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

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ABSTRACT

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 D2 was extreme in enzyme action. The combination of T8 and T9 with D2 or D3 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.

Keywords
Oat, Organic compounds, Quality seed, Seed priming

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
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 Jatropha 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, D2 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 D2 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         | 1  | 2  | 3  |
| T2        | (Nicotinic)    | 20ppm         | 1/2| 1  | 1 1/2 |
| T3        | Acid           | 25ppm         | 1  | 2  | 3  |
| T4        | SA             | 10ppm         | 1  | 2  | 3  |
| T5        | (Salicylic)    | 20ppm         | 1  | 2  | 3  |
| T6        | Acid           | 25ppm         | 1  | 2  | 3  |
| T7        | NAA            | 50ppm         | 1  | 2  | 3  |
| T8        | (Naphthalene)  | 75ppm         | 6  | 7  | 8  |
| T9        | Acetic Acid    | 100ppm        | 8  | 8  | 8  |
| T0        | control        |               | 8  | 8  | 8  |
Table 2: Seed priming influence on different laboratory parameters

| Durations Treatments | Germination % | Speed of germination (cm) | Shoot length (cm) | Root length (cm) | Vigour Index | Fresh weight (g) | Dry weight (g) | α-amylose (24hrs) µg min-1g-1 | α-amylose (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

|     | G%  | SpG | SL  | RL  | VI  | FW  | DW  | AA24 | AA96 | P24 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|-----|
| 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)

|     | G%  | SpG | SL  | RL  | VI  | FW  | DW  | AA24 | AA96 | P24 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|-----|
| 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(±)| 0.723 | 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** |     |     |
| 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** |

R-square value : 0.0652

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
References

Afzal, I. Rauf, S. Basra, S.M.A. and Murtaza G. (2008). Halopriming improves vigor metabolism of reserves and ionic contents in wheat seedlings under salt stress. Plant Soil and Environment. 54(9): 382-388.

Ahmad I, Khaliq T, Ahmad A, Shahzad M. A. Basra, Hasnain Z and Ali A (2012). Exogenous Application of Ascorbic acid, Salicylic acid and Hydrogen peroxide Improves the Productivity of Hybrid Maize at Low Temperature Stress. African Journal of Biotechnology. Vol. 11(5), pp. 1127-1132.

Anonymous (2002). Handbook of Animal Husbandry. Indian Council of Agricultural Research, New Delhi.

Anonymous. (2014). Forage crops and grasses, Handbook of Agriculture. ICAR, New Delhi.

Arun, M.N. Bhanuprakash, K. Shankar Hebbar, S. and Senthivel, T. (2017). Effects of seed priming on biochemical parameters and seed germination in cowpea [Vigna unguiculata (L.) Walp]. Legume Research-An International Journal. (40):562-570 DOI: 10.18805/lr.v0i0.7857

Azooz, Mohamed M, Alzahrani, Abdullah M and Youssef, Magdy M (2013). The potential role of seed priming with ascorbic acid and nicotinamide and their interactions to enhance salt tolerance in broad bean (‘Vicia faba’ L). Australian Journal of Crop Science, Vol. 7, No. 13, 2091-2100.

Bagheri, M. Z. (2014). The effect of maize priming on germination characteristics, catalase and peroxidases enzyme activity and total protein content under salt stress. International Journal of Biosciences, Vol. 4(2):104-112.

Bogdanova E.D. (2003). Epigenetic Variation Induced in Triticum aestivum L. by Nicotinic Acid. Russian Journal of Genetics. 39(9):1029–1034.

Chakraborti, P. (2010). Effect of Na-salts on seedlings of Sesame genotypes. Crop Research, 39(1, 2 & 3):160-165.

Damaris, R. N., Lin, Zhongyuan, Yang Pingfang and He Dongli. (2019), The Rice Alpha-Amylase, Conserved Regulator of Seed Maturation and Germination. Int. J. Mol. Sci. 20(2), 450; DOI: https://doi.org/10.3390/ijms20020450

Fagadar – Cosma, G., Fagadar – Cosma, M., Laichici, M., Vlascici, D. (2005). Chlorophyll a and b content development in wheat treated with a phosphonium compound. Agrochimica. 49(1/2): 51-59.

Farooq M, Aziz T, Basra S M A, Cheema M A and Rehman H. (2008). Chilling Tolerance in Hybrid Maize Induced by Seed Priming with Salicylic Acid. Journal of Agronomy & Crop Science. ISSN: 0931-2250.

Gibson, L. and Benson, G. (2002). Origin, History, and Uses of Oat (Avena sativa) and Wheat (Triticum aestivum). Deptt. Of Agronomy, Iowa State University.

