher germination *i.e.* 87.75 and 86.5%, respectively over control as compare to other treatments. Remaining treatments also contributed improving germination and field emergence than control. Seed priming with only water (T_1) could not significantly contribute for optimum plant stand and other quality studies. Gu, Gong Ping (2001) reported that the dry dressing of freshly harvested seed of soybean showed significant beneficial effects on germinability over the untreated control. The present finding confirms the results of Magalhaes *et al.* (1994), Mitamura *et al.* (1988), Lakatkin and Ibragimor (1982) and Varth and Clifford (1973).Significant variation in root length, shoot length and seedling vigour index were observed due to different seed priming treatments. Highest Root and shoot length (42.75 cm), vigour index I (3740.13) and vigourindex II (126.59) were recorded in T_4; and lowest (36.95 cm, 3075.60 and 93.22, respectively) were recorded in T_1. The above explanation regarding the superiority of GA_3 (100ppm) (T_4), $CaCl_2$ (2.0%) (T_3) primed seeds are plausible for the root length, shoot length and vigour index as a higher positive correlation exists among them (Table 1 and 3).Seedling dry weight (g) is one of the major components of seed quality in soybean. Most of the priming treatments recorded more seedling dry weight than control (Table 2). Seeds primed with T_4 (GA_3 100 ppm 12 hr) and T_7 (IAA 80 ppm 12 hr) were (1.45 g), (1.34 g) on which was statistically more than control (untreated). These findings are in agreement with the results of Dadlani *et al.* (1992) and Mitamura *et al.* (1988). Negalur *et al.* (2002) noted that the soybean seeds (var. TAMS-38) with different initial 70 per cent germination when invigourated with different chemicals including thiram showed increased germination, field emergence, vigour index and seedling dry matter. The enhanced growth of plumule and radicle associated with field emergence and seed vigour thus form important factor for establishment of initial crop stand. During seed germination, respiration intensity was initially lower but rapidly increased afterwards due to seed soaking.In the present investigation, the seed priming treatment T_4 (Hydration with 100 ppm GA_3 12 hr), T_5 (hydration with 0.5 % KNO_3 12 hr) 78.51% and treatment T_8 (IAA-80 ppm 12hr) emerged with more field emergence (%) showing their significant superiority. All seed primed treatments showed significantly more field emergence than control in present investigation. Zhang (1997) reported that the soybean seed treated with GA_3 accelerated the emergence. Gangacharya (1979) revealed emergence of soybean seed increased significantly (98.93%) when the seeds treated with thiram @ 3.0 g/kg. The present results also in conformity with the results reported by Negalur (2002), Dombarmathur *et al.* (2002), Hyedeckar *et al.* (1975) and Lee (1990). Results of the present investigation indicated improvement in the above seed quality parameters was only

Table 1: Effect of seed priming on germination (%) and root and shoot length (cm)

Treatments	Germination (%)	Root and shoot length (cm)
T_1: Untreated (control)	83.00	36.95
T_2: Hydration with distilled water (12 hrs)	84.00	39.92
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	85.00	40.71
T_4: Hydration with 100 ppm GA_3 (12 hrs)	87.33	42.75
T_5: Hydration with 0.5 per cent KNO_3 (12 hrs)	87.00	40.01
T_6: Hydration with KCl (0.5 %) (12 hrs)	85.33	40.93
T_7: Hydration with water (12 hrs) + Bavistin @ 3.0 g/kg of seed	86.67	41.85
T_8: Hydration with IAA @ 80 ppm (12hrs)	85.67	41.99
Mean	85.50	40.64
SE+/-	0.65	0.60
CD at 5%	1.98	1.81

Table 2: Effect of seed priming on dry matter content of seedling (g)

Treatments	Dry matter content of seedling (g)
T_1 : Untreated (control)	1.12
T_2 : Hydration with distilled water(12 hrs)	1.14
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	1.14
T_4 : Hydration with 100 ppm GA_3 (12 hrs)	1.45
T_5 : Hydration with 0.5 per cent KNO_3 (12 hrs)	1.17
T_6: Hydration with KCl (0.5 %) (12 hrs)	1.26
T_7 : Hydration with water 12 hr + Bavistin @ 3.0 g/kg of seed	1.34
T_8 : Hydration with IAA @ 80 ppm (12hrs)	1.17
Mean	1.22
SE+/-	0.03
CD at 5%	0.08

