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Effect of Seed Priming with Various Organic and Inorganic Compounds on Cotton Seed Germination and Seedling Development

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study was conducted to evaluate the effects of seed priming with various organic and inorganic compounds on cotton seed germination and seedling development.
Study design: Completely randomized design
Place and Duration of Study: The experiment was conducted in Department of cotton, AC & RI, TNAU, Coimbatore in 2022.
Methodology: The acid delinted seeds were treated with 10 different organic and inorganic priming materials and treatments are T_1- Hydropriming, T_2- Panchagavya 5%, T_3- Panchagavya 10%, T_4- Cow urine 3%, T_5- Cow urine 6%, T_6- KNO_3 2%, T_7- Mepiquat chloride 200 ppm, T_8- Mepiquat chloride 300 ppm, T_9- Salicylic acid 100 ppm, T_{10}- Salicylic acid 200 ppm. Seeds were soaked in priming materials for 12 hours and shade dried for 3 hours and following observations were made, Germination percent (%), Root length (cm), Shoot length (cm), Seedling length (cm), Number of lateral roots, Seedling fresh weight (g), Seedling dry weight (g), Seedling Vigor Index I, Seedling Vigor Index II and were taken between 10 days interval i.e., 10,20,30 DAS.

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Results: Maximum germination percent (100%) was recorded under treatment T5- Cow urine 6%. Maximum root length (9.3, 10.1 and 18.4 cm), shoot length (9.9, 18.8 and 26.0 cm), seedling length (19.2, 28.9, 44.4cm) were recorded with T_5- Cow urine 6%. Seedling fresh weight (0.75, 2.26, 6.97 g), seedling dry weight (0.075, 0.39, 0.83 g) were found highest in the treatment T_5- Cow urine 6% in all observations. Number of lateral roots (25, 28, 38) and vigor indices I (1920, 2893, 4437) & II (7.53, 39, 83.3) were recorded higher with T_5- Cow urine 6%.
Conclusion: Among seed priming with various organic and inorganic compounds, seed priming with 6 percent cow urine outperformed all other treatments and recorded highest seedling vigor.

Keywords: Cotton; seed priming; organic and inorganic; cow urine.

1. INTRODUCTION

Cotton is India's most important fibre and cash crop, and it plays a significant part in the country's industrial and agricultural economies. Cotton is the most significant fibre in the world, accounting for 40% of total global fibre production. India has surpassed China as the world's greatest producer of cotton, taking first place in terms of both total area and production. In India during 2020-21, production of cotton was 352.5 lakh bales cultivated under an area of 132.85 lakh hectares with a productivity of 451 kg per hectare [1]. The average exports of cotton by India are 77.59 lakh bales whereas the average imports in India are 11.03 lakh bales. For 2020-21, the total supply was 484.3 lakh bales and total demand was 412.5 lakh bales [2].

There are four cultivated species of cotton viz. *Gossypium arboreum*, G.*herbaceum*, *G.hirsutum* and *G. barbadense*. *G. hirsutum* is the predominant species which alone contributes about 90% to the global production. Approximately 65% of India's cotton is produced on dry land and 35% on irrigated lands. Cotton, a semi-xerophyte, is grown in tropical & sub-tropical conditions. Cotton is a *Kharif* crop in the major parts of the country. Most of the irrigated and rain-fed crop in Tamil Nadu is planted between August and September. Cotton sowings in Andhra Pradesh and Tamil Nadu rice fallows take place from the second half of December until the middle of January. In rice fallow condition excess moisture and previous crop stubbles are conserved and efficiently utilized for following crop. These stubbles make the cotton seeds difficult in germination [3].

Seed priming is a pre-sowing treatment that causes a physiological change in the seed, allowing it to germinate more quickly. Priming usually entails soaking the seed in a specific amount of water or limiting the imbibition time [4]. Seeds that have been primed have a higher germination rate and more uniform germination. Under stressful conditions, seed priming technique is commonly utilized to synchronize germination, reduce emergence time, and promote crop establishment [5]. Salicylic acid (SA) has been used to increase seed germination and seedling performance in different crops. Mechanisms by which the SA generates these improvements are related to the protection of cell membranes, increases in carbon metabolism [6], antioxidant system, and photosynthetic pigments [7].

