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Use of Seed Priming to Improve the Physiological Performances in Oat (*Avena sativa* L.) Seed

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A B S T R A C T

To achieve high seed vigour, seed priming can be utilized in definite manner in which three organic compounds viz. Naphthalene acetic acid (NAA), Salicylic acid (SA) and Nicotinic acid (NA) in diverse concentrations and treatment durations were applied for present analysis on Oat crop. In assessment of physiological performances of seed, the various parameters linked to seed germination, seedling quality and germination allied enzymes that showed evident disparity among dissimilar priming. The treatment T8 (NAA, 75 ppm), indicated its maximum efficacy for most characters except in root length and peroxidase activity at 96 hrs. Another concentration, T9 (NAA, 100 ppm) also exhibited its eminence particularly in root length, seedling dry weight and peroxidase action. The treatment durations were not promising though D_2 was extreme in enzyme action. The combination of T8 and T9 with D_2 or D_1 was leading for seedling characters. In biochemical parameters, the activity of α-amylase and peroxidase organized the germination process in exact direction by reducing the metabolic hazards where the T8 showed maximum effect. Diverse treatments specified the extent of effects on seed where the T8 and T9 with precise duration may be consider for Oat seed production to obtain proficient seed for sowing.

Introduction

Oat (*Avena sativa* L.) is a significant annual crop of the Poaceae family which is probably originated in Asia Minor region, Gibson and Benson (2002). The genus *Avena* consists of almost 70 species, though only a few of these are utilised for cultivation, specifying the self-pollinated, hexaploid (2n= 6x=42) nature. *Avena sativa* L. and *Avena byzantina* K., known as white oat and red oat, respectively, is the common grown oats for fodder and grain purpose. Recently, *A. strigosa* has become significant in subtropical and temperate situations as winter cover crop and a forage crop. The crop, oat has many uses *viz*., a cereal, a feed grain, green or conserved fodder.

Oat is mainly a European and North American crop as dual purpose considering both forage and grain, Suttie and Reynolds

(2004). It is a good source of protein, vitamin B, phosphorus and iron, Mehra (1978) in addition to abundant soluble carbohydrates and fibres, Peterson *et al.,* (2005). Hence, the crop can be utilised for dietary benefits of both human and livestock. Oat is grown as an exceptional fodder crop due to its quick regeneration ability in multi-cut system, palatability, succulence and nutritional value which will ensure regular supply of green fodder with balanced nutrition over a period of time for both milch and draft animals, Anonymous (2002). Therefore, it is necessary to include green fodder crops in cropping system to sustain economic livestock production. In India, the productivity of oat is about 35-40 MT ha-1 as green fodder, Anonymous (2014) which makes disparity in contrast to world productivity. To achieve the production upgradation, the quality assurance on seed at cultivation schedule is vital. In existing setup, the approachability of quality seed is very little particularly in the low value crop which faces striving in healthy seedling formation or deficiency in expression of valuable heritable characters. Hence, the seed quality enhancement may be one of the significant factors in cultivation practice for any crop.

One useful method for refining the seed quality is seed priming which contains hydro-priming, osmo-priming, matri-priming, halo-priming etc. Priming offers to raise seed performance that has been validated to advance the germination activity in quantitatively and qualitatively in many crops. Heydecker (1973) defined seed priming as a pre-sowing treatment in osmotic solution, where seeds imbibe water to continue the first stage of germination but it inhibits radicle protrusion through seed coat. Seed priming is a controlled hydration process in seed soaking under low water potential followed by re-drying that controls pre-germination metabolic activities with the restriction of radicle emergence. It has been well established that priming advances germination, condenses time of seedling appearance and develops healthy seedling. The on-farm seed priming can be helpful as low-cost, easy performable which create a definite impression on farmers' livelihoods through enrichment of crop emergence rate, higher crop growth rate, decreasing crop duration and higher productivity in ultimate. Persuading resistance against stresses like drought stress, heat stress, etc. is one of the noticeable advantages of seed priming in various significant field crops, Afzal *et al.,* (2008); Jisha *et al.,* (2013).

