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Short Research Article

Impact of KNO_3 Primed Seeds on the Performance of Late Sown Sesame (*Sesamum indicum* L.)

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Abstract

In the present piece of work the effects of seed priming with KNO_3 on late sown sesame crop (*Sesamum indicum*) var. T-4 (V_1), T-12 (V_2) and Shekhar (V_3) in respect of germination, physiomorphological, biochemical and yield parameters were observed. The treatments comprised of KNO_3 [10 mM (T_1), 15 mM (T_2)] and distilled water (DW) primed sets (T_0). The results showed that the KNO_3 treatment promoted germination percentage, root and shoot length, fresh and dry weights of seedling, catalase, peroxidase and proline content as well as yield attributes like number of capsules plant^{-1}, number of seeds capsule^{-1}, test weight (1000 seed weight in g) and yield plant^{-1} (g). After 80 h, the highest germination percentage was recorded in 15 mM KNO_3 (T_2) primed seeds of *Sesamum indicum* var. T-4, T-12 and Shekhar. The average of root length, shoot length, fresh weight, and dry weight was recorded highest in treatment T_2 in comparison to distilled water primed seeds (control) at 25 DAS in all varieties i.e., T-4, T-12 and Shekhar respectively. Yield attributes like number of capsules plant^{-1}, number of seeds capsule^{-1}, test weight and yield plant^{-1} were also highest in treatment T_2 in all varieties V_1, V_2 and V_3 respectively. Variety V_1 and treatment T_2 recorded the highest values of catalase, peroxidase and proline content followed by variety V_3 and V_2 and treatment T_1 and T_0 at 45 DAS respectively. It had been found that seed priming with KNO_3 ameliorate the effect of late sowing.

1. Introduction

Sesame (*Sesamum indicum* L.) is an ancient oilseed crop of the world. It is recognized by various names like Gingely, Til, Simsim, Gergelim and Biniseed etc., it is also known as *Queen of Oilseeds*. It is widely cultivated in tropical and sub-tropical parts of the world. India is a major producer of sesame and ranks first both in area and production. It's seed is the rich source of edible oil and varies from 46–52%. Sesame oil content highest antioxidant property among all edible oil. Seed is considered as one of the important basic agricultural inputs for obtaining higher yield. Harris et al. (1999) and Bose and her groups reported that seed priming is one of the most important technology now a days which improve the germination and emergence of seeds and increase tolerance to adverse environmental conditions. The beneficial effect of these seed priming treatments were reflected in greater cellular membrane integrity, counter action of lipid peroxidation and free radical chain reaction often found to be directly correlated with the maintenance of viability and reduced moisture uptake by hydrated dehydrated seed (Dollypan and Basu, 1985), antipathogenic effects (Powell and Mathews, 1986), repair of biochemical lesions by the cellular enzymatic repair system (Villers and Edgcumbe, 1975) and metabolic removal of toxic substances (Basu et al., 1973), counteraction of free radical and lipid peroxidation reactions (Rudrapal and Basu, 1982) and improvement in stress tolerating capacity (Anaytullah and Bose, 2007). Kumari et al. (2002) reported that pre-soaked hardening seeds of sesame resulted in good germination and seedling growth. Hence, with these points kept in mind in the present piece of work three varieties of sesame seed were sown after priming with distilled water (hydropriming) and different concentrations of KNO_3 (nitrate salt priming) in the late sown condition to see their comparative performance on the basis of following criteria: germination percentages, physio-morphological characters, changes in some biochemical parameters related to stress metabolism in growing crops and yield attributes.

2. Materials and Methods

The present study was carried out in Seed Physiology Laboratory at Department of Plant Physiology, Institute of Agricultural Sciences, B.H.U., Varanasi, India, during *kharif*

season of 2011 as pot culture experiment in the wire house by using factorial Completely Randomised Design with 3 replication. Seeds of Sesame (*Sesamum indicum*) cultivars T-4, T-12 and Shekhar were procured from the genetics and plant breeding department of the same institute.

Healthy and bold seeds of sesame were surface sterilized by keeping them in 0.01% $HgCl_2$ (Mercuric chloride) solution for 5 minutes and then thoroughly washed with distilled water for 5–6 times. These sterilized seed were used for priming purpose. The sterilized seeds were soaked in distilled water (T_0) and in different concentrations of KNO_3 [10 and 15 mM (T_1 and T_2)] for 8 hrs. After 8 hrs these seed were gently washed only once with distilled water and then they were further dried back to their original weight at the room temperature by placing under fan. After that these seeds were packed in paper bags and used as when required for experimentation.