Cow urine contains about 1.0% nitrogen, traces of P_2O_5 and 1.0% of K_2O. Iron, urea, uric acid, oestrogen, and progesterone are all found in cow urine, and they alter the inhibitory response to seed germination, shoot growth, and seedling vigor [8]. Biochemical constituents such as ash, nitrogen, potassium, and phosphorus were significantly affected by Panchagavya priming [9]. Priming with KNO_3 shows positive effect on seedling and enzyme production [10]. Mepiquat chloride (MC) is a synthetic growth retardant used to control plant height. It alters rooting patterns by acting on biomass partitioning, reducing the growth of some portions while boosting the growth of others [11]. MC also improves root growth by increasing the number of lateral roots, and it has an impact on lateral root formation by encouraging auxin to cooperate with other phytohormones [12]. Based on above facts, the experiment was formulated to find the effect of various organic and inorganic priming materials on cotton seed germination and seedling vigor.

The main objective of the study is

1. To find the best priming materials for cotton.
2. To assess the seedling vigor of cotton with different priming materials.

2. MATERIALS AND METHODS

The experiment was conducted in Department of cotton, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. Genetically pure cotton seeds of variety Co 17 were used for this study. The soil used for this study was calcareous black cotton soil. Seeds were first acid delinted and shade dried. To remove the acid from the seeds' surfaces, a stream of tap water was poured over them and through the funnel [13]. This experiment was laid out by Completely Randomized Design with 10 treatments and 3 replications. The acid delinted seeds were treated with 10 different organic and inorganic priming materials (see Table 1). The treatments are T_1- Hydropriming, T_2- Panchagavya 5%, T_3- Panchagavya 10%, T_4- Cow urine 3%, T_5- Cow urine 6%, T_6- KNO_3 2%, T_7- Mepiquat chloride 200 ppm, T_8- Mepiquat chloride 300 ppm, T_9- Salicylic acid 100 ppm, T_{10}- Salicylic acid 200 ppm. Cotton seeds were soaked in priming materials for 12 hours and shade dried for 3 hours. Observations were made in intervals of 10 days. Germination test was not according to ISTA standards because the germination percent was directly observed from the field. The following observations were made, Germination percent (%), Root length (cm), Shoot length (cm), Seedling length (cm), Number of lateral roots, Seedling fresh weight (g), Seedling dry weight (g), Seedling Vigor Index I, Seedling Vigor Index II. Data of germination percentage were transformed into arcsine square root percentage values for normalization. The observations were taken between 10 days interval i.e., 10,20,30 DAS. The data was analyzed using the AGRES software. Critical difference was calculated at 5 % level of significance. ANNOVA Mean sum of square for Treatment (Table 4) and error (Table 5) was represented.

Seedling Vigor Index I = Germination percent x seedling length (cm)

Seedling Vigor Index II = Germination percent x Seedling dry weight (g)

3. RESULTS AND DISCUSSION

3.1 Germination Percent

The effect of seed priming on germination percentage in cotton is given in Table 1(10 DAS), Table 2 (20 DAS) and Table 3 (30 DAS). Maximum germination percent (100%) and it was recorded under treatment T_5- Cow urine 6%. Treatment T_4- Cow urine 3%, T_5- Cow urine 6% and T_{10}- Salicylic acid 200 ppm was on par with one another. Increased seed physiological characteristics could be attributable to the presence of physiological active chemicals in cow urine, including as growth regulators and nutrients. The beneficial influence on germination of seeds may be due to growth promoting substances in cow urine [14]. Similar germination percentage results were obtained by Kumar et al. [15] in cotton with cow urine 6%.