In current studies, the seed priming through chemicals could be an active pre-germination approach for effective cultivation of Jatropa in cold, arid regions (Yadav *et al.,* 2011). Seed priming also showed assistances in rice at sowing after prolonged storage and diverged storage conditions, Saddam Hussain *et al.,* (2015) and a tremendous vigour enhancement in onion crop under different stress situations, Saranya *et al.,* (2017).

Insufficient works were done on oat seed priming and these were confined to reviewing its outcome on germination percentage, Shafi *et al.,* (2009). In present observation, the choice of appropriate organic acids to upgrade the seed quality is the prime motto that has been done through progress of physiological performances of seed in active fodder seed production predominantly on Oat.

Materials and Methods

The analysis was done at 2018 in RKVY Laboratory, Department of Seed Science and Technology, Mohanpur, Bidhan Chandra Krishi Viswavidyalaya, West Bengal using seven months old stored seeds that were originally collected from field during rabi season of 2018. According to the evidences of

different researchers, the experiment was continuing in application of 10 treatments (T) including control (water) in addition to 3 variable durations of soaking (D) under 25-27˚C (Table 1) on the crop Oat (*Avena sativa* L.) cv. JHO-99-2**.**

The de-husked oat seeds were soaked in aqueous solution of the above treatments with distinct durations at 25-27˚C, then air-drying/desiccation to restore the previous seed moisture condition. After 3 days, the treated (primed) seeds were undertaken for the observation considering 3 replications to evaluate the diverse parameters related to seed germination, seedling nature, through Glass-Plate method, Chakraborti (2010) in addition to germination linked action of enzymes (at 24 hrs & 96 hrs of imbibition) like peroxidase and alpha-amylase. The result was obtained allowing for 'two factor' analysis at 1% level of significance and correlation study was done using OPSTAT software.

Results and Discussion

To establish the objectives, the assessment on laboratory study was considered in view of physiological performances of seed. The present observations reflected the influence of priming to reform or conservation of seed quality considering the fodder crop, Oat. The various parameters related to seedling nature in addition to two germination allied isozymes showed noticeable variation in germination linked efficiency among diverse treatments considered for seed priming. In table 2, the T8, a specific concentration of NAA (75 ppm) indicated its maximum efficacy for the observable parameters with an exception in root length and peroxidase activity. Another concentration of NAA, T9 (100 ppm) also exposed its prominence for some characters particularly in root length, peroxidase activity, seedling dry weight and vigour index, however it was displayed its peak value only for first two characters. The other treatments i.e. T4 (SA, 10ppm) and T5 (SA, 20ppm) showed their effectiveness in agreeable mode particularly in action of peroxidase. The treatment T9 confirmed superior effect in peroxidase action particularly at 96 hrs. although the superiority was not continued for other parameters. Moreover, the parameter fresh weight of seed indicated the non-significant demarcation among dissimilar treatments. The promising effect of the above treatments indicated the superior effect allowing for detectable characters though these were also effective in other parameters indicating significant and non-significant demarcation with the top that intensified the seed quality in ultimate.

The achievement on treatment durations (Table 3) was not encouraging though the duration, D_2 was moderately effective predominantly in enzymatic action. In duration of D1, the seedling characters were prominent excepting fresh and dry weight of seed where D3 was top for these characters with alpha amylase activity at 24 hrs. Considering the different durations of treatment, the characters shoot length, vigour index and fresh weight displayed non-significant demarcation due to its minimum effectiveness for enhancing the considerable parameters of seed. But, the interaction of treatment-duration showed significant demarcation for all parameters. The interaction of T8D2 showed peak functioning value though T9, T5 (SA, 20ppm) in combination with D3 or D1 confirmed its prominence in sometimes with an inconsistent habit considering the parameters. In result, the enzymatic activity may be specified as inducer for seed quality enhancement through seed vigour in ultimate.

In existing study, the use of diverse seed treatments as priming can be acted as

enhancer through establishment of vigorous seedling that may be monitored the optimal plant growth, extending photosynthesis rate with ideal transpiration in later stages helpful to relieve the opposing effect of water stress, check lodging and salinity stress by proper growth of plant, Sanna *et al.,* (2006); Azooz *et al.,* (2013). Seed priming with SA upgraded the action of anti-oxidative isozymes like catalase, superoxide dismutase and ascorbate peroxidase etc., Ahmad *et al.,* (2012). The reformed act of the above characters may show its consequence in collective seedling appearance and enzymatic action as qualitative mode, Farooq *et al.,* (2008).

