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Standardization of Different Pre-sowing Seed Treatments on Growth, Yield and Yield Attributing Traits of Kodo Millet (*Paspalum scorbiculatum*)

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ABSTRACT

Background: *Paspalum scorbiculatum* is an annual crop and has superior nutritional properties including high micronutrients, dietary fiber content and gluten free. It has low glycemic index (GI) carbohydrate diets help in prevention of Obesity, Diabeties and Cardiovascular diseases, *etc*. The current study was aimed to find out the suitable pre-sowing seed treatments for Kodo millet.

Methods: During the *Kharif* season 2019- 2020 total of 12 pre- sowing seed treatments were subjected with Botanicals, Magnetic and Electric fields, Thermal (Hot water) treatments and to fix the best treatment based on Seed Quality and Morphological traits of treated seeds. Morphological traits play an major role in crop growth and development where as, the present investigation was carried out with farmer's variety in field (RBD) design in 3 replications and laboratory (CRD) design in 4 replications in order to "Standardization of different pre- sowing seed treatments on growth, yield and yield attributing traits of Kodo millet (*Paspalum scorbiculatum*). Seeds were subjected to various pre- sowing seed treatments *viz*. (T0) control, exposure to Magnetic field at 100 mT, 200 mT, 400 mT for 15,30 and 45 min; exposure to Electric field at 50 mA, 100 mA, 150 mA for 5,10, 15 min. Treatment with botanicals cow dung (5 gm) and Datura leaf extract (2.5 ml) for 12 hrs; Thermal hot water treatment at 46°C and 50°C for 10 min.

Result: Among all the treatments, T4-Magnetic field (200 mT) gave the best results in field and lab conditions of field emergence (98.610) and germination% (98.5), Magnetic field (400 mT) shown the good results and significantly higher values of all other yield (45.867, 78.833, 660.480, 165.120) and morphological traits as well as seed quality parameters like shoot length (86.925), root length (44.55), seedling length (13.131), vigour index- I and II (1267.138 and 5.058), fresh (0.343) and dry (0.0524) weight of seedlings and comparatively control (T0) was observed lowest to other treatments. As such, Magnetic treatment is quite effective for seedling establishment to overcome low germination and yield which helps in Qualitative and Quantiative seed production of Millets in sustainable agriculture.

Key words: Botanicals, Morphological traits, Magnetic and Electric fields, Thermal.

INTRODUCTION

Kodo millet is also known as kodon, arekelu and its origin is India. It has been cultivated for 3000years in India, where it is considered as a minor cereal crop except in the Deccan where it is a cereal crop of utmost importance. Kodo millet is well suited to dry conditions and can be grown in a variety of poor soil types from gravelly to clay. It has superior nutritional properties including high micronutrients and low glycemic index (GI). Grain contains protein: 11%, fiber: 9%, carbohydrates: 66.6g, vit- Band effective iron content (39.60ppm) (Chandel *et al.,* 2014). It is used as Herbpathy for heart disease, strangury and prevention of insulin resistance, diabetes, obesity, etc (Balasubramanium, 2013).

Kodo millet grown in India on marginal lands and produces high grain yields under limited water. Currently, it is being cultivated only in india on limited acre (0.20 million ha) (Ganapathy 2017; Bhat *et al*., 2018). It is grown in area of about 907,800 ha with annual production of about 310,710 tonnes (Yadav *et al*., 2013). Madhya pradesh and Tamil nadu have maximum share in production and promotion of kodon. The area under cultivation of small millets in India (where kodo is largely cultivated) from 5.29 to 0.69 million ha between 1951 and 1955 and 2011 to 2015, with exception of finger millet (ICAR- All India Coordinated Research Project on small millets Annual report 2017-2018, available at www.aicrpsm.res.in).

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Botanical seed treatment is derived from natural sources based on botanical ingredient. It is liquid, natural seed treatment and root growth promoter formulation. Pearl millet is treated with viscum album extract with 10% concentration was found to be more effective in seed quality characters and also in increasing resistance against to downy mildew disease variance from (44-70%) protection reported by Chandrashekhara *et al*., 2010.

Exposure of seeds to electromagnetic fields is one of the safest and potential physical pre sowing treatments to enhance the post germination development and crop stand (Florez *et al.*, 2007). The magnetic field of 125 mT stimulating the effect of initial growth stages of barley seeds which were subjected to a magnetic field for various times and increase in the length and weight were observed by (Carbonell *et al*., 2000). The magnetic field as a single treatment was used widely as the subject of different studies as shown positive effects to improve the rate of germination of seeds and growing plants. (Aladjadjiyam 2002; Martinez *et al*., 2017) found a optimistic growth response to the static magnetic field ranging between 50 and 250 mT at distinct periods of time in rice, wheat, maize and barley seeds and also (Pittman, 1970; Kordas 2002) was found to improve crop growth and yield.