3.2 Root, Shoot and Seedling Length

The effect of seed priming on Root, Shoot and Seedling length in cotton is given in Table 1(10 DAS), Table 2 (20 DAS) and Table 3 (30 DAS). Maximum root length of 9.3 cm, 10.1 cm and 18.4 cm was recorded with treatment T_5- Cow urine 6% at 10, 20, 30 DAS respectively. Treatment T_5- Cow urine 6% was significantly higher. Maximum shoot length of 9.9 cm, 18.8 cm, 26.0 cm was recorded with treatment T_5- Cow urine 6% at 10, 20, 30 DAS respectively and treatment T_5- Cow urine 6% was significantly higher at 10 DAS and at 20 and 30 DAS T_5 and T_{10} were on par with one another. Similarly maximum seedling length of 19.2 cm, 28.9 cm, 44.4 cm was recorded with treatment T_5- Cow urine 6% at 10, 20, 30 DAS respectively and treatment T_5- Cow urine 6% was significantly higher at 10 DAS and at 20 and 30 DAS T_5 and T_{10} were on par with one another. The comparison between control and cow urine 6 % was shown in Fig. 1 & Fig. 2. The reason for increased length of seedling may be because of cow urine contains iron, urea, uric acid, oestrogen, and progesterone which affect the inhibitory response to seed germination, shoot growth and seedling vigor [8]. Similar results were obtained by kumar et al. [15] in cotton with cow urine 6% and Tiwari et al. [16] in chickpea with cow urine 6%.

3.3 Seedling Fresh Weight and Seedling Dry Weight

The effect of seed priming on Seedling fresh weight and Seedling dry weight in cotton is given in Table 1(10 DAS), Table 2 (20 DAS) and Table 3 (30 DAS). Maximum seedling fresh weight of 0.75 g, 2.26 g, 6.97 g was recorded under the treatment T_5- Cow urine 6% at 10, 20, 30 DAS respectively and at all observations treatment T_5- Cow urine 6% was significantly higher. Similarly Maximum seedling dry weight of 0.075 g, 0.39 g, 0.83 g was recorded under the treatment T_5- Cow urine 6% at 10, 20, 30 DAS respectively

and at all observations treatment T_5- Cow urine 6% was significantly higher. The beneficial influence on germination of seeds may be due to growth promoting substances in cow urine [14]. Similar results were obtained by kumar et al., 2017 in cotton with cow urine 6% and Desai et al. [17] also recorded similar results in papaya. Shatpathy et al. [18] obtained similar results with SA 100 ppm in rice.

Fig. 1. T_1- Control seedling length at 30 DAS

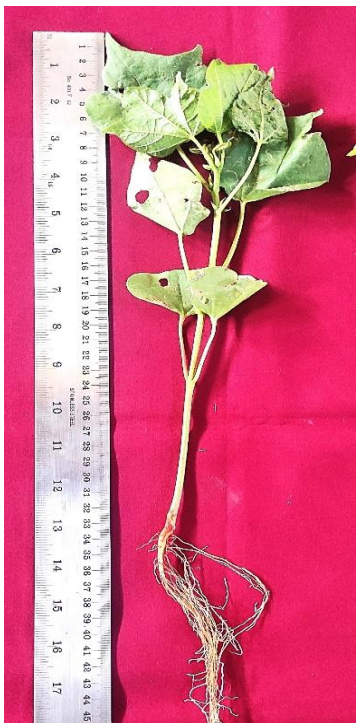

Fig. 2. T_5- Cow urine 6 % seedling length at 30 DAS

Table 1. Effect of seed priming on cotton seedlings on 10 DAS

	Germination %	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling Fresh weight (g)	Seedling dry weight (g)	Number of Lateral roots
Control (T_1)	65.9* (83.3)**	5.10	6.9	12.0	0.553	0.050	17
Panchagavya 5% (T_2)	45.0* (50)**	3.30	5.1	8.4	0.293	0.028	11
Panchagavya 10% (T_3)	30.0*(25)**	2.50	4.5	6.9	0.207	0.018	9
Cow urine 3% (T_4)	73.2* (91.7)**	6.40	8.9	15.2	0.640	0.061	22
Cow urine 6% (T_5)	90.0* (100)**	9.30	9.9	19.2	0.753	0.075	25
KNO3 2% (T_6)	45.0* (50)**	4.50	5.8	10.3	0.420	0.048	12
MC 200 ppm (T_7)	60.0* (75)**	5.80	6.3	12.1	0.463	0.059	17
MC 300 ppm (T_8)	45.0* (50)**	3.40	4.8	8.2	0.393	0.050	11
SA 100 ppm (T_9)	60.0* (75)**	6.90	6.4	13.3	0.490	0.057	18
SA 200 ppm (T_{10})	73.2* (91.7)**	7.40	8.0	15.3	0.607	0.059	20
SEd	6.45	0.52	0.42	0.77	0.04	0.004	1.25
CD (*P = .05*)	13.46	1.09	0.88	1.61	0.08	0.01	2.62
C.V.	9.68	11.77	7.78	7.85	9.08	9.86	9.42

