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Seed Priming as a Tool for Enhancing Yield in Ragi (*Eleusine corocana*)

V. Deepa Priya[1]*, A. L. Narayanan[2], P. Saravanane[2] and L. Aruna[2]

[1]Department of Soil Science and Agricultural Chemistry,
[2]Department of Agronomy, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal - 609 603, India

**Corresponding author*

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A B S T R A C T

A field experiment was conducted in agronomy farms at Department of Agronomy, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during *kharif* season of 2019 to investigate the performance of different seed priming materials in ragi (TRY 1) for coastal deltaic regions of Karaikal. The crop was raised in Randomised Block Design (RBD) with nine treatments and replicated thrice. Ragi seeds were primed in different botanical extract and it was used for sowing. Primed seeds had generally shown higher germination percentage, deeper root system and early flowering than unprimed seeds. Seeds primed with three percent panchakavya had shown better growth attributes like plant height (109. 8 cm), LAI (4.64) and DMP (9965 kg ha^{-1}) and yield attributes like number of productive tillers (4.1), weight of an ear head (7.75 g) and number of grains per ear head (1923). Grain yield of ragi was higher in panchakavya priming (1993 kg ha^{-1}). However, certain priming treatments like pungam leaf extract, ocimum leaf extract and plain water was comparable with panchakavya priming. Lowest grain yield was obtained in control (1256 kg ha^{-1}) Panchakavya priming had a higher B: C ratio of 2.37 with added returns of Rs. 18,078 ha^{-1}.

Introduction

Millets play an important role in food and nutritional security. In India, the total area under millet is 1.74 m ha out of which ragi alone occupies 1.19 m ha. Ragi is rich in calcium, iron, phosphorus, manganese and magnesium and hence, plays an important role in alleviation of malnutrition. Productivity per unit area has to be increased apart from mitigating climate change. Seed priming ensures uniform germination and helps to overcome the adverse conditions as a result of some of the physiological and biochemical changes that take place in a seed.

Higher effect of primed seeds over control was observed under sub optimal conditions like higher temperature, soil salinity, usage of poor-quality

seeds etc., Seed priming with botanical leaf extract and other organics are cost effective and are easily available to the farmers. Beneficial influence of botanicals in seed invigoration was reported by several authors such as Anbarasan and srimathi (2015), Punithavathi and Palanisamy (2001). Hence, a study was undertaken to identify a suitable seed priming practice for ragi.

Materials and Methods

The field experiment was conducted in Eastern block of Agronomy farms during *Kharif* season (June – September) 2019 at PAJANCOA & RI, Karaikal which is located at $10^0$55'N latitude, $79^0$49'E longitude and 4m above the Mean Sea Level.

Climate and weather

During the cropping period, a total rainfall of 434 mm was received against the normal rainfall of 274 mm and the heavy rainfall occurred during flowering and ripening stage of ragi. The mean maximum and minimum temperature were 35.7and 25.2°C respectively against the normal of 36 and 26.3°C respectively.

During germination and seedling stage of the crop, the mean maximum temperature and minimum temperature was slightly higher by 2˚C than normal (at 24 and 25th MSW) (39.4˚C and 28.4˚C against normal temperature of 36.7˚C and 26.5˚C). Moreover, the RH was lower by 10% than normal at the germination stage. The total bright sunshine hour was 855.7 during the cropping period.

Soil Characteristics

The soil of the experimental field was sandy loam in texture with neutral pH (7.65) and normal in EC (0.25 dS m^{-1}). The soil is low in available nitrogen (109.76 kg ha^{-1}), high in available phosphorus (39.69 kg ha^{-1}) and medium in available potassium (144.48 kg ha^{-1}) and the organic carbon (4.5 g kg^{-1}) was found to be low in initial soil.

Treatment details

The experiment was carried out in Randomised Block Design (RBD) with nine treatments which were replicated thrice. The treatments are T_1 – Farmer's practice (control); T_2 – priming with plain water; T_3 – priming with two per cent moringa leaf extract; T_4 – priming with one per cent pungam leaf extract; T_5 – priming with one per cent ocimum leaf extract; T_6 – priming with one per cent prosopis leaf extract; T_7 – priming with three per cent panchakavya; T_8 – priming with three per cent cow's urine; T_9 – priming with three per cent tender coconut water.

