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Effect of Temperature, Physical and Chemical Treatments on Seed Quality Enhancement in Senna (*Senna alexandrina*)

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ABSTRACT: Senna is an important medicinal plant which belongs to family Fabaceae. Its seeds attribute lower germination, usually due to seed coat-imposed dormancy. A laboratory experiment was conducted at Department of Seed Science and Technology, BACA, Anand Agricultural University, Anand, Gujarat during 2018-19 to study the effect of temperature, physical and chemical treatments on seed quality enhancement. The experiment was carried out in two different parts. First one to standardize optimum temperature requirements for germination of senna seeds, there were four different temperatures are considered *viz.* 20°C, 25°C, 30°C and 35°C. The results revealed that temperature 25°C shown higher germination per cent (32.33 %). In the second experiment various physical, chemical and hot water treatments like mechanical scarification, H_2SO_4 (100%) and 100ºC water treatments with different duration were given. The result indicated that mechanical scarification for two minutes increased the germination per cent (94.66%) as compared to control (32.33 %) and also improved seedling growth parameters at 25°C.

Keywords: Senna, Germination per cent, Temperature, Mechanical scarification, H_2SO_4, Hot water

Senna is one of the most important medicinal crops. Scientifically, it is known as *Senna alexandrina* and belongs to family Fabaceae. It is native to southern India and north eastern Africa. The sporadic distribution of senna crop is reported in parts of Sindh province of Pakistan as well as Mundra and Anjar of Kutch districts of western Gujarat, India [1]. Senna is predominantly a self-pollinated species. It attains a height of 1.0 to 2.0 meter under normal cultivation. The plant bears compound, pinnate leaves, having 5 to 8 pairs of shortly stalked leaflets, which are oval-lanceolate 2 to 5 x 1.5 cm, pale green, glabrous with smooth margin, acute apex and oblique at base. The plant produces a 30-45 cm long axillary or sub-terminal raceme bearing many large brilliant yellow coloured showy flowers. The pods are pale green in the beginning which change to greenish brown and dark brown on maturity after drying. The crop is photo-insensitive and can be grown twice a year [2].

Senna leaves contain anthraquinone derivates, which are present in both free and combined state. Two crystalline glucosides sennoside A & B have been reported from the leaves and pods. Sennoside A & B are reported to have potent laxative action. It also contains a yellow flavanol colouring matter kaempferol. The leaf of the senna plant is used for the treatment of constipation, to clear the bowel before a colonoscopy. Senna plant is also used for treatment of hemorrhoids and weight loss. Senna is used for irritable bowel syndrome, leprosy, in the treatment of bronchitis, cough, cold, asthma, skin disorder called leukoderma, typhoid, cholera, gout and jaundice. Senna with water pills can decrease potassium in the body. Senna is mixed with tea for dieters because it decreases appetite without affecting the body system. It regulates gastric juice secretion in the body. Senna was originally used for the treatment of fever, indigestion and killing ringworm naturally or any kind of intestinal worm.

Senna seeds usually exhibit seed coat-imposed dormancy which may be due to impermeability of testa to water and gases [3]. The seed germination is the first and foremost pre-requisite in assessing the quality and optimizing yields from a given seed lot. Seed testing protocols of some medicinal crops are available in International Rules for Seed Testing, edition 2018, where prescription for substrate, temperature, test duration and dormancy breaking treatments. However, the information on requirement of temperature and substrate for seed germination in senna is neither available in ISTA rules (2018) nor any systematic study has been reported. Some preliminary information on seed germination in senna [4,5] is available in literature and needs further validation in order to encourage the successful and economical seed germination percentage in senna crop. The most common cause of delay in seed germination in senna seeds is the imperviousness of the seed coat *i.e.* blocking of water entry into the seed [6,7]. For germination to start, the impermeable seed coat must be rendered permeable. Hence, dormancy breaking treatment of *cassia* seeds is of big importance and needs specific treatments for breaking seed dormancy [8,9]