Table 3: Effect of seed priming on vigour index I and vigour index II

Treatments	Vigour index I	Vigour index II
T_1 : Untreated (control)	3075.60	93.22
T_2 : Hydration with distilled water (12 hrs)	3362.52	96.03
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	3474.63	97.17
T_4 : Hydration with 100 ppm GA_3 (12 hrs	3740.13	126.59
T_5 : Hydration with 0.5 per cent KNO_3 (12 hrs)	3482.01	101.80
T_6: Hydration with KCl (0.5 %) (12 hrs)	3500.23	107.73
T_7 : Hydration with water (12 hrs) + Bavistin @ 3.0 g/kg of seed	3629.60	116.55
T_8 : Hydration with IAA @ 80 ppm (12hrs)	3601.20	100.30
Mean	3483.24	104.92
SE+/-	64.90	2.31
CD at 5%	196.86	6.99

Table 4: Effect of seed priming on field emergence (%) and days to 50% flowering

Treatments	FieldEmergence(%)	Days to 50 % flowering
T_1 : Untreated (control)	73.28	42.33
T_2 : Hydration with distilled water (12 hrs)	77.42	41.00
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	77.43	39.33
T_4 : Hydration with 100 ppm GA_3(12 hrs)	79.18	39.00
T_5 : Hydration with 0.5 per cent KNO_3(12 hrs)	78.51	40.33
T_6: Hydration with KCl (0.5 %) (12 hrs)	75.15	39.33
T_7 : Hydration with water (12 hrs)+ Bavistin @ 3.0 g/kg of seed	78.15	39.67
T_8 : Hydration with IAA @ 80 ppm (12hrs)	78.31	41.33
Mean	77.18	40.29
SE+/-	0.63	0.63
CD at 5%	1.92	1.93

with the use of the priming materials with chemicals/growth regulators.The effect of seed priming on height showed rapid increase in growth. Amongst the seed priming treatments T_4, (100 ppm GA_3 12h), T_7 (hydration with water 12h + Bavistin @ 3.0 g/kg), T_3 (with CaCl2 (2.0 %) 12 hr) maintained significantly more plant height *i.e.* 47.37, 45.63 and 44.78 cm respectively, than control. Similar findings were reported by Deb and Zeliang (1976), Boronskikh (1977), Thombre and Kurundkar (1989) and Scott (1991). The priming treatments T_4 (100 ppm GA_3 2h), T_8 (IAA 80 ppm 12h) were recorded significantly more number of leaves (71.39 and 68.33, respectively) over control. The treatments T_1 and T_2 were recorded lower number of leaves/plant. As the shoot elongates it bears number of branches. Seed priming treatments T_4, T_7 and T_5 were recorded significantly more number of branches per plant *i.e.* 6.93, 6.40, 6.33 showing the positive effects of priming towards branching formation. Rests of the treatments also produced more number of branches than the control.

Table 5: Effect of seed priming on plant height (cm)

Treatments	Plant height (cm)
T_1 : Untreated (control)	40.04
T_2 : Hydration with distilled water(12 hrs)	42.92
T_3: Hydration with $CaCl_2$ (2.0%)(12 hrs)	44.78
T_4 : Hydration with 100 ppm GA_3 (12 hrs)	47.37
T_5 : Hydration with 0.5 per cent KNO_3(12 hrs)	44.52
T_6: Hydration with KCl (0.5 %) (12 hrs)	43.02
T_7 : Hydration with water (12 hrs) + Bavistin @ 3.0 g/kg of seed	45.63
T_8 : Hydration with IAA @ 80 ppm (12hrs)	42.78
Mean	43.88
SE+/-	0.36
CD at 5%	1.08

Similar findings were reported by Thombre and Kurundkar (1989), Mishra and Yadav (1989) and Negaluret *al.* (2002) in soybean.