Hot water thermal treatment results, the seed quality improved by breaking dormancy of seed at 50°C and 60°C at optimum room temperature of foxtail millet shown best results of germination and seedling length (Sebastian *et al*., 2015). So keeping these aspects in view the present study was carried out with following objectives.

1. To assess the combined and individual effect of different pre-sowing seed treatments on seedling characters of kodo millet.
2. To find out the suitable pre-sowing seed treatments for kodo millet.

MATERIALS AND METHODS

The present investigation entitled “Standardization of different pre-sowing seed treatments on growth, yield and yield attributing traits of kodo millet (*Paspalum scorbiculatum*)”. Experiment was conducted in field (RBD) design and in laboratory (CRD) design at post graduate laboratory of department of physics in *Kharif* season, 2019-2020 at department of Genetics and Plant breeding, SHUATS, Prayagraj.

Source of seed

The seed was collected from the farmer named “Anantha Ramulu” at Kamareddy district, Telangana. The variety is farmers variety and is a pure seed, no breeding techniques are done. He was a farmer and seed supplier as whole sale, he was also the member of farmers committee in Indian Institute of Millets (IIMR), Hyderabad, Telangana.

Quality of seed

Seeds are the foundation of agriculture. The Kodo millet has such characteristics like trueness to variety, good germination percentage, purity, vigour and appearance which are always important to farmers during sowing or planting crops. As it is a self- pollinated crop there is no problem of fertilization and having a strong embryo often doesn’t affect the quality of seed when exposed to adverse weather conditions. But the Monocot seed (kodo millet) having hard seed coat, embryonic axis can cause severe damage, resulting in abnormal seedlings and having very slow germination and seedling emergence in field.

Experimental site

The Crop Research farm is situated at 250 57°N Latitude, 870 50p E Longitude and 98 meter altitude above the MSL. The temperature falls down to as low as 1°C - 2°C during winters in December to January and 46°C to 48°C during summers. The average rainfall is 1013.4 mm annually.

Experimental materials

The experimental material consists of 12 treatments which includes different materials in various concentrations and methods. The details of the treatment are furnished in Table 3.

Organic and medicinal plants with different mechanisms of action have been suggested, they may inhibit microorganisms, interfere with some metabolic processes and Impact of Pre-sowing seed treatments and organo mineral fertilizer on spring barley production given by S.E.A. Abd Ei Hamid *et al.* (2020).

Exposure of seeds to magnetic field for specified duration improves germination and vigour and treated seed respire slowly with higher respiration quotient value that increase activity of enzyme *viz*., α- amaylase and nitrate reductase. Germination and vigour of seeds are enhanced due to increased activity of enzymes.

Electric field involves treating seeds with sodium chloride and electric conductivity meter that affects on ions in the soil and can influence the plant metabolism, growth patterns by effecting on the electron transport chain and the dark and light reactions of photosynthesis in leaves (Celestino *et al*., 2000).

Hot water treatment is a actual practice of suggesting physical seed dormancy and seed- coat damage results, studies that water imbibition. An indication of the amount of possible seed injury, traceable to the hot- water treatment. By overcoming seed coat- related dormancy *in situ* would have implications for the conservation of this species.

RESULTS AND DISCUSSION

Analysis of variance revealed that the differences among 12treatments were significant for seedling characters and field parameters. Mean value is defined by the ratio of the sum of observations to the total number of observations. It avoids variation of over all data and depends only on extreme values. The data is presented in field parameters (Table 1a and 1b, Fig 1) and seedling characters (Table 2, Fig 2) which show the mean performance of 12 treatments and is used

to check whether they are statistically at par by subtracting the CD value from the highest value of a particular set of observations.

Analysis of variance for field revealed that mean sum of squares due to seed priming treatments were highly significant at @5% and 1% level of significance for 2 parameters and 5% significant for all other characters under study indicating presence of good amount of variability among the treatments for all parameters of (Fig 1 and Fig 2) used in the study. This indicated the ample scope of seed priming treatments in kodo millet. Replications were non-significant for all parameters except panicle length indicating good homogeneity among replications. This suggested, an ample scope to identify suitable seed priming method to improve seed quality and yield attributing traits of kodo millet.