MATERIALS AND METHODS

The seeds of senna varieties KKM 1 and GAS 1 were obtained from ICAR- Directorate of Medicinal and Aromatic Plant Research, Anand and Medicinal and Aromatic Plant Research Station, Anand Agricultural University, Anand, respectively. The germination test was conducted by adopting "Between Paper (BP)" method. A one hundred number of seeds in four replications were taken at random from the seed lot of each variety and placed uniformly on germination paper. The rolled towel was kept in germinator at different temperatures (20°C, 25°C, 30°C and 35°C), where the relative humidity was maintained as per ISTA procedures. The final count of germination percentage was recorded on 7th day of germination test. In the second experiment, seeds were scarified mechanically for one and two minutes in seed scarifier, chemical scarification was done by using H_2SO_4 (100%) for 2, 4, 6 minutes and soaking of seeds in Hot water (100°C) for one and two minutes, after the seed treatments they were kept in germination chamber with best suitable temperature obtained from the first experiment study.

Mechanical scarification

The 50 g seeds were taken at random from the fresh seed lot of each variety and mechanically scarified using INDOSAW electrical seed scarifier for one and two minutes.

Acid scarification

The 50 g seeds were taken at random from the fresh seed lot of each variety and seeds was soaked in 100% H_2SO_4 for 2 minutes, 4 minutes and 6 minutes, after that the seeds was washed in running tap water several times to remove residual chemical from seed coat.

Hot water treatment

The 50 g seeds were taken at random from the fresh seed lot of each variety and seeds was placed in muslin cloth bag and dipped in boiling water (100°C) and allowed to stand for 1 minute, seeds were removed and cooled at room temperature (28 ± 2°C). The same procedure was repeated for 2 minutes treatment.

Germination (%)

The germination test was conducted by adopting "Between Paper (BP)" method. 100 seeds in four replications were taken at random from the seed lot of each variety and placed uniformly on germination paper. The rolled towel was kept in germinator at different temperature (20°C, 25°C, 30°C and 35°C), where the relative humidity was maintained as per ISTA procedures. The final count of germination percentage was recorded on 7th day of germination test.

Seedling length (cm)

Final count was observed on 7th day and ten normal seedlings were selected randomly, and their seedling length was measured. The root length was measured from the tip of primary root to base of the hypocotyls and shoot length was measured from the base of primary leaf to the base of hypocotyls. Seedling length was calculated by adding seedling root and seedling shoot length.

Seedling dry weight (g)

To record seedling dry weight, ten seedlings were counted, cut free from their cotyledons and seedlings were placed at 80°C in an oven for 24 hr for drying. Thereafter, the seedlings were removed and cooled in desiccator for one hour before weighing on an electronic balance.

Seedling vigour indices

The vigour indices were calculated using the procedure suggested by [10].

Seedling vigour index-I = Germination (%) × Seedling length (cm)

Seedling vigour index-II = Germination (%) × Seedling dry weight (g)

RESULTS AND DISCUSSIONS

Effect of different temperatures on germination per cent and other seedling quality parameters

Seed germination increases as temperature rises to optimum level for most crop species. Temperature is one of the important environmental factors influencing the induction of seed dormancy during seed development and expression of seed dormancy during germination. The seed germination percent was least at 20°C (19.33%) and highest at 25°C (32.33 %) followed by 30°C (26.66 %) and 35°C (25.00 %) in seed germination chamber (Table 1 and Plate 1). In case of varieties, highest germination per cent was recorded in KKM 1 (34.50%). High temperatures are associated with high endogenous abscisic acid contents that inhibit germination [11]. The seedling growth parameters like seedling length (17.92 cm) seedling dry weight (0.089 gm), seedling vigour index I (594) and seedling vigour index II (2.86) were maximum at 25°C temperature (Plate 2). Higher temperature may inhibit the catabolic activities in seeds, it may also result in failure of activation of pre-existing enzymes resulting in delaying emergence of radicle and plumule. These results are in conformity with the findings of [12-16] also found similar results.

