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Standardization of Different Doses and Duration of Plant Derived Smoke Water on Growth, Yield and Yield Attributing Traits of Linseed (*Linnum usitatissimum* L.) (LCK-9312)

B Lohitha*, Prashant Kumar Rai*

Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Science, Uttar Pradesh, India

Research Article

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***For Correspondence:**
B Lohitha, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Science, Uttar Pradesh, India
Prashant Kumar Rai, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Science, Uttar Pradesh, India
E-mail: lohithabonthu123@gmail.com
E-mail: prashant.rai@shiats.edu.in

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ABSTRACT

Background: Smoke Water, derived from burned plant material contains a diverse bioactive compound that plays a crucial role in seed germination and plant growth. This study investigates the potential of plant derived smoke water as a seed treatment to enhance the seed germination, growth and yield of the crop.

Methods: Field experiment was conducted at Post Graduate Central Research Farm, Department of Genetics and Plant Breeding, Sam Higginbottom University of agriculture technology and sciences, Prayagraj (U.P) during Rabi season 2022-2023, in order to standardize the best treatment of plant derived smoke water specific for Linseed (LCK-9312). Plant derived smoke water with control (un primed) were evaluated by screening 16 hours and 18 hours duration and different concentration *Viz.,* T_0-Unprimed; T_1-Smoke water (0.5%@16 hrs); T_2- Smoke water(1%@16 hrs); T_3-Smoke water (2%@16 hrs); T_4-Smoke water(5%@16 hrs); T_5- Smoke water (10%@16 hrs); T_6-Smoke water (12%@16 hrs); T_7-Smoke water (0.5%@8 hrs); T_8-Smoke water (1%@18 hrs); T_9-Smoke water (2%@18 hrs); T_{10}- Smoke water (5%@18 hrs); T_{11}-Smoke water (10%@18 hrs); T_{12}-Smoke water (12%@18 hrs).

Results: low concentration of smoke water (1%) for 16 hrs promoted maximum seed germination. All the concentrations have shown significance. Pre sowing treatment with plant derived smoke water has improved the seed germination and other parameters compared to control.

Keywords: Linseed; Smoke-water; Different duration (16 hrs and 18 hrs)

INTRODUCTION

Oilseed crops occupy prestigious place in Indian agriculture due to their vital role in sustainable economy of the country. Linseed, also known as Jawas in India, is a major oil seed crop. Linseed is called (*Linum usitatissimum* L.) with the somatic chromosome complement, (2n=30), and belongs to the genus Linum in the family Linaceae [1]. Linseed is believed to be originated from the Middle East and subsequently introduced to the other parts of the world. It is mainly a temperate climates rabi crop moderate and cool weather patterns are ideal for growth. Depending on the variety, the crop matures in 120-140 days. Drought and hot temperatures during the early and seed filling stages are both damaging to yield and quality [2]. Linseed contains the highest oil content among the crop plants grown with 36-40% which is also the richest source of PUFA (Poly Unsaturated Fatty Acids). Which contains 9-10% of saturated fatty acids (palmitic and stearic), about 20% monounsaturated fatty acids (mainly oleic acid), and more than 70% alpha-linolenic fatty acids acid. The protein content in seeds of flax varies from 20-30%, fibre 20-28 % and moisture content 4-8%. [3-7]. Oil extracted is mainly used for industrial purposes for the manufacturing of paints, varnishes, soaps *etc.,* as it is having drying and hardening properties from the high linolenic acids whereas low linolenic acid is preferable for human consumption [8-10]. The fibre is known for its good quality having high strength and durability, therefore, used in the textile industry, liquid proof pipes, paper and strawboard. [11-13]. Linseed is grown on 1.799 lakh ha in India, with a total production of 1.207 lakh tones and an annual productivity of 671 kg/ha [14-16]. Whereas in Uttar Pradesh, it occupies an area of 0.73 million ha with an average productivity of 1.67 t/ha and production of 1.23 million tonnes [17-19]. Pre-sowing treatment is the treatments given to the seeds before sowing to improve the germination and vigour potential and to maintain the health of the seed. Pre-sowing techniques or seed priming are a low cost and safe solution to improve crop stand establishment [20-22]. Fire is an integral element of rural agronomy. In traditional farming communities, the burning of fields is an inexpensive and efficient method of eliminating the residue of previous crops. In addition, it protects fields from weeds, pests, diseases and it increases the fertility of the soil [23,24]. Recently, the germination response to smoke has been studied through the use of smoke water, which is derived from burning plant material and bubbling the smoke through water. Plant-derived smoke water was proven to be a promoting factor for several growth-related phenomena of plants including breaking seed dormancy, accelerating seed germination, and increasing seedling vigour [25]. The main active germination compound of smoke water derived from burned plant materials and cellulose bas been identified as butenolide (3-Methyl-2H-furo (2,3-c) pyran-2 one) which is effective at very low concentrations [26]. The compound is recently identified as 'kkarikinolide' [27-30]. The action of smoke in promoting seed germination in many species is attributed to the presence of this compound [31-34].