Field emergence

The mean performance of field emergence ranged from 79.160% to 98.610% with mean value of 86.110% and found significantly maximum of 98.610% of T4- magnetic@200mT and T5- magnetic@400mT was found to be at par value. After post- harvest conditioning seeds are more vigorous and less sensitive to unfavourable environmental conditions during field emergence given by (Rochalska *et al*., 2005). Similar findings were reported by Rajesh (2011) in Finger millet.

Table 1a: Mean table for growth parameters of kodo millet.

Treatment	Field	Plant Height		Days of 50%	Days of	No. of tillers	No. of panicle	Panicle	Peduncle
	Emergence	60 days	90 days	flowering	maturity	per plant	per plant	length	length
T_0	79.160	259.033	358.433	94.333	124.333	3.667	14.667	52.000	23.300
T_1	82.403	276.100	372.333	88.333	118.333	6.000	18.333	54.833	25.233
T_2	81.013	267.567	365.667	90.667	120.667	5.000	16.333	53.667	24.400
T_3	87.497	317.800	399.900	82.000	112.000	10.667	25.333	59.533	28.067
T_4	98.610	341.833	421.700	78.667	108.667	16.000	33.333	64.767	32.200
T_5	95.830	358.600	437.667	77.667	108.333	18.000	36.667	67.500	32.933
T_6	90.733	323.633	409.300	80.000	110.000	13.000	28.667	61.067	30.133
T_7	86.110	310.867	393.567	83.667	113.667	9.333	23.333	58.833	27.433
T_8	93.050	329.367	414.667	79.333	109.333	14.000	30.667	63.233	31.067
T_9	88.883	318.800	404.133	81.333	111.333	12.000	27.000	60.067	29.000
T_{10}	83.790	283.733	380.233	86.000	116.000	7.333	20.000	56.067	25.900
T_{11}	84.720	292.567	385.833	85.333	115.333	8.333	21.667	58.033	26.733
Grand total	**1051.799**	**3679.9**	**4743.433**	**1007.333**	**1367.999**	**123.333**	**296**	**709.6**	**336.399**
F Test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
C.D.	3.818	5.086	11.198	3.710	3.837	0.910	0.995	2.320	0.618
SE(m)	1.293	1.723	3.793	1.257	1.300	0.308	0.337	0.786	0.209
SE(d)	1.829	2.437	5.365	1.778	1.838	0.436	0.477	1.112	0.296

Table 1b: Mean table for yield and yield attributing traits.

Treatment	Grain yield	Biological yield	Seed yield per plot (gm)	Seed yield per (kg/ha)
T_0	27.900	57.233	401.760	100.440
T_1	31.700	62.000	456.480	114.120
T_2	29.167	60.100	421.920	105.480
T_3	36.833	66.167	530.400	132.600
T_4	43.300	75.567	623.520	155.880
T_5	45.867	78.833	660.480	165.120
T_6	39.400	70.267	567.360	141.840
T_7	35.933	65.333	517.440	129.360
T_8	41.233	73.833	593.760	148.440
T_9	38.000	68.500	547.200	136.800
T_{10}	33.367	63.433	480.480	120.120
T_{11}	34.667	64.467	499.200	124.800
Grand total	**437.367**	**805.733**	**6300**	**1575**
F Test	**S**	**S**	**S**	**S**
C.D.	2.757	2.509	40.046	10.011
SE(m)	0.934	0.850	13.566	3.392
SE(d)	1.321	1.202	19.186	4.796

Plant Height (60 and 90 days)

The mean performance of plant height ranged from (259.033 to 358.600 cm) and (358.433 to 437.667 cm) with mean value of 310.867 cm and 393.567 cm significantly maximum, highest plant height was recorded(358.600 and 437.667 cm) by T5 magnetic field@400 mT. The results are of findings of Kalaraju *et al.* (2009) in pearl millet found taller plants at harvest stage. Similar results are in conformity with the findings of Makkhanlal *et al.* (2007) and Michael *et al.* (2016) in pearl millet. The enhancement of most vegetative characteristics of a plant can be explained by magnetic seed treatment that the groups of molecules become small in size compared to their pre-magnetization status. This allows for good and rapid transfer through root cells and come up with enhanced mineral uptake.

Days of 50% flowering

It was presented in the mean performance of Days of 50% flowering ranged from 94.333% to 77.667% with mean value of 83.667%. Significantly maximum percentage of Days of 50% flowering (77.667) highest value was recorded by T5 - Magnetic field @400 mT. Similar results of Days of 50% flowering was observed by Sridevi and Manonmani (2016).