**MC- mepiquat chloride, SA- salicylic acid*

** Germination percent was represented by arc sin data transformation*

*** Non transformed data expressed in percentage*

Table 2. Effect of seed priming on cotton seedlings on 20 DAS

	Germination %	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling Fresh weight (g)	Seedling dry weight (g)	Number of Lateral roots
Control (T_1)	65.9* (83.3)**	7.70	14.40	22.10	1.23	0.16	20
Panchagavya 5% (T_2)	45.0* (50)**	6.50	13.50	20.10	1.19	0.16	18
Panchagavya 10% (T_3)	30.0* (25)**	5.30	10.70	16.00	1.04	0.11	16
Cow urine 3% (T_4)	73.2* (91.7)**	8.10	15.80	23.80	1.50	0.24	22
Cow urine 6% (T_5)	90.0* (100)**	10.10	18.80	28.90	2.26	0.39	28
KNO3 2% (T_6)	45.0* (50)**	6.70	12.30	19.00	1.27	0.15	18
MC 200 ppm (T_7)	60.0* (75)**	7.50	14.70	22.20	1.49	0.20	20
MC 300 ppm (T_8)	45.0* (50)**	6.50	10.80	17.30	1.02	0.11	18
SA 100 ppm (T_9)	60.0* (75)**	8.20	15.60	23.80	1.51	0.27	21
SA 200 ppm (T_{10})	73.2* (91.7)**	8.70	17.10	25.70	1.88	0.30	23
SEd	6.45	0.64	1.02	1.65	0.14	0.02	1.05
CD (*P = .05*)	13.46	1.35	2.13	3.44	0.29	0.04	2.19
C.V.	11.43	10.53	8.71	9.24	11.92	11.93	6.31

**MC- mepiquat chloride, SA- salicylic acid*

** Germination percent was represented by arc sin data transformation*

*** Non transformed data expressed in percentage*

Table 3. Effect of seed priming on cotton seedlings on 30 DAS

	Germination %	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling Fresh weight (g)	Seedling dry weight (g)	Number of Lateral roots
Control (T_1)	65.9*(83.3)**	12.00	19.30	31.40	2.94	0.52	26
Panchagavya 5% (T_2)	45.0* (50)**	10.40	17.80	28.30	2.53	0.48	25
Panchagavya 10% (T_3)	30.0* (25)**	9.50	17.40	26.90	1.76	0.37	22
Cow urine 3% (T_4)	73.2*(91.7)**	14.30	22.60	39.30	4.59	0.67	33
Cow urine 6% (T_5)	90.0* (100)**	18.40	26.00	44.40	6.97	0.83	38
KNO3 2% (T_6)	45.0* (50)**	11.60	17.70	29.20	2.30	0.44	22
MC 200 ppm (T_7)	60.0* (75)**	12.90	20.30	33.20	3.16	0.52	26
MC 300 ppm (T_8)	45.0* (50)**	9.90	17.60	27.60	1.60	0.30	23
SA 100 ppm (T_9)	60.0* (75)**	15.00	21.90	35.10	3.99	0.62	28
SA 200 ppm (T_{10})	73.2*(91.7)**	16.20	23.70	41.20	5.65	0.72	34
SEd	6.45	0.66	1.41	1.85	0.32	0.04	1.89
CD (*P = .05*)	13.46	1.38	2.94	3.87	0.67	0.09	3.95
C.V.	11.57	6.26	8.46	6.72	11.09	10.23	8.36