Objectives

- To determine the effect of different doses and duration of plant derived smoke water on growth, yield and yield attributing traits of linseed.
- To evaluate the effect of different doses and duration of plant derived smoke water on chlorophyll content, oil content and protein content of linseed.
- To identify the suitable dose and duration of plant derived smoke water for linseed crop.

MATERIALS AND METHODS

Seed source

The seeds of linseed genotype LCK-9312 were obtained from Directorate of Research, SHUATS. The present study was conducted at Field experimentation centre of the Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P) during Rabi 2022–2023 on linseed genotype LCK-9312 was made to identify the effect of pre-sowing on seed quality parameters.

Smoke water preparation

A smoke water solution was prepared by igniting 10 kg dry paddy straw material in a 20 litre stainless steel barrel. Using compressed air, the smoke was continuously bubbled through a 1000 ml graduated cylinder containing distilled water for 45 minutes. The smoke water was filtered ad used as stock solution. The smoke extracts were added to 100 ml, of distilled water. After preparation of smoke water solution, the seeds were soaked in 6 different concentrations (0.5%, 1%, 2%, 5%, 10%, and 12%) for 16 hrs and 18 hrs respectively. Untreated seed is called as control. After 16 hrs and 18 hrs of soaking the solution was drained out from the beaker and the pre-soaked seeds were air dried to original weight and sown in the field. The seeds were treated with different concentrations *viz.,* T_0-Unprimed; T_1-Smoke water (0.5%@16 hrs); T_2- Smoke water (1%@16 hrs); T_3-Smoke water (2%@16 hrs); T_4-Smoke water (5%@16 hrs); T_5-Smoke water (10%@16 hrs); T_6-Smoke water (12%@ 6 hrs); T_7-Smoke water (0.5% @18 hrs); T_8-Smoke water (1%@18 hrs); T_9-Smoke water (2%@18 hrs); T_{10}-Smoke water (5%@18 hrs); T_{11}-Smoke water (10%@18 hrs); T_{12}-Smoke water (12%@18 hrs).

Growth, yield and biochemical parameters

The performance of the crop was assessed in terms of field emergence, plant height (30, 60, 90 DAS), first flowering, days to 50% flowering, number of capsules, seeds per capsule, number of branches, seed yield per plant, seed yield per plot, seed yield (q/ha), biological yield, harvest index, oil content, protein content and chlorophyll content. The method of Arnon (1949) was used for chlorophyll estimation. Oil of the seeds was estimated by grounding 2 gm of seeds and transferring to Soxhlet apparatus. Protein content was estimated by using Lowry method. Data were analysed statistically with WASP (ICARGOA). By applying F-test, error due to replicates was derived. F-test was found to be significant at 5% level of probability, critical difference was calculated.

RESULTS AND DISCUSSION

The effect of Plant derived smoke water is shown in Table 1. In this present study treating the seeds with smoke water has shown significant effect on all growth and yield parameters. At all concentrations tested Field emergence (%) was maximum recorded for treatment T_2-Smoke water @ 1% for 16 hrs (77.5%). The smoke water reduced the ABA level and regulated GA level. This may result in breaking seed dormancy and increasing the germination. Similar results were stated by [26, 32-35].

Table 1. Mean performance of smoke water on Pre-harvest characters of linseed.

Treatments	Field emergence	Plant height at 30 DAS	Plant height at 60 DAS	Plant height at 90 DAS	Days to first flowering	Days to 50% flowering	Number of primary branches per plant	Number of secondary branches per plant	Days to maturity