Effect of different physical treatments on germination per cent and other seedling quality parameters

Mechanical and acid scarification treatment shows significant increase in germination per cent (Table 2 and Plate 3). The highest germination per cent was recorded in mechanical scarification for two minutes (94.66%) followed by mechanical scarification for one minutes (89.00%) and H_2SO_4 (100 %) for six minutes (73.00 %) as comparison to control (32.33). The fact that mechanical and acid scarification improved germination of senna seeds indicates that the dormancy of the species tested in this study is due to the presence of hard seed coats that block the entrance of water into the seeds. The seeds of *Cassia angustifolia* treated with hot water showed the least performance in germination percentage because of its effect on the seed coat that must have ruptured or damaged the seeds embryo. A sudden dip of dry seeds in boiling water may lead to the rupture of the seed coat allowing water to permeate the tissues causing physiological changes and subsequent germination of the embryo [17-19]. However, it can be well detrimental when in excess leading to the death of the seeds. Several works [20, 21] showed that germination of several Cassia species increased when seeds were either mechanically scarified or treated with concentrated sulphuric acid. Germination of Cassia fistula L. was improved when seeds were mechanically scarified (84%) or treated with concentrated sulphuric acid (84%) [22]. The result showed that highest seedling root length and seedling

Table 1. Influence of different temperature treatments and varieties on germination (%), seedling length (cm), seedling dry weight (g), vigour index-I and vigour index-II

Treatments	Germination %			Seedling length (cm)			Seedling dry weight (g)			Seedling Vigour index-I			Seedling Vigour index-II		
	Varieties		Mean T	Varieties		Mean T	Varieties		Mean T	Varieties		Mean T	Varieties		Mean T
	V1	V2		V1	V2		V1	V2		V1	V2		V1	V2	
T1	18.00	20.66	19.33	4.17	4.54	4.35	0.058	0.053	0.055	75	93	84	1.04	1.09	1.06
T2	42.66	22.00	32.33	19.38	16.45	17.92	0.088	0.09	0.089	726	362	594	3.75	1.98	2.86
T3	40.00	13.33	26.66	16.43	15.78	16.11	0.079	0.074	0.076	657	210	433	3.16	0.98	2.07
T4	37.33	12.66	25.00	8.23	10.11	9.17	0.085	0.083	0.084	307	127	217	3.17	1.05	2.11
Mean V	34.50	17.16	25.83	12.05	11.72	11.89	0.077	0.075	0.077	466	198	332	2.78	1.27	2.03

Source of Variation	S.Em ±	C.D. 5%	S.Em ±	C.D. 5%	S.Em ±	C.D. 5%	S.Em ±	C.D. 5%	S.Em ±	C.D. 5%
V	0.56	1.69	0.23	NS	0.001	NS	12.09	36.26	0.07	0.23
T	0.79	2.39	0.33	0.99	0.002	0.005	17.1	51.28	0.11	0.33
V×T	1.13	3.38	0.46	1.4	0.002	NS	24.19	72.52	0.15	0.46
CV%	7.58		6.81		5.03		12.56		13.21	

Varieties: - V_1- KKM 1, V_2- GAS 1; Treatments: - T_1- 20 °C, T_2- 25 °C, T_3-30 °C, T_4- 35 °C

Table 2. Influence of different scarification treatments and varieties on germination (%), seedling length (cm), seedling dry weight (g), vigour index-I and vigour index-II

Treatments	Germination (%)			Seedling length (cm)			Seedling dry weight (g)			Seedling Vigour index-I			Seedling Vigour index-II		
	Varieties		Mean T	Varieties		Mean T	Varieties		Mean T	Varieties		Mean T	Varieties		Mean T
	V1	V2		V1	V2		V1	V2		V1	V2		V1	V2	
T_1	42.66	22.00	32.33	17.37	17.61	17.49	0.088	0.090	0.089	741	387	564	3.75	1.98	2.86
T_2	92.00	86.00	89.00	16.67	16.40	16.54	0.089	0.090	0.090	1534	1410	1471	8.18	7.74	7.96
T_3	92.66	96.66	94.66	21.82	16.93	19.38	0.092	0.091	0.092	2021	1636	1829	8.53	8.79	8.66
T_4	56.00	50.00	53.00	8.56	9.66	9.11	0.079	0.088	0.084	479	483	481	4.42	4.40	4.41
T_5	78.66	52.66	65.66	8.80	9.20	9.00	0.083	0.085	0.084	692	484	588	6.52	4.47	5.50
T_6	79.33	66.66	73.00	8.71	9.79	9.25	0.083	0.088	0.086	691	652	671	6.59	5.86	6.22
T_7	16.66	68.66	42.66	6.37	12.31	9.34	0.023	0.071	0.047	106	845	476	0.38	4.87	2.62
T_8	15.33	42.00	28.66	5.43	10.65	8.04	0.030	0.062	0.046	83	447	265	0.46	2.61	1.53
Mean V	59.16	60.58	59.87	11.72	12.82	12.27	0.071	0.083	0.078	794	793	793	4.85	5.09	4.97