Days of maturity

It was presented the mean performance of Days of maturity ranged from 124.333 to 108.333 with mean value of 113.667. Significantly maximum percentage of Days of maturity (108.333) highest value was recorded by T5 – Magnetic field @400mT. Similar results of Days of maturity was observed by Sridevi and Manonmani, (2016).

No. of tillers per plant

It was presented the mean performance of No. of tillers per plant ranged from 3.667 to 18.00 with mean value of 9.333. Significantly maximum No. of tillers per plant (18.00) highest value was recorded by T5 - Magnetic field @400 mT. The results were in conformity with the findings of Kalaraju *et al.*

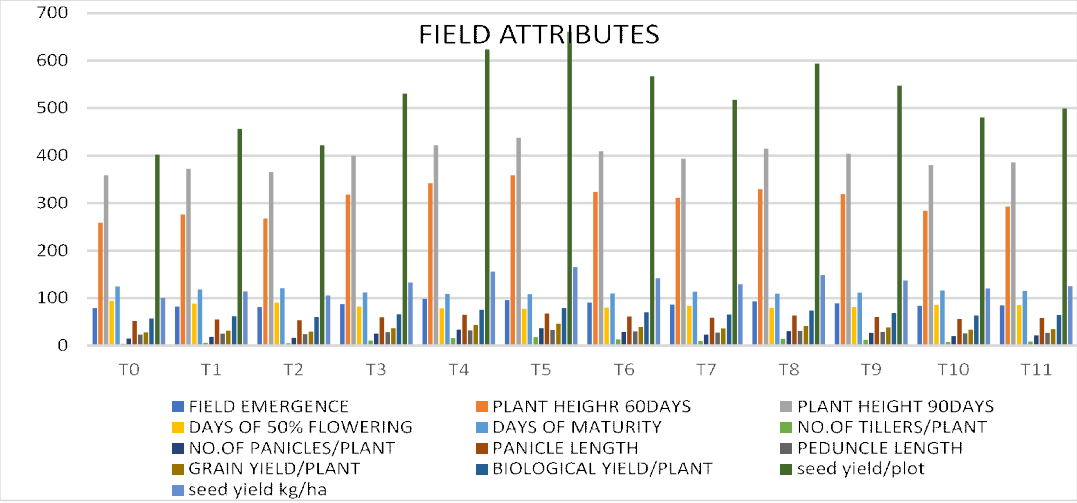

Fig 1: Standardization of different seed priming treatments on field parameters in kodo millet.

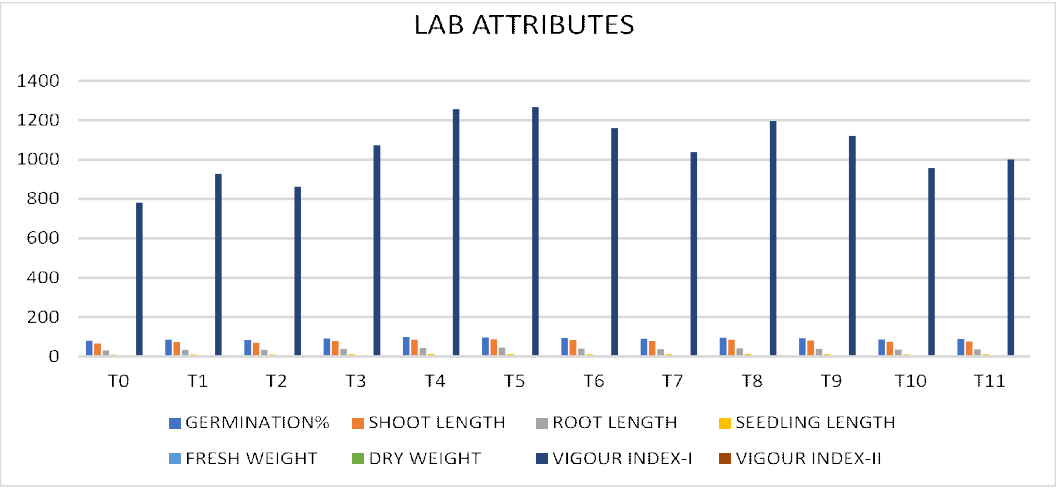

Fig 2: Standardization of different seed priming treatments on seedling parameters in kodo millet.