The seeds were sown on August 31, 2011, this date of sowing was taken as late sowing condition of this crop as it has been established that the proper sowing time of sesame in North Indian condition ranges between last week of June to first week of July. Twenty five seeds were sown in each pot (20×20 cm^2), which was duly soaked with water. Physio-morphological parameters like germination percentage, radicle/root length (cm), shoot/plumule length (cm), fresh and dry weights (g) of seedling were determined by using conventional method. The biochemical parameters such as catalase (Aebi, 1983), peroxidase (Kar and Mishra, 1976) and proline content (Bates et al., 1973) of leaves were studied in different days after sowing as per the necessity of the work. Various yield attributes like number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$, test weight (g) and yield $plant^{-1}$ were also studied.

3. Results and Discussion

In the present investigation where KNO_3 primed seeds showed improved percentage of germination (Figure 1) of the studied varieties of sesame over distilled water priming. The lower used concentration of KNO_3 i.e., 10 mM showed maximum germination as compared to 15 mM KNO_3 at early stage (hrs) but at later stage the reverse was observed. This might be due to presence of higher amount of inorganic salt concentration used for seed priming. It has been noted from the literature that soaking of sesame seed in water for 3 hour and 2% H_2SO_4 solution for 90 sec followed by shade drying, enhance germination percentage upto 23.2% and 21.6% in respect to non-hardened seeds (Singh et al., 2002). Kumari et al. (2002) observed that KH_2PO_2, $(NH_4)_2 SO_4$ and KNO_3 when used as seed priming showed to improve the germination even in presence of varying concentration of NaCl.

In the present piece of work the Table 1 represented the shoot and root lengths, fresh and dry weights were measured from 5 to 25 days after sowing (DAS). Shoot length was observed to increase with increasing age of plant. Shoot length was found to increase in rapid rate in variety V_1 followed by V_3 and V_2 varieties. Among all three varieties and treatments shoot length of variety V_1 and treatment T_2 were recorded highest followed by variety V_3 and V_2 and treatment T_1 and T_0 respectively. Root length was found to increase with increasing age of the plants raised from distilled water and nitrate primed seeds. Higher

Table 1: Effect of seed priming with distilled water (D.W.) and different concentrations of KNO_3 on shoot and root length (cm), fresh and dry weights (g) of 5, 10, 25 days old seedlings of *Sesamum indicum* L. varieties (T-4, T-12 and Shekhar)

Varieties/ treatments	Shoot length			Root length			Fresh weight of seedlings			Dry weight of seedlings		
	Days after sowing											
	5	10	25	5	10	25	5	10	25	5	10	25
V_1-T_0	5.36	8.76	37.73	5.20	6.63	8.63	0.114	0.280	16.45	0.006	0.015	1.367
V_1-T_1	5.60	9.73	40.40	5.80	7.06	9.23	0.116	0.320	17.19	0.006	0.016	1.443
V_1-T_2	6.20	10.30	42.94	5.90	8.76	11.10	0.131	0.357	17.90	0.007	0.018	1.567
V_2-T_0	5.20	8.26	35.40	5.30	6.33	7.83	0.111	0.271	12.69	0.005	0.013	0.940
V_2-T_1	5.36	9.13	36.66	6.06	6.66	8.80	0.115	0.299	14.04	0.006	0.015	1.203
V_2-T_2	5.63	9.86	39.64	6.56	7.26	9.96	0.118	0.314	15.80	0.007	0.015	1.327
V_3 -T_0	5.16	8.53	35.93	5.53	6.36	8.14	0.113	0.271	12.55	0.006	0.013	1.193
V_3-T_1	5.63	9.33	36.93	5.90	6.80	9.50	0.114	0.320	14.43	0.006	0.015	1.397
V_3-T_2	5.93	10.16	40.33	7.06	7.73	10.86	0.128	0.353	15.86	0.007	0.017	1.460
SEm±	0.16	0.32	1.18	0.20	0.27	0.51	0.004	0.014	0.85	0.0002	0.001	0.1
CD (p=0.05)	0.34	0.67	2.49	0.42	0.58	1.08	0.010	0.031	1.78	0.0005	0.003	0.210
CD (p=0.01)	0.46	0.93	3.42	0.58	0.79	1.48	0.014	0.042	2.45	0.0007	0.004	0.287