Number of pods per plant is the major component of yield in

Table 6: Effect of seed priming on number of leaves per plant

Treatments	Leaves at 30DAS	Leaves at pod development
T_1 : Untreated (control)	14.07	47.53
T_2 : Hydration with distilled water (12 hrs)	15.53	49.40
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	16.07	58.67
T_4 : Hydration with 100 ppm GA_3 (12 hrs)	18.27	71.39
T_5 : Hydration with 0.5 per cent KNO_3 (12 hrs)	16.73	60.33
T_6: Hydration with KCl (0.5 %) (12 hrs)	15.00	49.83
T_7 : Hydration with water (12 hrs) + Bavistin @ 3.0 g/kg of seed	15.67	68.07
T_8 : Hydration with IAA @ 80 ppm (12hrs)	16.87	68.33
Mean	16.03	59.19
SE+/-	0.36	1.05
CD at 5%	1.09	3.19

Table 7: Effect of seed priming on number of branches and plant stand at harvest

Treatments	Number ofbranches	Plant stand at harvest(%)
T_1 : Untreated (control)	5.40	72.74
T_2 : Hydration with distilled water(12 hrs)	5.93	74.92
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	6.20	76.22
T_4 : Hydration with 100 ppm GA_3(12 hrs)	6.93	77.19
T_5 : Hydration with 0.5 per cent KNO_3 (12 hrs)	6.33	75.55
T_6: Hydration with KCl (0.5 %) (12 hrs)	6.00	74.55
T_7 : Hydration with water (12 hrs) + Bavistin @ 3.0 g/kg of seed	6.40	74.86
T_8 : Hydration with IAA @ 80 ppm (12hrs)	6.33	76.55
Mean	6.19	75.36
SE+/-	0.08	0.42
CD at 5%	0.23	1.26

Table 8: Effect of seed priming on days to maturity and number of pods per plant

Treatments	Days tomaturity	No. of pods per plant
T_1 : Untreated (control)	94.00	36.20
T_2 : Hydration with distilled water(12 hrs)	91.00	44.47
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	90.00	43.47
T_4 : Hydration with 100 ppm GA_3 (12 hrs)	89.00	53.40
T_5 : Hydration with 0.5 per cent KNO_3 12 hrs	90.67	46.47
T_6: Hydration with KCl (0.5 %) (12 hrs)	92.33	40.47
T_7 : Hydration with water (12 hrs) + Bavistin @ 3.0 g/kg of seed	92.33	48.47
T_8 : Hydration with IAA @ 80 ppm (12hrs)	91.67	47.47
Mean	91.38	45.05
SE+/-	0.86	1.13
CD at 5%	2.62	3.41

Table 9: Effect of seed priming on number of seeds per pod

Treatments	Number of seeds per pod
T_1 : Untreated (control)	2.62
T_2 : Hydration with distilled water (12 hrs)	2.76
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	2.76
T_4 : Hydration with 100 ppm GA_3 (12 hrs)	3.13
T_5 : Hydration with 0.5 per cent KNO_3 (12 hrs)	2.69
T_6: Hydration with KCl (0.5 %) (12 hrs)	2.77
T_7 : Hydration with water (12 hrs) + Bavistin @ 3.0 g/kg of seed	2.90
T_8 : Hydration with IAA @ 80 ppm (12hrs)	2.97
Mean	2.83
SE+/-	0.06
CD at 5%	0.19

soybean (Table 8). All seed priming treatments beard significantly more number of pods than control T_1 (36.20). Seeds priming with T_4 (GA_3 100 ppm-12 hours), T_7 (Hydration with water 12 hrs + Bavistin @ 3.0 g/kg of seed) were recorded significantly higher number of pods, i.e. 53.40 and 48.47 respectively. Rest of the seed priming treatments was also statistically produced more number of pods than control. The number of seeds per pod (Table 9), T_4 (GA_3 100 ppm) and T_8 (IAA 80 ppm 12h) were recorded significantly higher number of seeds per pod *i.e.* 3.13, 2.97 as compare to other priming treatments. Treatment T_1 (12.95g) was found inferior. Treatments T_4, T_3 were recorded statistically higher values of test weight *i.e.* 14.18, 13.89 (g) as compare to other treatments (Table 12). All the treatments produced significantly more test weight than control. In respect of seed yield per plot (Table 10), all the seed priming treatments were significantly produced more seed yield per plot than control, T_1 (1647.67 g per plot). The treatments T_4 (hydration with 100 ppm GA_3 12 hour) (2078.00 g per plot), T_8 (hydration with IAA-80 ppm 12hr) (2008.67 g per plot), T_5 (hydration with 0.5 per cent KNO_3 for 12 hr) (1991.00 g per plot) and T_7 (Hydration with water 12 hr + Bavistin @ 3.0 g/kg of seed) (1984.00 g per plot) recorded higher seed yield than control.