Preparation of extract and soaking of seeds

For preparation of leaf extracts fresh leaves of moringa, pungam, ocimum and prosopis were collected, weighed and macerated with water @ 2g of moringa and 1g of pungam, ocimum and prosopis respectively in 100 ml of water. Then, the extract was filtered through muslin cloth for priming the seeds (Venudevan *et al.*, 2016). Three per cent panchakavya, cow's urine and tender coconut water was prepared by taking 3ml of solution and make up the volume to 100 ml. Ragi (TRY 1) seeds were soaked in different leaf extract and other organic solution for 6 hours in 1:0.7 seed to solution ratio. After soaking the seeds were shade dried to bring back to its original moisture content.

Crop management

Germination percentage was calculated as per ISTA rules in the laboratory. Primed seeds of ragi were sown on june 17th in raised bed of size 3m X 1 m for each treatment totaling to nine beds with channels in between. Eighteen days old seedlings were used for transplanting with two seedlings per hill at a spacing of 30 cm X 10 cm. The gross plot area and net plot area of the main field were 5.1 m X 4 m = 20.4 $m^2$and 3.3 m X 3.4 m = 11.22 m^2 respectively. A blanket recommendation of 60:30:30 kg ha^{-1} of N, P_2O_5 and K_2O was adopted. The pre-emergence herbicide pendimethalin @ 1.0 kg a.i. ha^{-1} was

applied at 3 DAT with light irrigation followed by one manual hand weeding at 40 days after transplanting. A spray of chlorotranilprole @ 40 ml per acre was given at peak vegetative stage to manage stem borer in the experimental field. Five plants were randomly selected from each plot from net plot area for recording observations on growth and yield attributes. The N, P and K contents in the plants were analysed by micro-kjeldahl, triple acid digestion with vanado molybdate yellow colour and triple acid digestion with flame photometric methods respectively.

Results and Discussion

Germination percentage

Germination percentage was found to be significantly higher in primed seeds. Higher germination percentage was recorded in seeds primed with pungam leaf extract and prosopis leaf extract. However, it was on par with all other priming treatments except control. Lowest germination percentage was recorded in control. (Table 1.) The reason for higher germination percentage might be due to solubilisation and mobilization of compounds such as amino acids, soluble sugars etc., from storage organs to growing embryo before sowing. Presence of bioactive chemicals in pungam and prosopis leaf extracts triggers the synthesis of GA_3 which aids in translocation.

Growth attributes

Primed seeds had shown a significant increase in plant height, LAI and dry matter production over control. Growth parameters were found to be lower in control, but it was comparable with plots sown with prosopis and cow's urine primed seeds. Priming had resulted in deeper root system and flowering was found to be hastened in primed seeds. The typical reason might be due to increase in enzyme activity. Higher number of stomata per unit leaf area, increase in foliage area, increase in root system with more absorbing surfaces as a result of priming as depicted by Jerlin and Sumathi (2010). Among different priming treatments, seeds primed with three per cent panchakavya had recorded higher plant height(109. 8 cm), LAI (4.64) and DMP (9965 kg ha^{-1})at later stages. The growth rate of panchakavya primed seeds was found to be more at later stages than at initial stages. The probable reason may be due to the presence of EMO (Effective Micro Organism) cultures present in panchakavya. The growth parameters were also found to be better in seeds primed with tender coconut water, pungam leaf extract, ocimum leaf extract and moringa leaf extract.

Nutrient uptake

In the present investigation, the nutrient uptake (176.83 kg ha^{-1} of N, 47.50 kg ha^{-1} of P and 215.48 kg ha^{-1} of K) was found to be higher in plants primed with three per cent panchakavya (Table 2.) because of solubilisation of nutrients due to the presence of microorganism in the priming material besides having deeper root system.