In correlation study (Table 4) on considerable physiological performances of seed, all parameters indicated strong positive relationship except in speed of germination with enzymatic action though the action of alpha amylase showed significant correlation at 24 hrs. encouraging for early seedling establishment. The considerable attributes exposed positive significant association with each other that may initiate or supportive to retain the ideal situation associated to seedling development. Moreover, the action of enzyme at initiation of germination may also be constructive to advance seed vigour through sharing its expanding weight and length of the seedling, Arun *et al.,* (2017).

The present experiment was restricted to seed treatment only due to its minimum application cost as well as eco-friendly mode. The present observation indicated no promising effect was followed in duration though D_2 i.e. medium level of duration of each chemical was promising in some cases. The superiority of T8 i.e. NAA at 75ppm indicated valuable information for up-gradation of fodder crop particularly in Oat though other treatments are also effective over control in most of the cases. The proper use of precise treatment in specific crop may upgrade the of seed production essential to steady the demand of quality seed at cultivation time.

In figure 1, the effect of priming was clearly enlightened for scheduled parameters through their percent of deviation over the control (T10). The uppermost positive effect was observed in alpha-amylase at 96 hrs. followed by seedling dry wt., vigour index, root length etc. But, the other parameters showed a discrepancy in positive or negative manner among treatments over control predominantly in speed of germination and peroxidase action. The parameters, percent of germination indicated negligible deviation to control. In findings, it was clear that seed priming precisely responsible for qualitative progress of seed in germination rather than quantitative progress.

In application of treatment, the preceding opinions were primarily limited to foliar application on plant however seed treatments were also perceived by limited researchers on few crops. The different approaches of researchers were advantageous for progression of seed on various crops in which the diverse seed priming was persuasive, Neeraj *et al.,* (2012); Torkal *et al*., (2015); Mohamadui *et al.,* (2012); Rajesh *et al.,* (2017); Luckwill (2015). The effect of different chemicals such as Salicylic Acid (SA) influenced the seedling potentiality as mentioned in earlier worker, Bhageri (2014); Singh *et al.,* (2014). Boghdanova (2002) and Meher *et al*., (2015) reported that the treatments of Nicotinic Acid (NA) or SA was favourable for seedling establishment not only for its increasing tendency, a protective nature was also found at germination. The specified role of NAA increased the productivity of different crops pursuing the establishment of healthy plant, Soyler (2014); Moniruzzaman *et al.,* (2014) and Luckwill (2015) however the superiority was indicated for the similar parameters in utilisation of Salicylic Acid.

Hosseinzadeh, *et al.*, (2013). Sanna *et al.*, (2006) and Fagadar *et al.*, (2008) suggested that various forms of growth regulators enhanced the chlorophyll content, soluble protein etc. that may directly linked to the crop produce as well as quality enhancer. The activity of different protective enzymes viz. catalase, peroxidase accelerated the anti-oxidative mechanism responsible for protection of germination behaviour, seedling quality and seed vigour in ultimate that was also authenticated in observation of M'barek *et al.*, (2007). The isozymes alpha-amylase showed promising influence in application of priming that was vital in creation of the storage starch granule during seed maturation and motivate the stored starch to nourish the developing seedling during germination which will directly affect the plant growth and field yield, Damaris (2019). The existing experiment was restricted to seed treatment due to least association of expenses in fodder seed production with attention of its eco-friendly nature. The present observation specified the superiority of T8 (NAA, 75ppm) priming type through valuable evidences on qualitative with quantitative up-gradation in fodder seed production specifically in Oat crop however other considerable treatments, predominantly T9 (NAA, 100ppm), were also effective over control in most cases. There was no promising effect in soaking duration while D2 i.e. medium duration for each chemical was encouraging. Therefore, the selective seed treatment as priming can be included in seed production technique to achieve quality seed of fodder.