T_0- Control	11.25	8.07	38	77.2	61	76.33	3.1	22.93	123.67
T_1-Smoke water 0.5% (16 hrs)	12.67	8.66	38.25	77.71	55	74.67	3.47	23.2	117.33
T_2- Smoke water 1% (16 hrs)	15.5	9.7	42.38	80.93	52.67	67	3.87	24.17	111.67
T_3- Smoke water 2% (16 hrs)	13.5	9.67	41.47	79.29	53	71.67	3.27	23.63	114.67
T_4- Smoke water 5% (16 hrs)	12	8.39	37.67	77.06	55.67	75.33	3.33	23.27	117.67
T_5- Smoke water 10% (16 hrs)	11.5	8.55	38.32	77.48	55.33	75	3.4	23.4	119.67
T_6- Smoke water 12% (16 hrs)	12.17	8.49	38.16	77.22	55	74.67	3.37	23.33	117
T_7- Smoke water 0.5% (18 hrs)	11.25	8.83	38.15	77.63	54.67	74	3.5	23.27	118.67
T_8- Smoke water 1% (18 hrs)	14.67	10.19	43.07	81.28	52	65.67	4.27	24.83	112.33
T_9- Smoke water 2% (18 hrs)	12.5	9.25	41.41	77.74	53.67	70	3.67	23.4	115.33
T_{10}- Smoke water 5% (18 hrs)	11.5	8.55	38.03	77.03	55	75	3.57	23.13	113.33
T_{11}- Smoke water 10% (18 hrs)	12.5	9.17	38.25	76.69	55	74.67	3.53	23.6	114.67
T_{12}- Smoke water 12% (18 hrs)	12.67	8.44	38.11	76.31	54.67	74	3.4	23	117.67
Grand mean	12.59	8.92	39.33	77.97	54.82	72.92	3.52	23.47	116.44
SE(d)	1.31	0.64	2.1	1.86	2.36	3.48	0.35	0.69	3.32
SE(m)	0.21	0.1	0.34	0.3	0.38	0.56	0.06	0.11	0.53
CD at 5%	0.73	0.38	1.617	2.225	2.323	2.194	0.434	0.901	1.878
Note: Each value mean of 3 replications and NS=Non-Significant									

This study shows that the T_8- Smoke water @ 1% for 18 hrs has enhanced Plant height at 30DAS (10.19 cm), 60DAS (43.07cm) and 90DAS (81.28 cm). Smoke water treatment enhanced seed growth and development leading to developed seed. The active compound affects plant hormones which stimulate cell division and increase its number and thus stimulate rooting and increase the absorption surface, thereby the absorption of a nutrient that at the end is reflected in the strong vegetative growth characteristic. similar results were reported by Kulkarni and H H Abou [36-39]. Table 1 has shown treated seeds with T_8-Smoke water @1% for 18 hrs significantly reduced days to 1st flowering (52 days) and days to 50% flowering (65.67). The active compound in smoke water speeds up the flowering phase by influencing the plant physiological processes. Similar results were stated by Light et al. [40-42]. The results show that seeds treated with treatment T_8-Smoke water @1% for 18 hrs significantly improved number of primary branches (4.27) and secondary branches (24.88). Smoke water has enhanced the nutrient intake which has improved the vegetative growth characters of the crop. Similar results were stated by Abou El-Nour [43-45]. Table 1 shows seed treated with the treatment T_2-Smoke water @1% for 16 hrs has reduced days to maturity (111.6), as compared to unprimed seeds it was recorded T_0-control (123.6). Treating the seeds with smoke water T_2-Smoke water @1% for 16 hrs gave more capsules (97.9) than the untreated seeds (95.7). The treatments showed significant effect of pre-sowing seed treatment number of capsules per plant. The smoke water enhanced the photosynthetic activity and chlorophyll content which has increased the number of capsules. Similar results were stated by Kulkarni *et al*. [25]. The Table 2 shows that the smoke water has significant effect on seeds per capsule except for number seeds per capsules.

Table 2. Mean performance of smoke water on post-harvest characters of linseed.

Treatments	No. of capsules per plant	No. of seeds per capsule	Seed yield per plant (gm)	Seed yield per plot (gm)	Seed yield (q/ha)	Test weight (gm)	Biological yield	Harvest index (%)
T_0- Control	95.73	7.35	2.6	66.67	6.67	5.23	10.78	24.14
T_1-Smoke water 0.5% (16 hrs)	96.23	7.37	3.4	67	6.7	5.9	11.23	30.3
T_2-Smoke water 1% (16 hrs)	97.9	7.43	4.37	70	7	6.4	12.04	36.26
T_3-Smoke water 2% (16 hrs)	97	7.38	4.07	68.67	6.87	5.8	11.75	34.31
T_4-Smoke water 5% (16 hrs)	96.53	7.37	3.7	67.67	6.77	5.77	12.11	30.14
T_5-Smoke water 10% (16 hrs)	96.63	7.38	3.2	67.33	6.73	5.63	10.49	30.52
T_6-Smoke water 12% (16 hrs)	96.9	7.38	3.03	64	6.4	5.8	11.45	26.49