Yield attributes and yield of ragi

Higher yield parameters like number of productive tillers per hill (4.1), weight of individual ear head (7.75 g), weight of ear head per hill (43.29 g), number of grains per ear head (1923) were recorded in plots sown with three per cent panchakavya primed seeds (Table 3.). However, the yield parameters were found to on par with plots sown with primed seeds of pungam leaf extract, ocimum leaf extract and plain water. Test weight (1000 seed weight) was found to be higher in moringa leaf extract priming (3.36 g), however it was comparable all other priming treatments except cow's urine and prosopis leaf extract priming. Number of fingers per ear head and length of the fingers were found to be unaffected by seed priming practices in transplanted ragi since they are genetic characters of the crop.

The higher yield (1993 kg ha^{-1}) was obtained in plots primed with three per cent panchakavya, which was comparable with other priming treatments like

one per cent pungam leaf extract, one per cent ocimum leaf extract and plain water. Lower grain yield was reported in control (1257 kg ha^{-1}) Panchakavya primed seeds had shown a yield increase of 58.63% over control.

Yield increase of 54.61% to 40.89% were noted in seeds primed with pungam leaf extract, ocimum leaf extract and plain water respectively.

Economics of seed priming practices

In the present investigation, the gross returns, net returns and B: C ratio was higher in all priming treatments except prosopis leaf extract. The yield of prosopis leaf extract was almost similar to control. The seeds primed with three per cent panchakavya gave an added return of Rs. 18,079 per hectare over control with a higher B:C ratio of 2.37.

Effect of seed priming practices on germination and growth of ragi

Germination percentage along with seedling vigour provides a very good estimate of the potential field performance. Seed priming tends to increase the germination percentage and vigour of the seedling by solubilisation and mobilization of compounds such as amino acids, soluble sugars etc., from storage organs to growing embryo. The percentage increase in germination of primed seeds over control was generally higher.

The result of the present investigation also showed that the germination percentage was higher in case of seeds primed with one per cent pungam leaf extract. The reason for the above may be due to the presence of bio active chemicals present in pungam leaf powder triggers synthesis of gibberellin as depicted by Prakash *et al.,* (2020).GA3 aids in translocation of food materials to the germinating radical. Hence the germination percentage was found to be higher. The other priming materials like Prosopis leaf extract and panchakavya also possess GA3 which was confirmed by Perumal (2006). In general, the plant height and DMP of ragi was found to be higher from active tillering to flowering stage. Primed seeds of ragi had shown the better growth parameters like higher plant height, LAI, deeper root system, number of tillers and DMP than that of unprimed seeds.

Priming increases the viscosity and elasticity of protoplasmic colloids, increases phosphorylation activity of mitochondria, reduces solute leakage and regains cell integrity as depicted by Simon and Harun (1972). Similar results of higher growth parameters in primed seeds of ragi was reported by Dawson (1965). Jerlin and Sumathi (2010) also reported higher foliage area and increase in root system of hardened seeds.

Among different priming treatments, seeds primed with three per cent panchakavya had recorded higher plant height, LAI, number of tillers and DMP at later stages. The growth rate of panchakavya primed seeds was found to be more at later stages than at initial stages.

The probable reason may be due to the presence of EMO (Effective Micro Organism) cultures present in panchakavya which could synthesize phytoharmones (i.e. auxins and other growth regulators. Ram (2017) also reported production of larger leaf, denser canopy, enhanced growth and deeper root system in several crops when panchakavya was given as spray or amended in soil.

Influence of seed priming practices on yield parameters and yield of ragi

The results from the present investigation showed that the yield parameters like number of productive tillers per hill, weight of individual ear head, weight of ear head per hill, number of grains per ear head, test weight (1000 seed weight) etc., were influenced by seed priming practices.

However, number of fingers per ear head and length of the fingers were found to be unaffected by seed priming practices in transplanted ragi since they are genetic characters of the crop. The yield of ragi was

influenced by number of productive tillers per hill and number of grains per ear head. This was in accordance with Pramod Kumar *et al.,* (2002) who reported plant height and total dry matter with yield were non-significant. Bhagat *et al.,* (1972) observed significant association between yield and number of productive tillers and days to heading. Seed priming practices had shown better yield with panchakavya, pungam leaf extract, ocimum leaf extract, plain water and moringa leaf extract.