For improvement in the seed yield one has to consider the biological yield per plant (Table 10). The treatments T_4 (5084.77), T_7 (5058.27) and T8 (4944.97) were recorded significantly higher biological yield (g) than control T_1 (4508.67 g per plot). Harvest index (%) also noticed significantly more (Table 11) in T_4 (40.88%), numerically more in T_8 (40.63%) as compare to other treatments. The lowest H.I. (%) was noted by treatment T_1 (36.61%). Harvest index (H.I.) is the ratio of partitioning of biological yield into economic yield. Plant stand at harvest (Table 7) is also found significant among the different treatments. Treatments T_4 (77.19), T_8 (76.55), T_3 (76.22) recorded higher plant population at harvest. All the seed priming treatments maintained more plant populations than untreated control T_1 (72.74), which was ultimately reflected in good seed yield at harvest. Sinclair (1974) reported more pods per plant by fungicidal treatments. Kwon and Gah (1987) reported when soybean seed treated with IAA resulted in increase in pods per plant number of seeds/plant, 100 seed weight (g) and also the yield per plant. The present results of yield and yield attributes are in conformity with the findings of Rao and Singh (1997), Chatterjee *et al.* (1985), Ravikumar and Kulkarni (1998) and Khan *et al.* (2003). Results of the present investigation indicates, successful use of seed priming with growth regulators/chemicals as tool to improve seed quality,

Table 10: Effect of seed priming on seed yield per plot and biological yield

Treatments	Seed yield per plot (g)	Biological yield per plot (g)
T_1 : Untreated (control)	1647.67	4508.67
T_2 : Hydration with distilledwater (12 hrs)	1812.00	4771.90
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	1940.67	4856.27
T_4 : Hydration with 100 ppm GA_3 (12 hrs)	2078.00	5084.77
T_5 : Hydration with 0.5 per cent KNO_3(12 hrs)	1991.00	4904.80
T_6: Hydration with KCl (0.5 %) (12 hrs)	1823.33	4794.40
T_7 : Hydration with water 12 hr + Bavistin @ 3.0 g/kg of seed	1984.00	5058.27
T_8 : Hydration with IAA @ 80 ppm (12hrs)	2008.67	4944.97
Mean	1910.67	4865.50
SE+/-	30.87	71.31
CD at 5%	93.65	216.29

Table 11: Effect of seed priming on seed yield (q/ha) and harvest index

Treatments	Seed yield (q/ha)	Harvest index(%)
T_1 : Untreated (control)	22.88	36.61
T_2 : Hydration with distilled water (12 hrs)	25.17	38.01
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	26.95	39.98
T_4 : Hydration with 100 ppm GA_3 (12 hrs)	28.86	40.88
T_5 : Hydration with 0.5 per cent KNO_3 (12 hrs)	27.65	40.60
T_6: Hydration with KCl (0.5 %) (12 hrs)	25.32	38.03
T_7 : Hydration with water (12 hrs) + Bavistin @ 3.0 g/kg of seed	27.56	39.24
T_8 : Hydration with IAA @ 80 ppm (12hrs)	27.90	40.63
Mean	26.54	39.25
SE+/-	0.43	1.01
CD at 5%	1.30	NS

Table 12: Effect of seed priming ontest weight (g)

Treatments	Test weight (g)
T_1 : Untreated (control)	12.95
T_2 : Hydration with distilled water (12 hrs)	13.40
T_3: Hydration with CaCl2 (2.0%) (12 hrs)	13.89
T_4 : Hydration with 100 ppm GA_3 (12 hrs)	14.18
T_5 : Hydration with 0.5 per cent KNO_3 (12 hrs)	13.89
T_6: Hydration with KCl (0.5 %) (12 hrs)	13.77
T_7 : Hydration with water (12 hrs) + Bavistin @ 3.0 g/kg of seed	13.83
T_8 : Hydration with IAA @ 80 ppm (12hrs)	14.04
Mean	13.74
SE+/-	0.12
CD at 5%	0.37

crop stand, morph physiological parameters and yield and its components in soybean variety JS-9305.

REFERENCES

Ahuja and Ahija, K. R. 2000. Field efficiency of seed dressing chemicals on seedling emergence, seed yield and seed weight in soybean. Seed Research. **28(1):** 54-58.