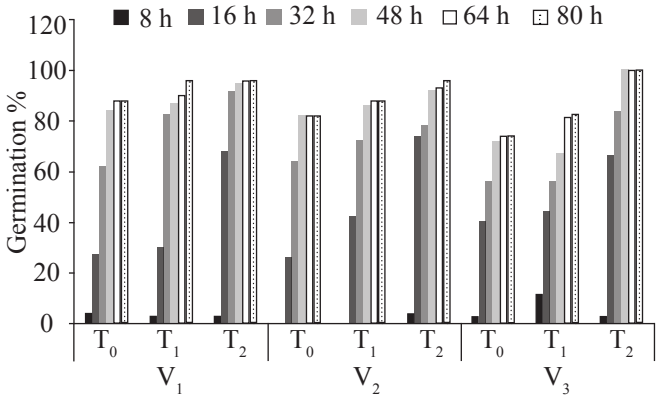

Figure 1: Effect of seed priming with distilled water (D.W.) and different concentrations of KNO_3 on germination percentage of *Sesamum indicum* L. varieties (T-4, T-12 and Shekhar) at different study periods

used concentration of nitrate salt i.e., T_2 (15 mM) found to be more effective in increasing root length followed by T_1 (10 mM) and T_0 (distilled water). Higher used concentration of nitrate salt i.e., T_2 found to be more effective in increasing fresh and dry weights of whole seedling followed by T_1 and T_0. This trend was similar in all treatments and varieties at different DAS interval. In the same context, Kumari et al. (2002) found that seed treatment with NaCl enhances the shoot and root lengths, fresh and dry weights of sesame plant. Ramlala et al. (1993) noted that KH_2PO_4 treated maize seed enhances root length in comparison to without KH_2PO_4 treated seed. Sharma and Bose (2006) and Shakila and Ponni (2008) observed that seeds of wheat and *Phyllenthus* sp. while primed with nitrate salts improved seedling characteristics. These reports support the data of the present investigation where the seed priming with KNO_3 showed improved shoot and root lengths and fresh and dry weights of all the varieties of sesame over distilled water priming.

Figure 2–4 showed the activities of catalase, peroxidase and relationship between catalase and peroxidase measured in the sesame leaves obtained from the plant primed with distilled water and KNO_3. The enzymes activities in general increased with the age of the plant; 15 DAS old plant showed less activity whereas 45 DAS old plant showed maximum activity of these enzymes. Among treatments higher concentration of KNO_3 i.e., treatment T_2 found to show maximum activity of all these enzymes followed by T_1 and T_0. Similar trend was observed in each variety. However, among varieties the highest activity of these enzymes was appeared in variety V_1. Varieties V_2 and V_3 showed statistically significant values at 15 DAS whereas in other two DAS all the varieties were found to attain non significant results. Whereas, Study of regression analysis and correlation coefficient showed that peroxidase (Eu g^{-1} fresh weight m^{-1}) activity was positively correlated with catalase

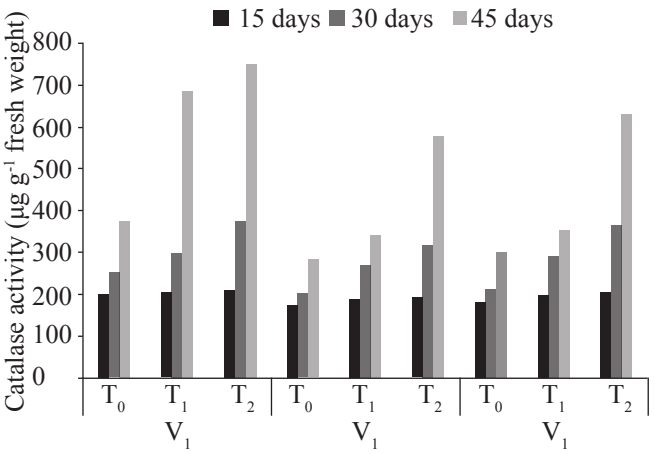

Figure 2: Effect of seed priming with distilled water (D.W.) and different concentrations of KNO_3 on catalase activity (ug g^{-1} fresh weight) of leaves, collected from 15, 30 and 45 days old plants of *Seasamum indicum* L. varieties (T–4, T–12 and Shekhar)