MC-mepiquat chloride, SA- salicylic acid

** Germination percent was represented by arc sin data transformation*

*** Non transformed data expressed in percentage*

3.4 Number of Lateral Roots

The effect of seed priming on Number of lateral roots in cotton is given in Table 1 (10 DAS), Table 2 (20 DAS) and Table 3 (30 DAS). Highest number of lateral roots of 25, 28, 38 was recorded with the treatment T_5- Cow urine 6% at 10, 20, 30 DAS respectively and observation at 10 DAS, treatment T_4, T_5 was on par with one another and at 20 DAS treatment T_5- Cow urine 6% was significantly higher and observation at 30 DAS, treatment T_{10}, T_5 was on par with one another. Increased seed physiological characteristics could be attributable to the presence of physiological active chemicals in cow urine, including as growth regulators and nutrients [14]. Cow urine contains about 1.0% nitrogen, traces of P_2O_5 and 1.0% of K_2O [19].

3.5 Seedling Vigor Indices

The effect of seed priming on Seedling vigor indices is given in Figs. 1 & 2. Highest Vigor index I of 1920, 2893, 4437 was recorded with treatment T_5- Cow urine 6% at 10, 20, 30 DAS respectively and observation at 10 and 20 DAS, treatment T_5- Cow urine 6% was significantly higher and at 30 DAS treatment T_4, T_5 was on par with one another (see Fig. 3). Highest vigor index II of 7.53, 39, 83.3 was recorded with treatment T_5- Cow urine 6% at 10, 20, 30 DAS respectively and at all observations treatment T_5- Cow urine 6% was significantly higher (see Fig. 4). Cow urine contains iron, urea, uric acid, oestrogen, and progesterone which affect the inhibitory response to seed germination, shoot growth and seedling vigor [8]. Similar results

Table 4. Analysis of treatment (d.f = 9) mean sum of square of seedling characters

S. No.	Characters	Treatment Mean sum of squares		
		10 DAS	20 DAS	30 DAS
1	Germination %	1761.57	1761.57	1761.57
2	Root length	13.54	5.46	25.29
3	Shoot length	9.53	20.62	26.92
4	Seedling length	43.78	46.40	116.73
5	Seedling fresh weight	0.080	0.44	9.17
6	Seedling dry weight	0.0008	0.023	0.203
7	Lateral roots	83.03	32.45	90.53
8	Vigor index I	1099158.91	1800183.81	4661941.78
9	Vigor index II	16.55	376.52	1782.95