In present investigation, the grain yield was higher in three per cent panchakavya primed seeds with a yield increase of 58.63% over control. Sridhar and Kumar (2013) also recommended soaking of ragi seeds in panchakavya before sowing for the production of healthy seedlings.

Also a yield increase of 54.61% to 40.89% were noted in seeds primed with pungam leaf extract, ocimum leaf extract and plain water respectively. The invigorative effects of pungam leaf extract was due to various alkaloids like pinnalin, pongamol, saponin, β sisterol and tannins and bioactive substances like auxin and Gibberllin as depicted by Prakash *et al.,* (2020). The results were also in accordance with Punithavathi and Palaniswamy (2001) who narrated an improvement in seed quality character of ragi when hardened with aqueous leaf extract of one per cent pungam.

It was also interesting to note that the yield attributes and yield of seeds primed with MLE was higher because of the presence of zeatin, a natural cytokinin which helps in cell division and cell elongation.

Role of seed priming materials on hardening and biochemical process of ragi crop

Seed priming is a technique of controlling hydration and drying, that results in more rapid germination when the seeds are re-imbibed. Seed priming tends to modify physiological and biochemical nature of seed so as to get the desirable character for drought and stress resistance. Moreover, priming ensures uniform seed germination and enhance tolerance to pest and disease during early stage of crop growth. In botanical seed treatment, the extract is obtained from naturally occurring plants. These plants have some chemicals, growth hormones and nutrients which enhances the germination percentage and seedling vigour.

As panchakavya possess almost all the major nutrients, micronutrients and growth harmone which enhances the metabolic activity of plants it had supported the seed invigoration in a better way. Panchakavya priming had enhanced the nitrogen (nutrient) uptake of the plant because of the presence of naturally occurring beneficial Effective micro-organism mixture present in it.

The presence of growth promoting substances like auxin and gibberllin had paved way for better growth and development in seeds primed with pungam leaf extract. The presence of all the major nutrients and the water soluble saponins present in the pungam leaf extract might have enhanced the nutrient absorption as evidenced by Prakash *et al.,* (2020).

The higher root length and biomass of ocimum leaf extract primed seeds might be probably due to the presence of alkaloids like eugenol, urosolic acid, linallool, carvacrol etc, present in it. Moreover, the presence of antioxidants increases the free radical scavenging activity and dehydrogenase activity which helps to overcome the stress conditions.

As moringa leaf extract and tender coconut water contains cytokinin which helps in cell division and cell elongation the growth of the plants was better.

In general, some of the biochemical changes that take place in primed seeds are time shortening for DNA replication, increased life span of m RNA under moisture stress condition and higher proline content were reported by Srivatsava and Randhawa (1983). The presence of specialized materials in natural seed priming compounds has paved the way for better growth and yield as reported by Anbarasan and Srimathi (2015).

Table.1 Effect of seed priming practices on germination percentage and growth attributes of ragi.

Treatments	Germination percentage	Plant height (cm)			LAI			Dry matte production (kg ha^{-1})		
		20 DAP	40 DAP	60 DAP	20 DAP	40 DAP	60 DAP	Vegetative stage	Flowering stage	Harvest stage
T1: Farmer's practice (control)	82.0	36.17	54.60	90.13	0.75	2.16	3.12	771	4626	6213
T2: Plain water	89.3	42.59	62.73	105.93	1.79	3.15	4.35	1018	6027	7571
T3: Moringa leaf extract (2%)	89.3	42.67	61.87	100.63	1.31	3.07	4.28	1240	5704	7497
T4: Pungam leaf extract (1%)	93.0	45.39	63.67	100.93	2.28	3.07	4.17	1146	6236	8789
T5: Ocimum leaf extract (1%)	88.3	42.02	65.00	103.07	1.86	3.33	4.16	1526	6548	9247
T6: Prosopis leaf extract (1%)	92.3	39.71	55.87	92.13	0.91	2.30	3.24	831	4783	6807
T7: Panchakavya (3%)	89.0	46.32	65.47	109.80	2.09	3.54	4.64	1431	7524	9965
T8: Cow's urine (3%)	88.0	38.15	60.46	96.40	1.33	2.67	3.59	1145	5133	6944
T9: Tender coconut water (3%)	89.3	46.54	64.80	100.60	2.00	3.29	4.53	1199	5567	7063
S Ed	2.63	2.26	3.38	4.23	0.28	0.33	0.49	80.2	502.3	476.3
C.D (p = 0.05)	5.41	4.79	7.18	8.97	0.60	0.71	1.03	170.19	1064.8	1009.61