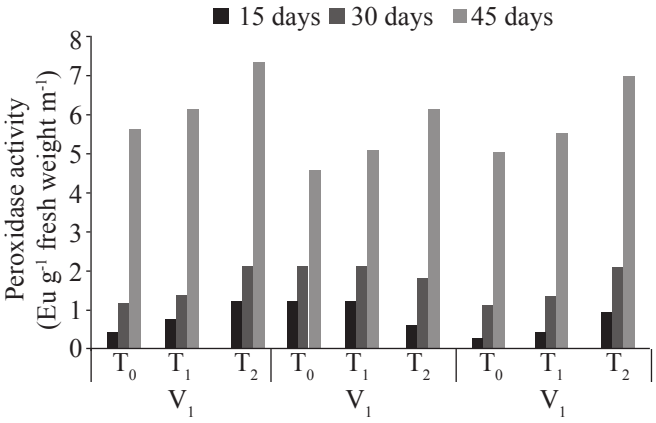

Figure 3: Effect of seed priming with distilled water (D.W.) and different concentrations of KNO_3 on peroxidase activity (Eu g^{-1} fresh weight m^{-1}) of leaves, collected from 15, 30 and 45 days old plants of *Seasamum indicum* L. varieties (T-4, T-12 and Shekhar)

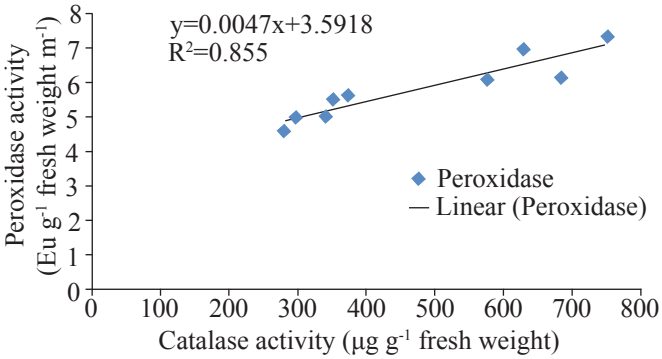

Figure 4: Relationship between peroxidase (Eu g^{-1} fresh weight m^{-1}) and catalase activity (ug g^{-1} fresh weight) in sesame varieties T-4, T-12 and Shekhar as at 45 days affected by priming with distilled water (D.W.) and different concentrations of KNO_3

activity (ug g^{-1} fresh weight) in all sesame varieties at 45 days. Moonsavi et al. (2009) indicated that when amaranth seeds primed with osmotic solution increased antioxidant enzymes activity in plants comparison to non-primed seeds. Farhoudi et al. (2011) observed that NaCl primed seed showed improved concentration of antioxidant enzymes 'especially catalase and peroxidase' in plant in comparison to non-primed seeds. These results are well correlated with the data of present investigation where KNO_3 primed seed showed to an increase in these enzyme activities in sesame leaves in comparison to distilled water primed seeds.

The Table 2 represents the value of proline content in harvested materials (root, shoot and leaves) and yield attributes of sesame plant, obtained from distilled water and KNO_3 primed seeds. Among all varieties and treatments, variety V_3 and treatment T_2 showed the highest proline content. It has been noted that plants, obtained from nitrate hardened seeds found to have more proline content in comparison to plants raised from hydro-hardened seeds (2005). Yang et al. (2009) reported that seed priming increased proline content in the plants. The data regarding yield attributes of sesame varieties showed an increment in the number which was maximum in the highest used concentration i.e., 15 mM KNO_3 (T_2) for each variety. Among varieties however V_1 showed maximum response for KNO_3 treatments followed by V_2 and V_3. It has been noted that various chemicals like succinic acid, potassium dihydrogen phosphate, KNO_3, $CaCl_2$ and plant hormone like GA_3 and NAA were found to improve the production of cotton, chickpea, okra, tomato, capsicum and sunflower (Powell and Mathews, 1986; Barlow and Haigh, 1987; Kumar et al., 1985; Pawar et al., 2003).

Table 2: Effect of seed priming with distilled water (D.W.) and different concentrations of KNO_3 on proline content (mg g^{-1} fresh weight), yield attributes of *Sesamum indicum* L. varieties (T-4, T-12 and Shekhar)

Varieties/ treatments	Proline content	Yield attributes			
	In harvest materials (root, shoot, leaf)	Number of capsules $plant^{-1}$	No. of seeds $capsule^{-1}$	Test weight (1000 seed weight) in (g)	Yield $plant^{-1}$ (g)
V_1-T_0	182.82	15.43	68.86	3.10	3.30
V_1-T_1	244.66	16.48	77.10	3.23	4.11
V_1-T_2	254.74	17.13	80.59	3.36	4.64
V_2-T_0	142.53	13.88	61.31	3.01	2.56
V_2-T_1	171.38	14.15	72.45	3.10	3.17
V_2-T_2	224.74	15.09	74.01	3.17	3.62
V_3 -T_0	153.87	15.00	69.42	3.06	3.18
V_3-T_1	197.54	15.39	77.84	3.12	3.78
V_3-T_2	255.23	16.13	79.41	3.23	4.14
SEm±	11.31	0.38	2.36	0.06	0.22
CD (p=0.05)	23.77	0.81	4.96	0.13	0.48
CD (p=0.01)	32.56	1.11	6.80	0.17	0.65