Source of Variation	S.Em ±	C.D. 5%	S.Em ±	C.D. 5%	S.Em ±	C.D. 5%	S.Em ±	C.D. 5%	S.Em ±	C.D. 5%
V	1.07	NS	0.16	0.48	0.001	0.003	16.94	NS	0.11	NS
T	2.15	6.20	0.33	0.96	0.002	0.006	33.89	97.70	0.23	0.68
V×T	3.04	8.77	0.47	1.36	0.003	0.009	47.93	138.16	0.33	0.97
CV%	8.81		6.69		6.79		10.46		11.68	

Varieties: - V_1- KKM 1, V_2- GAS 1

Treatments: - T_1- Control, T_2- Mechanical Scarification (1 minute), T_3-Mechanical Scarification (2 minutes), T_4- H_2SO_4 (100%) 2 minutes T_5- H_2SO_4 (100%) 4 minutes, T_6- H_2SO_4 (100%) 6 minutes, T_7- Hot Water (100 °C) 1 minute, T_8- Hot Water (100 °C) 2 minutes

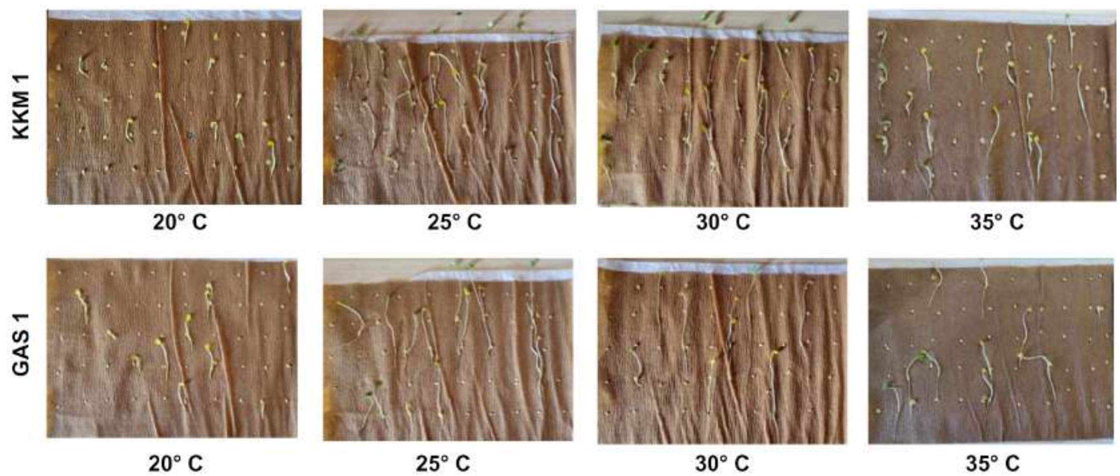

Plate 1. Influence of different temperature treatments and variety on germination (%)