** Mean sum of square values is significant at 5 % level of significance*

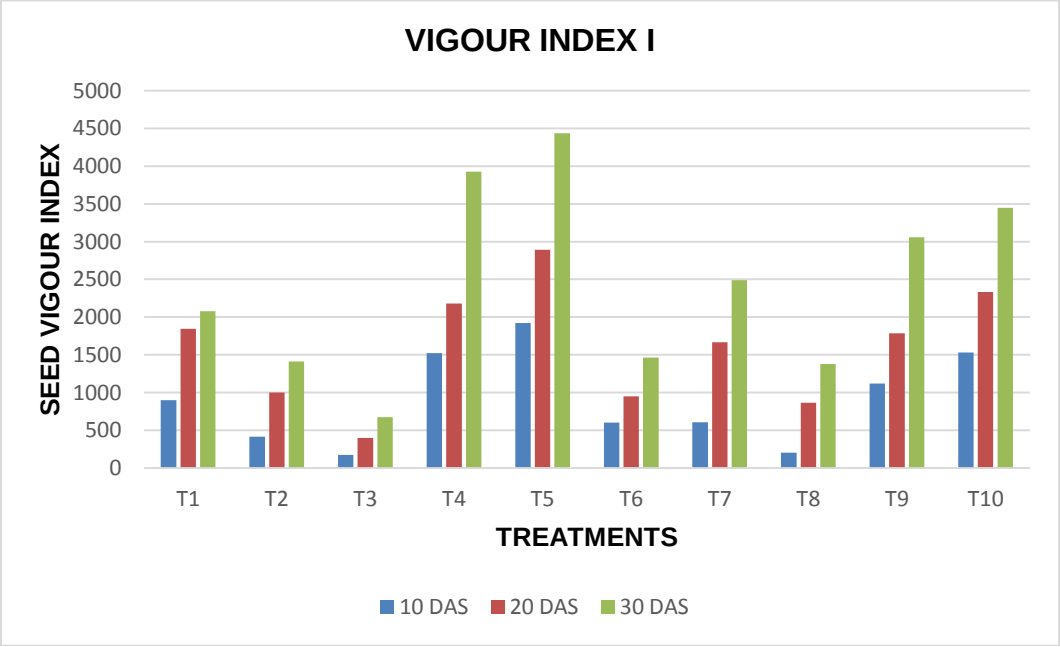

Fig. 3.

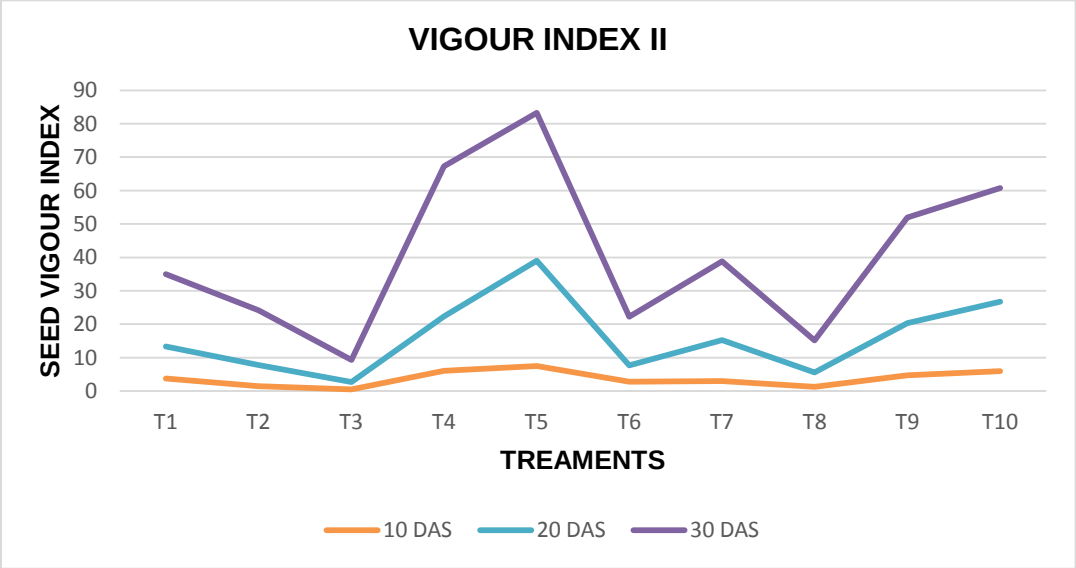

Fig. 4.

Table 5. Analysis of error (d.f = 20) Mean sum of square of seedling characters

S. No.	Characters	Error Mean sum of squares		
		10 DAS	20 DAS	30 DAS
1	Germination %	62.50	62.50	62.50
2	Root length	0.41	0.63	0.66
3	Shoot length	0.26	1.56	2.98
4	Seedling length	0.90	4.10	5.16
5	Seedling fresh weight	0.002	0.029	0.15
6	Seedling dry weight	0.00003	0.0006	0.17
7	Lateral roots	2.36	1.66	5.40
8	Vigor index I	6759.16	33590.62	92752.29
9	Vigor index II	0.13	3.30	13.75

** Mean sum of square values is significant at 5 % level of significance*

were found by Pavan et al. [14] with cow urine 3% in foxtail millet and Similar results were obtained by kumar et al. [15] in cotton with cow urine 6%.

4. CONCLUSION

From the experiment, it is concluded that cotton seeds shown significant effect with all priming materials. Seed priming with Cow urine 6% performed better among all the treatments. Seed priming with Cow urine 6% resulted highest germination percent, maximum root length, shoot length, seedling length, no of lateral roots, seedling fresh and dry weight, and vigor indices

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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