4. Conclusion

Seeds of sesame were primed with KNO_3 salt found to improve the germination percentage, seedling vigour, antioxidant metabolism and yield parameters. These improvements in cumulative form may help the crop to sustain in adverse condition of late sowing. The correlation study of catalase and peroxidase also supported the above results (Figure 4). Hence, it can be suggested that the nitrate primed seeds of sesame can be used to avoid the adverse effect of late sowing.

5. Acknowledgement

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6. References

Anaytullah Bose, B., 2007. Nitrate-hardened seeds increase germination, amylase activity and proline content in wheat seedlings at low temperature. Physiology and Molecular Biology of Plants 13(3 & 4), 199–207.

Barlow, E.W.R., Haigh, A.M., 1987. Effect of seed priming on the experience, growth and yield of UC 82B tomatoes in the field. Acta Horticulturae 200, 153–164.

Basu, R.N., Chattopadhyay, K., Pal, P., 1973. Maintenance of seed viability in rice (*Oryza sativa* L.) and Jute (*Corchorus capsularis* L. and *C. olitorius*). Indian Agriculture 18, 76–79.

Bates, L.S., Waldren, R.P., Teare, I.D., 1973. Rapid determination of free proline for water stress studies. Plant and Soil 39, 205–207.

Dollypan, Basu, R.N., 1985. Mid-storage and pre-sowing seed treatments for lettuce and carrot. Scientia Horticulturae 33(6), 1026–1027.

Farhoudi, R., Saeedipour, S., Mohammad reza, D., 2011. The effect of NaCl seed priming on salt tolerance, antioxidant enzyme activity, proline and carbohydrate accumulation of Muskmelon (*Cucumis melo* L.) under saline condition. African Journal of Agricultural Research 6(6), 1363–1370.

Harris, D., Joshi, A., Khan, P.A., Gothkar, P., Sodhi, P.S., 1999. On farm seed priming in semi-arid agriculture development and evaluation in maize, rice and chickpea in India using participatory methods. Experimental Agriculture 35, 15–29.

Kar, M., Mishra, D., 1976. Catalase, peroxidase and polyphenoloxidase activities during rice leaf senescence. Plant Physiology 57, 315–319.

Kumar, V., Mehta, N.P., Gohil, M.D., Patel, G.S., 1985. Cotton Development 14, 18.

Kumari, V.K., Sivaprasad, Hri, N., Gopal krishnana, P.K., 2002. Effect of pre-sowing hardening treatment with various chemicals on germination and seedling growth of an important oil yielding crops *Sesamum indicum* var. Kylml. Advances in Plant Sciences 15(1), 345–348.

Pawar, K.N., Sajjan, A.S., Prakash, B.G., 2003, Influence of seed hardening on growth and yield of sunflower. Karnataka Journal of Agriculture Science 16(4), 539–541.

Powell, A.A., Mathews, S., 1986. Cell membranes and seed leachate conductivity in relation to the quality of seeds for sowing. Journal of Seed Technology 10, 81–100.

Rudrapal, A.B., Basu, R.N., 1982. Use of chlorine and bromine in controlling mustard seed deterioration. Seed Research 9, 188–191.

Shakila, A., Ponni, C., 2008. Influence of seed treatment on germination and seedling vigour of *Phyllanthus niruri*. Acta Horticulturae 782, 155.

Sharma, M.K., Bose, B., 2006. Effect of seed hardening with nitrate salts on seedling emergence, plant growth and nitrate assimilation of wheat (*Triticum aestivum* L.). Physiology and Molecular Biology of Plants 12(2), 173–176.

Singh, B., Singh, S., Singh, J., Kumar, A., 2002. Seed priming techniques in sesame (*Sesamum indicum*). Indian Journal of Agricultural Science 72, 319–321.

Yang, X.H., Wang, Y.G., Yang, W.X., Wang, H.F., Ma, J.H., 2009. Effect of seed priming on physiological characteristics of soybean seedling under water stress. Chinese Journal of Eco-Agriculture 17(6), 1191–119.