Heydecker W, Higgins J, Gulliver RL (1973). Accelerated germination by osmotic seed treatment. Nature. 246: 42-44

Hosseinzadeh, M. Shekari, F. Janmohammadi M. and Sabaghnia N. (2013). Effect of sowing date and foliar application of salicylic acid on forage yields and quality of globe artichoke (Cynara scolymus L.). VOL. LXVIII (2).

Jisha K. C., Vijayakumari, K. and Puthur, J. T. (2013). Seed priming for abiotic stress tolerance: An overview. Acta Physiologiae Plantarum 35:1381–1396.

Luckwill L.C. (2015). Studies of plant harmones in relation to plant harmones: II. The effect of NAA on fruit set and fruit development in Apples. Journal of...
Horticulture Sciences, Vol. 28(1).
Mahmoudi H, Zargouni H, Tarchoune I, Baatour O. (2012). Combined effect of hormonal priming and salt treatments on germination percentage and antioxidant activities in lettuce seedlings. African Journal of Biotechnology. 11(45):10373-10380.

M'barek B.N., Hatem Cheick-M'hamed, Raoudha A. and Leila Bettaib-Kaab. (2007). Relationship Between Peroxidase Activity and Salt Tolerance During Barley Seed Germination. Journal of Agronomy, 6(3): 433-438.

Meher H.C., Gajbhiye, V. T., Singh G and Chawla G. (2015). Altered metabolomic profile of selected metabolites and improved resistance of Cicer arietinum (L.) against Meloidogyne incognita (Kofoid & White) Chitwood following seed soaking with salicylic acid, benzothiadiazole or nicotinic acid. Acta Physiologiae Plantaram Vol. 37: 140.

Mehra, K. L. (1978). Technical Bulletin. ICAR, New Delhi.
Moniruzzaman M, Khatoon R, Hossain M. F. B, Jamil M. K and Islam M. N. (2014). Effect of GA3 and NAA on physio-morphological characters, yield and yield components of brinjal (Solanum melongena L.). Bangladesh Journal of Agricultural Research. 39(3): 397-405.

Neeraj, V. Singh, B. K. Singh, A. K. and Bhagat Singh. (2012). Varietal response of NAA on fruiting and seed yield of chilli (Capsicum annuum L.). Environment and Ecology. Vol. 30(4) pp.1264-1266.

Peterson, D. M., Wesenberg, D. M., Burrup, D. E. and Erickson C. A. (2005). Relationships among agronomic traits and grain composition in oat genotypes grown in different environments. Crop Science. 45(4):1249–1255.

Rajesh Kanwar and D. K. Mehta. (2017). Studies on solid matrix priming of seeds in bitter gourd (Momordica charantia L.) Journal of Applied and Natural Science 9 (1): 395 – 401.

Saddam, H. Zheng, M. Khan, F. Khaliq, A. Fahad, S. Peng, S. Huang, J. Cui, K. and Nie L. (2015). Benefits of rice seed priming are offset permanently by prolonged storage and the storage conditions. Scientific reports. DOI: 10.1038/srep08101.

Sanna, A.M.Z., Mostafa, M.A., and Shehata, S.A.M. (2006). Physiological studies on the effect of kinetin and salicylic acid on growth and yield of wheat plant. Annals of Agricultural Science- Cairo. 51(1): 41-55.

Shafi, M., H. Tariq, J. Akbar, B. Bakht and M.Rehman. (2006). Response of wheat varieties to different levels of salinity at early growth stage. Sarhad. Journal of Agriculture. 22: 585-589.

Singh, R. Hemantaranjan, A. and Patel, P K. (2015). Salicylic acid improves salinity tolerance in field pea (Pisum sativum L.) by intensifying antioxidant defense system and preventing salt-induced nitrate reductase (NR) activity loss. Legume Research, 38 (2): 202-208.

Soyler D and Khawar K M. (2014). Seed Germination of Caper (Capparis ovata var. Herbacea) using α Naphthalene Acetic Acid and Gibberellic Acid. International Journal of Agriculture & Biology, 09(1): 35–37.

Suttie, J.M. and Reynolds, S.G. (2004). Fodder oats: A World Review. Plant Production and Protection Series No. 33. FAO (Rome).

Torkel, B. Lindstro, A. Aghelpasand, H. Stattein, E. and Anna B. Ohlsson. (2015).
Protection of spruce seedlings against pine weevil attacks by treatment of seeds or seedlings with nicotinamide, nicotinic acid and jasmonic acid. *International journal of Forest Research*. 89:127-130.

USDA, Foreign Agriculture Service. (September, 2016). World agriculture production, Circular Series.

Yadav, P V, Kumari, M, Meher, LC, Arif, M & Ahmed, Z. (2011). Chemical Seed Priming as an Efficient Approach for Developing Cold Tolerance in Jatropha. *Journal of Crop Improvement*. Vol. 25 (5).

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