Arif, M. 2005. Effect of seed priming on emergence, yield and storability of soybean. *PhD. Thesis, NWFP Agriculture University, Peshawar.*

Dighe, R. S., Zade, V. R., Zode, N. G. and Asalmol, M. N. 1982. Indices for proper stage of seed harvest in relation to seed quality in soybean. *Ann. of Pl. Physiol.* **9(2):** 142-145.

Dombaarmathur, S. I., Shashidhara, S. D., Kudiker, M. S. and Raiker, S. D. 2002. Influence of desiccant and chemical seed treatment on seed quality of soybean (*Glycine max* (L.) Merril) during storage. Seed Tech. News. **32(1):** 179.

Ganacharya, N. M. 1979. Effect of fungicidal seed treatment on emergence nodulation and grain yield of soybean in Marathwada. *J. Maharastra Agric. Univ.* **4(1):** 112-113.

HosseinSadeghi, FardinKhazaei, Liela,Y. and Saman, S. 2011. Effect of seed osmopriming on seed germination behavior and vigor of soybean (glycine max l.). ARPN *J. Agri. and Bio. Sci.* **6(1):** 39-43

H. Rafath and S. Ghosh, 2008. Influence of certain chemicals on biochemical changes associated with abscission in cestrum nocturnum M. leaves. *The Bioscan.* **3(3):** 249-257.

Gong Ping, G. 2001. Seed invigoration treatments for improved storability, field emergence and productivity of soybean. *Crop Physiology Abst.* **27(2):** 1030.

Kawale, B. R., Kurundkar, B. P. and Thombre P. A. 1975. Effect of fungicides, insecticides, weedicides on emergence and yield of soybean. *J. Oilseed Res.* **6:** 357-359.

Maske, V. G., Deotale, R. D., Sorte, V. N., Gorammager, H. B. and Chore, C. N. 1998. Influence of GA_3 and NAA on growth and yield contributing parameters of soybean. *J. Soils and Crops.* **8(1):** 91-94.

Murungu, F. S., Zuva, E., Madanzi, T., Matimati, I. and Dube, Z. P. 2005. Seed priming and water potential effects on soybean (*Glycine max* L.) Merr.) germination and emergence. *J.* New Seeds. **7(17):** 57-73.

Negalur, S. B., Kurdiker, M. B., Shekhargouda, M. and Shashidhara, S. D. 2002. Field performance and storability of invigorated seeds of soybean. *Seed Tech. News.* **32(1):** 181.

N. Savithramma, G. Fareeda AND J. Saradvathi 2008. Influence of amended cacl2 on antioxidant enzyme activities in green leafy vegetables. *The Bioscan.* **3(1):** 57-60.

Nene, Y. L., Agrawal, V. K. andShrivastava, S. S. L. 1969. Influence of fungicidal seed treatment on the emergence and nodulation of soybean.

Pesticide. **3:** 26-27.

Panse, V. G. and Sukhtane, P. V. 1967. Statistical Methods for Agricultural Workers, *ICAR, Publication,* New Delhi, pp. 100-116.

Rao, R. G. and Singh, B. Gopal. 1997. Effect of hydration dehydration on growth analysis and yield in soybean. *Annals of Plant Physiology*. **11(1):** 30-33.

Rathod, T. H., Padaui, A. B., Patil, B. N. and Rathod, R. R. 2005. Effect of seed pelleting on seed quality and dry matter production in soybean Anm. *Plant Physiol.* **19(2):** 220-223.

Ravikumar, G. H. and Kulkarni, G. N. 1998. Effect of growth regulators on seed quality in soybean genotypes. (*Glycine max*. L. Merill.) *Seeds and Farms.* pp. 25-28.

Sanjeevakumar, B. N. 2000. Effect of invigouration on storability and field performance of soybean (*Glycine max* (L.) Merrill). M.Sc.(Agri.) Thesis. University of Agricultural Sciences, Dharwad.

Singh, H. 1986. Effect of growth regulators on germination growth and yield of soybean. M.Sc. Thesis (Unpub.) PAU, Ludhiana.

Singh, S. N. and Agrawal, S. C. 1988. Interaction effect of seed dressers and period of expresser on germination and nodulation of soybean. *Indian J. Plant Pathology*. **6(1):** 63-66.

Thombre, P. A. and Kurundkar B. P. 1989. Effect of fungicidal seed treatments on nodulation and yield of soybean. *J. Oilseed Res.* **6:** 353-356.