Table.1 Details of various treatments and soaking durations

Treatment	Priming agents	Concentration	Soaking durations (hrs.)		
			D1	D2	D3
T1	NA	10ppm			
T2	(Nicotinic	20ppm	½	1	1½
T3	Acid)	25ppm			
T4	SA	10ppm			
T5	(Salicylic	20ppm	1	2	3
T6	Acid)	25ppm			
T7	NAA	50ppm			
T8	(Naphthalene	75ppm	6	7	8
T9	Acetic Acid)	100ppm			
T0	control		8	8	8

Table.2 Seed priming influence on different laboratory parameters

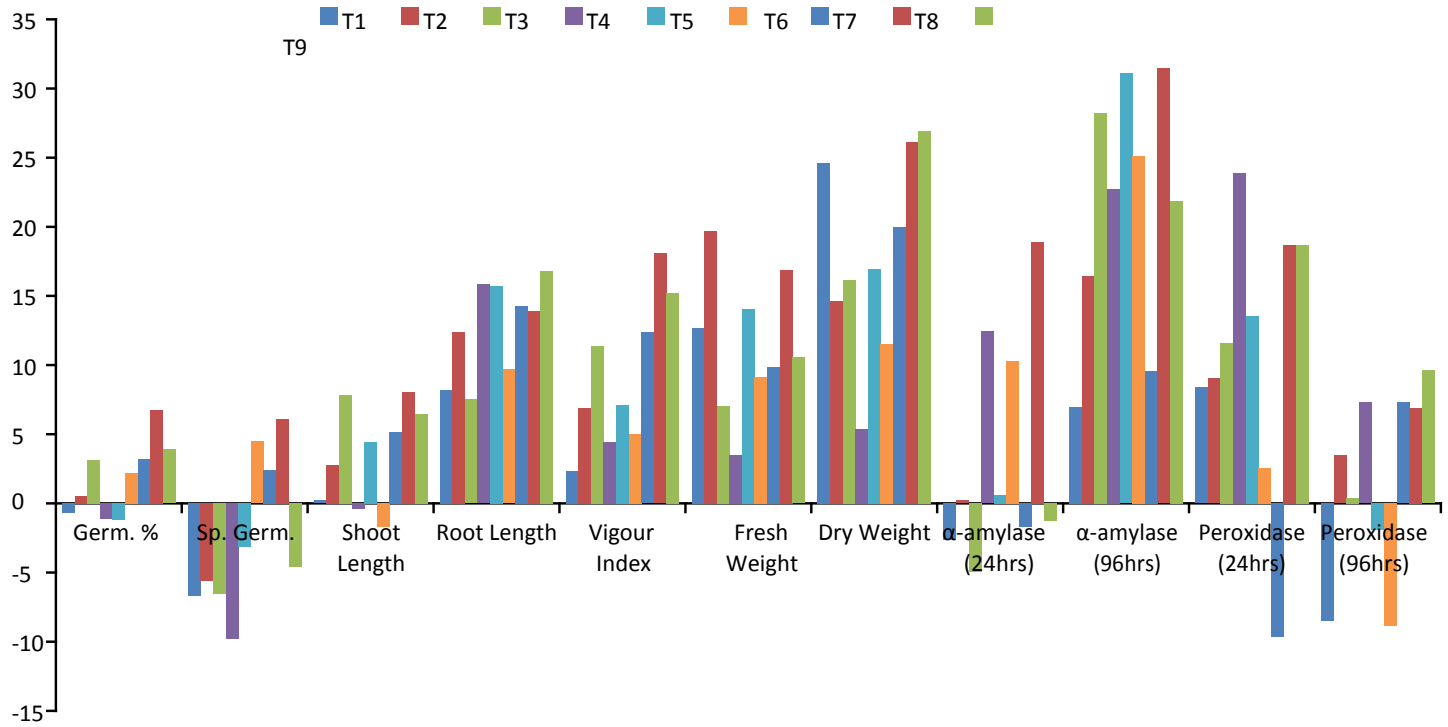
Dura-tions / Treat-ments	Characters										
	Germi-nation %	Speed of germi-nation	Shoot length (cm)	Root length (cm)	Vigour Index	Fresh weight (g)	Dry weight (g)	α-amylase (24hrs) µg min-1g-1	α-amylase (96hrs) µg min-1g-1	Peroxidase (24hrs) ΔA min-1g-1	Peroxidase (96hrs) ΔA min-1g-1
T1	62.78	20.59	17.64	12.51	2,365.16	1.60	0.162	253.47	326.52	0.168	0.238
T2	63.57	20.82	18.09	12.99	2,471.36	1.70	0.149	260.86	355.40	0.169	0.269
T3	65.21	20.62	18.98	12.43	2,574.15	1.52	0.151	247.46	391.35	0.173	0.261
T4	62.53	19.90	17.53	13.39	2,413.51	1.47	0.137	292.67	374.50	0.192	0.279
T5	62.46	21.37	18.38	13.38	2,476.35	1.62	0.152	261.96	400.06	0.176	0.255
T6	64.63	23.05	17.30	12.68	2,427.88	1.55	0.145	287.15	381.80	0.159	0.237
T7	65.25	22.59	18.51	13.21	2,597.06	1.56	0.156	255.93	334.34	0.140	0.279
T8	67.51	23.41	19.02	13.17	2,729.32	1.66	0.164	309.52	401.16	0.184	0.278
T9	65.70	21.05	18.74	13.50	2,662.84	1.57	0.165	257.01	371.88	0.184	0.285
T10	63.23	22.06	17.60	11.56	2,311.48	1.42	0.130	260.30	305.18	0.155	0.260
Mean											
SEm(±)	0.417	0.308	0.256	0.335	39.47	0.062	0.002	4.456	2.357	0.004	0.006
LSD 0.05	1.21	0.893	0.743	0.973	114.55	NS	0.006	12.933	6.841	0.013	0.017