Table.2 Effect of seed priming practices on days to 50% flowering, root length at the time of flowering and nutrient uptake N, P and K by ragi

Treatments	Root length (cm)	Days to 50% flowering	Nutrient uptake by plants		
			N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})
T1: Farmer's practice (control)	82.0	78.67	95.68	24.23	114.56
T2: Plain water	89.3	76.00	127.20	33.35	147.41
T3: Moringa leaf extract (2%)	89.3	77.00	132.86	32.75	155.38
T4: Pungam leaf extract (1%)	93.0	74.67	156.25	43.66	194.41
T5: Ocimum leaf extract (1%)	88.3	74.33	168.29	41.38	187.81
T6: Prosopis leaf extract (1%)	92.3	77.33	126.78	27.92	139.72
T7: Panchakavya (3%)	89.0	73.67	176.83	47.50	215.48
T8: Cow's urine (3%)	88.0	78.00	128.86	27.83	134.08
T9: Tender coconut water (3%)	89.3	77.00	128.55	29.11	139.22
S Ed	2.63	0.87	14.42	2.33	10.83
C.D (p = 0.05)	5.41	1.84	30.57	4.93	22.95

Table.3 Effect of seed priming practices on yield attributes and yield of ragi

Treatments	Number of productive tillers per hill	Weight of single ear head (g)	Number of fingers per ear head	Length of ear head (cm)	Number of grains per ear head	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index
T1: Farmer's practice (control)	3.1	6.00	6.1	7.49	1438	3.04	1257	4303	0.23
T2: Plain water	3.9	6.96	6.2	7.47	1606	3.25	1771	6010	0.24
T3: Moringa leaf extract (2%)	3.8	6.82	5.9	7.39	1533	3.36	1518	5324	0.22
T4: Pungam leaf extract (1%)	3.9	7.18	6.5	7.48	1858	3.34	1943	5961	0.23
T5: Ocimum leaf extract (1%)	3.9	7.15	6.3	7.65	1763	3.27	1783	6200	0.22
T6: Prosopis leaf extract (1%)	3.2	6.23	6.6	7.42	1473	3.10	1263	4864	0.21
T7: Panchakavya (3%)	4.1	7.75	6.7	7.79	1923	3.35	1993	6151	0.25
T8: Cow's urine (3%)	3.4	6.37	6.4	8.08	1442	3.15	1393	5048	0.22
T9: Tender coconut water (3%)	3.6	6.57	6.1	7.75	1505	3.16	1449	5644	0.20
S Ed	0.13	0.31	0.39	0.41	148.68	0.09	107.24	385.94	0.015
C.D (p = 0.05)	0.287	0.663	NS	NS	315.193	0.200	227.34	818.160	NS