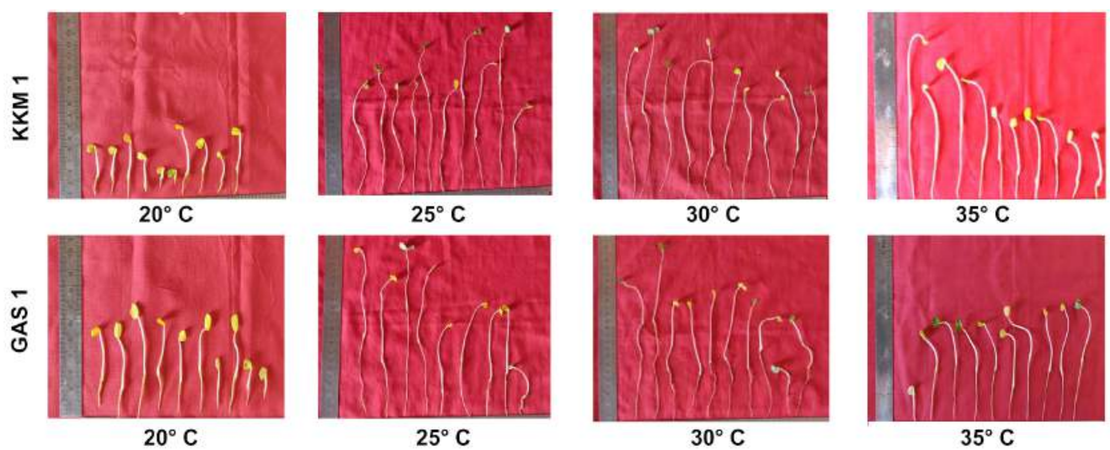

Plate 2. Influence of different temperature treatments and variety on seedling length (cm)

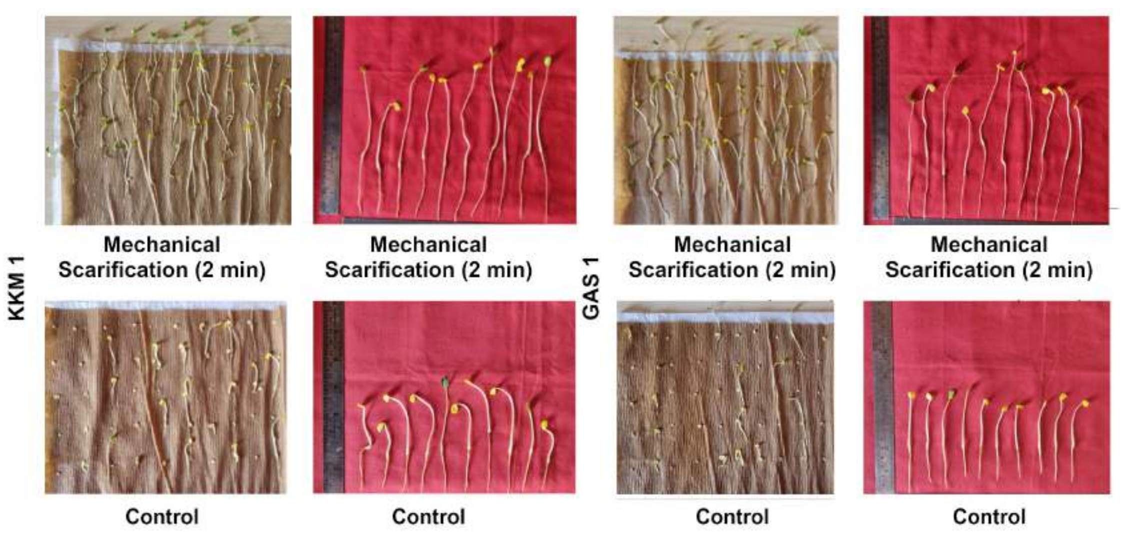

Plate 3. Influence of different scarification treatments on germination (%) and seedling length of variety KKM 1 and GAS 1

shoot length was in mechanical scarification treatment, fast growth of seedlings from scarified seeds occurred because radicle and plumule originated from scarified seeds had an advantage of absorbing much water and started the metabolic process much earlier than others. The results are in conformity with to [23, 24]. The higher seedling fresh weight (2.47 g), seedling dry weight (0.092 g), seedling vigour index I (1829) and seedling vigour index II (8.66) were also recorded in mechanical scarification treatment. The results were in conformity with findings [25].

CONCLUSION

Different temperature regimes affected seed germination per cent and other quality parameters of senna. Seeds grown at 25°C temperature enhanced the germination per cent and other seedling parameters also mechanical scarification treatments performed better than other scarification treatments. Seeds treated with mechanical scarification for 2 min increased germination per cent and other seedling parameters.

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