(2009) and in pearl millet taller plants, no. of tillers/ plant were found at harvest reported by (Nandini *et al.*, (2019).

No. of panicles per plant

It was presented the mean performance of No. of panicles per plant ranged from 14.667 to 36.667 with mean value of 23.333. Significantly maximum No. of panicles per plant (36.667) highest value was recorded by T5 - Magnetic field @400mT. Similar findings were also reported by Naidu and Rao (1958), Narasimha Rao *et al.,* (1963); Rajesh (2011) in Finger millet.

Panicle length per plant

It was presented the mean performance of Panicle length per plant ranged from 52.00 cm to 67.5 cm with mean value of 58.833 cm. Significantly maximum Panicle length per plant (67.5 cm) highest value was recorded by T5 - Magnetic field @400 mT Similar findings were reported and observed high variability for panicle length and width of earlier reports in Sorghum by Elangovan *et al.* (2013)) and similar results were reported by Dossou - Aminon *et al*. (2015) and reports of R. Akatwijuka *et al.* (2016) in millets.

Peduncle length per plant

It was presented the mean performance of Peduncle length per plant ranged from 23.3 cm to 32.933 cm with mean value of 27.433 cm. Significantly maximum Peduncle length per plant (32.933 cm) highest value was recorded by T5 - Magnetic field @400 mT. Similar reports by Upadhyaya *et al*., (2006) also observed a strong association of peduncle length in finger millet.

Grain yield per plant

It was presented the mean performance of Grain yield per plant ranged from 27.9 gm to 45.867 gm with mean value of 35.933 gm. Significantly maximum Grain yield per plant (45.867 gm) highest value was recorded by T5 - Magnetic field @400mTand T0 - Control (27.9 gm) was recorded and found to be lowest value. Cultivation of plants with desirable density has positive effect on crop yield components, so that the suitable yield was achieved by superlative plant density by (Ullah *et al*., 2005).

Biological yield per plant

It was presented the mean performance of Biological yield per plant ranged from 57.233 gm to 78.833 gm with mean value of 65.333 gm. Significantly maximum Biological yield per plant (78.833 gm) highest value was recorded by T5 - Magnetic field @400mT. Similarly, the results of this investigation are in conformation with the findings and the results were reported by Nandini K. M. *et al*., (2019) in foxtail millet.

Seed yield per plot

It was presented the mean performance of Seed yield per plot ranged from 401.76 gm to 660.48gm with mean value of 517.44 gm. Significantly maximum Seed yield per plot (660.48 gm) highest value was recorded by T5 - Magnetic field @400 mT. The results were observed by Moobe , Martha *et al*. (2014) and findings of Rahem Djelal Belahcene Nabiha *et al*. (2020) on growth and grain yield in finger millet.

Seed yield per kg/ha

It was presented the mean performance of Seed yield per kg/ha ranged from 100.44 kg to 165.12 kg with mean value of 129.36 kg. Significantly maximum Seed yield per kg/ha (165.12 kg) highest value was recorded by T5 - Magnetic field @400 mT. The results were observed by Moobe, Martha *et al*. (2014) on growth and grain yield in finger millet. But Morphological differences in plants of Barley grown from

Table 2: Mean performance table of seedling parameters.

Treatment	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Seedling Fresh weight (gm)	Seedling Dry weight (gm)	Seedling Vigour index- I	Seedling Vigour index- II
T_0	80.250	65.925	31.375	9.733	0.163	0.00329	781.113	0.268
T_1	85.500	73.675	34.175	10.843	0.195	0.007	927.053	0.599
T_2	84.000	68.975	33.475	10.270	0.178	0.00553	862.595	0.464
T_3	91.500	79.100	38.150	11.728	0.263	0.0276	1,073.167	2.528
T_4	98.500	85.375	42.350	12.7475	0.325	0.0475	1,255.775	4.673
T_5	96.500	86.925	44.550	13.131	0.343	0.0524	1,267.138	5.058
T_6	94.000	83.125	40.225	12.339	0.290	0.0425	1,159.887	3.990
T_7	90.250	78.100	36.900	11.51	0.250	0.020	1,038.035	1.825
T_8	95.000	84.625	41.225	12.587	0.313	0.045	1,195.775	4.275
T_9	93.000	81.375	38.975	12.038	0.275	0.035	1,119.570	3.255
T_{10}	86.750	75.025	35.200	11.0261	0.210	0.01079	956.518	0.938
T_{11}	89.000	76.525	35.775	11.237	0.228	0.0171	1,000.170	1.528
Grand total	1084.25	938.75	452.375	139.172	3.033	0.311	12636.8	29.401
F Test	S	S	S	S	S	S	S	S
C.D.	4.281	5.719	1.937	0.536	0.028	0.010	79.669	0.952
SE(m)	1.487	1.986	0.672	0.186	0.010	0.003	27.664	0.330
SE(d)	2.102	2.809	0.951	0.263	0.014	0.005	39.123	0.467

Table 3: Treatment details.