Fig.1 Effect of seed priming practices on plant height of ragi at 60 DAP

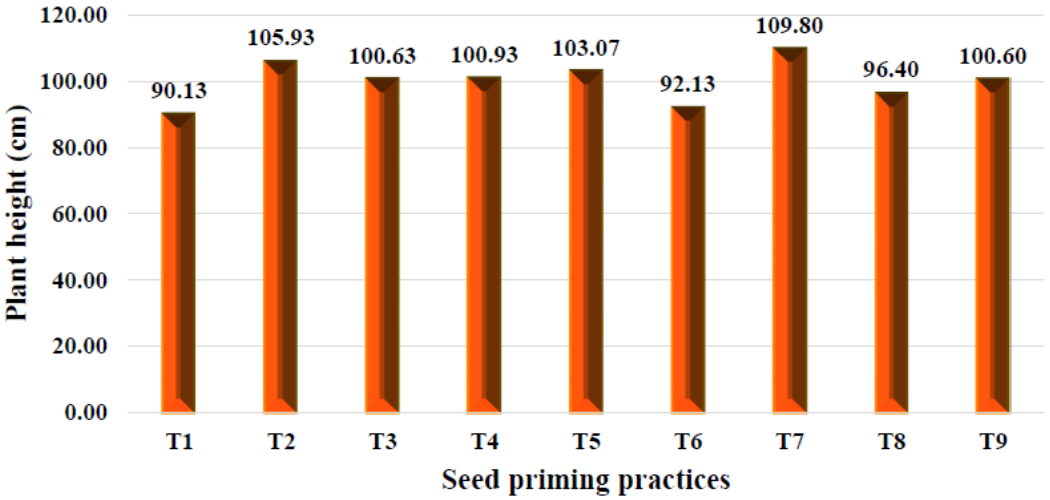
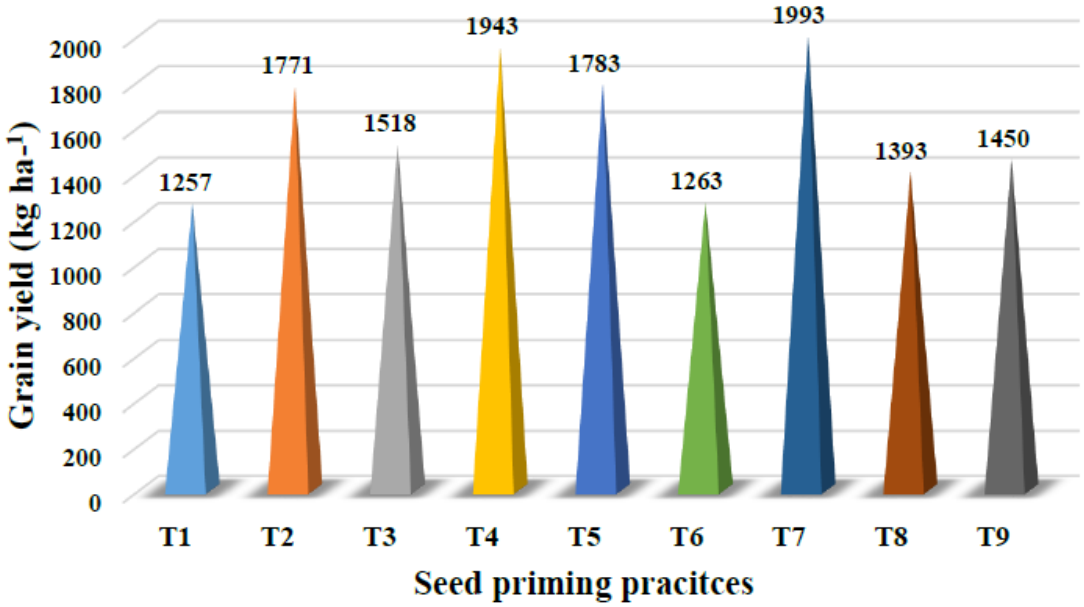


Fig.2 Effect of seed priming practices on grain yield of ragi



Economics of seed priming practices

In the present investigation, the gross returns, net returns and B: C ratio was higher in all priming treatments except prosopis leaf extract. The yield of prosopis leaf extract was almost similar to control.

The seeds primed with three per cent panchakavya gave an added returns of Rs. 18,079 per hectare over control with a higher B: C ratio of 2.37. Francis and Smith (2006) also realized that benefit cost ratio to the farmers was greatest when panchakavya was used as a growth promoter.

From the above investigation it could be concluded that all the priming practices had increased the yield of ragi over control. Priming of ragi seeds with three per cent panchakavya may be better options for farming community of Karaikal to achieve higher yield in *Kharif* season. In case of non-availability of panchakavya the other seed priming materials like pungam leaf extract, ocimum leaf extract and plain water can be adopted for better yield in ragi.

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