Table.3 Effect of treatment duration on laboratory parameters and the interaction effects

D1	64.39	21.95	18.32	13.13	2,539.33	1.56	0.147	260.99	364.02	0.162	0.252
D2	64.81	21.21	18.07	12.44	2,481.25	1.56	0.143	271.07	367.99	0.177	0.284
D3	63.66	21.48	18.14	13.07	2,488.15	1.59	0.163	273.84	360.63	0.171	0.256
Mean											
SEm(±)	0.228	0.168	0.140	0.184	21.62	0.034	0.001	2.441	1.291	0.002	0.003
LSD 0.05	0.663	0.489	NS	0.533	NS	NS	0.003	7.084	3.747	0.007	0.009
				Interaction	**of Treatments and Durations (T X D)**						
SEm(±)	0.723	0.533	0.443	0.581	68.36	0.108	0.003	7.719	4.083	0.008	0.010
LSD 0.05	2.097	1.546	1.286	1.686	198.41	0.313	0.010	22.401	11.850	0.022	0.029

Table.4 Correlation Matrix

	G%	**SpG**	**SL**	**RL**	**VI**	**FW**	**DW**	**AA24**	**AA96**	**P24**	
SpG	0.719**										
SL	0.182NS	0.211*									
RL	0.242*	0.253*	0.517**								
VI	0.665**	0.552**	0.791**	0.745**							
FW	0.311**	0.278**	0.576**	0.550**	0.645**						
DW	0.465**	0.357**	0.492**	0.639**	0.706**	0.766**					
AA24	0.494**	0.439**	0.213*	0.413**	0.498**	0.484**	0.489**				
AA96	0.403**	0.196NS	0.299**	0.499**	0.525**	0.374**	0.406**	0.560**			R-square value : 0.0652
P24	0.255*	0.046NS	0.283**	0.490**	0.440**	0.546**	0.574**	0.480**	0.621**		
P96	0.378**	0.176NS	0.318**	0.464**	0.512**	0.509**	0.448**	0.558**	0.505**	0.817**	Multiple R-value : 0.255



T1- NA @10ppm; T2- NA @20ppm; T3- NA @25ppm; T4- SA @10ppm; T5- SA @10ppm;
T6- SA @10ppm; T7- NAA @50ppm; T8- NAA @75ppm; T9- NAA @100ppm

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