Treatment symbols	Treatments	Duration
T_0-	Control	(untreated)
T_1-	Cow dung powder(5gm)	12 hours
T_2-	Datura leaf extract(2.5ml)	12 hours
T_3-	Magnetic field (100mT)	15 minutes
T_4-	Magnetic field (200 mT)	30 minutes
T_5-	Magnetic field (400mT)	45 minutes
T_6-	Electric field (50mA)	05 minutes
T_7-	Electric field (100mA)	10 minutes
T_8-	Electric field (150mA)	15 minutes
T_9-	Magnetic + Electric field (200mT +50mA)	40 minutes
T_{10}-	Hot Water Treatment(46p C)	10 minutes
T_{11}-	Hot Water Treatment (50p C)	10 minutes

treated seed were significantly lower than those of barlev grown from untreated seed. The decrease in yield might be related to the lack of sufficient soil moisture during the later stages of development of the early maturing plants grown from treated seed is indicated by the lower test weight of the crop produced by the treated seed.

Germination%

It was presented the mean performance of Germination % ranged from 80.25% to 98.5% with mean value of 90.25%. Significantly maximum percentage of Germination % (98.5%) highest value was recorded by T4 - Magnetic field @200 mT. Similar findings were reported by Rajesh (2011) in Finger millet. Germination ratios in bean and wheat seeds were reported by Cakmak *et al.,* 2010; Carbonell *et al*., 2011.

Seedling length

It was presented the mean performance of Seedling length ranged from 9.733 cm to 13.131 cm with mean value of 11.51 cm. Significantly maximum Seedling length (13.131 cm) highest value was recorded and T0 - Control (9.733 cm) and found to be lowest value. Seed priming showed significantly good results over control for time taken to germination % root length and shoot length (Afzal *et al.,* 2009) and the potential to improve the early seedling growth and nutrient contents of seedlings (Harshan *et al*., 2011) in Barley. Magnetic field treatments were used in agriculture to improve the germination and growth seedling. In this research, general results showed that the magnetically treated sorghum seed gave the significant effect on all germination and growth seedling parameters studied, where the best period to expose the seeds recorded in 6 hour treated seeds in all measurements parameters in comparision with untreated seed, except root length.

Dry weight

It was presented the mean performance of Dry weight ranged from 0.00329 gm to 0.0524 gm with mean value of 0.02 gm. Significantly maximum Dry weight (0.0524 gm) highest value was recorded by T5 - Magnetic field @400 mT and T0 - Control (0.00329 gm) and found to be lowest value. It might also due to result of better activity of mitochondrial enzymes accompanied by an increase of the Oxygen consumption. The similar results were observed by Mahmoudi *et al.*, (2012); Piri *et al.* (2009). An increase in the wet and dry weights of the treated plants was recorded with magnetized water was reported.

Vigour index I and II

It was presented the mean performance of Vigour index I ranged from (781.113 to 1267.138) and (0.268 to 5.058) with the mean value of 1038.035and 1.825 Significantly maximum Vigour index I and II (1267.138 and 5.058) highest value was recorded by T5 - Magnetic field @400 mT and found to be best among all treatments. Seed priming showed significantly better results over control for time taken to 50 % germination, final germination % , root length, shoot length and vigour indices I and II (Afzal *et al.,* 2009). Similar results of agro-morphological characters in finger millet observed by Patil *et al*. (2019).

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CONCLUSION

It is evident from the above that seed priming have significant role for all lab and field characters studied. Treatment T5(magnetic field@400mT) was found significantly superior for most of all lab parameters in comparison to other treatment combinations as well as T0 control is lowest and at par value to all other treatments in kodo millet. The profitable effect of the magnetic field was demonstrated not only in laboratory experiments but also in field experiments (Rochalska, 1998).This effect was more visible for the seeds of stenothermal plant, such as maize and barley germinating at low temperature. Germination ability at pre- mature stages of this process rise significantly. Hence, Magnetic field treatment can be recommended as a seed priming treatment of kodo millet and other minor millets for improving the seed quality, germination and yield of millets.

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