T_7-Smoke water 0.5% (18 hrs)	96.7	7.38	2.93	67.67	6.77	5.87	11.21	26.18
T_8-Smoke water 1% (18 hrs)	97.6	7.41	4.23	69.33	6.93	6	12.02	35.22
T_9-Smoke water 2% (18 hrs)	97.23	7.47	3.5	68.33	6.83	5.93	11.15	31.4
T_{10}-Smoke water 5% (18 hrs)	96.63	7.41	3	67	6.7	5.6	10.55	28.47
T_{11}-Smoke water 10% (18 hrs)	96.73	7.35	3.25	67.33	6.73	5.43	10.63	30.63
T_{12}-Smoke water 12% (18 hrs)	96.27	7.36	3.1	67.67	6.77	5.7	11.27	27.51
Grand mean	96.78	7.39	3.41	67.59	6.76	5.77	11.28	30.12
SE(d)	0.74	0.07	0.55	1.94	0.19	0.3	0.61	3.87
SE(m)	0.12	0.01	0.09	0.31	0.03	0.05	0.1	0.62
CD at 5%	1.01	NS	0.332	2.714	0.271	0	0.512	3.018
Note: Each value mean of 3 replications and NS=Non-Significant								

It is evident from Table 2 that smoke water treated seeds with T_2-Smoke water @ 1% for 16 hrs was significant to all yield characteristics. The smoke water has enhanced Seed yield per plant (4.37 gm), seed yield per plot (70 gm) and seed yield(q/ha) (7.0 q/ha). The smoke water enhanced more photosynthetic activity and improved the nutrient uptake by which carbohydrate content has increased which lead to more cell division and cell enlargement. Due to which the seed yield of the plant has increased. Similar results were stated by Kulkarni *et al.* [46,47]. The Table 2 shows significant effect of smoke water T_2-Smoke water @1% for 16 hrs on test weight. The treated seeds has more test weight (6.4 gm) as compared to untreated seeds (5.25 gm). Smoke water treatment has enhanced the photosynthetic activity with increased chlorophyll content. This may result in better seed development and test weight [48-50].

The study shows that the smoke water treatment T_2-Smoke water @1% for 16 hrs (12.04 gm.) Significantly increased the biological yield (12.04 gm.) as compared to untreated seeds (10.78 gm). From Table 2 the effect of smoke water T_2-Smoke water @1% for 16 hrs showed significant effect of pre-sowing seed treatment Harvest index % (36.25%) as compared to non-treated seeds 24.13%.

Table 3 shows that the treating the seeds with smoke water improved significantly most of physiological and biochemical parameters. The treatment T_2-Smoke water @ 1% for 16 hrs showed significant effect of pre-sowing seed treatment Chlorophyll content 60DAS (0.0261 mg/g) and 90DAS(0.02897 mg/g). Smoke water has enhanced seed development and vigour of the seed which has developed a healthy seedling. This has increased the chlorophyll content and has improved photosynthetic activity. Similar results were reported by Komatsu *et al.*,

Chumpookam *et al*. Mohamed A. *et al.* [26,51,52]. The study shows that smoke water has no effect on oil content %. The seeds treated with smoke water have no significant effect as compared to non-treated seeds.

Table 3 shows that seeds treated with smoke water showed significant effect on protein content. The smoke water treated seeds with T_2-Smoke water @1% 16 hrs has significantly enhanced protein content (1.07 µg) as compared to non-treated seeds (0.909 µg). Smoke water has improved the absorption of nutrients which has increased the biosynthesis of protein. Similar results were stated by Aslam MM, Iqbal, Rehman A [53-57].

Table 3. Mean performance of smoke water on biochemical characters of linseed.

Treatments	Chlorophyll content 60DAS (mg/g)	Chlorophyll content 90DAS (mg/g)	Oil content (%)	Protein content (µg)
T_0- Control	0.025658	0.027244	35	0.909752
T_1-Smoke water 0.5% (16 hrs)	0.025364	0.027704	35.16667	0.965449
T_2-Smoke water 1% (16 hrs)	0.026148	0.028977	36	1.055131
T_3-Smoke water 2% (16 hrs)	0.025064	0.027636	35.83333	1.072123
T_4-Smoke water 5% (16 hrs)	0.025826	0.027778	35.16667	0.989049
T_5-Smoke water 10% (16 hrs)	0.025853	0.028813	35.66667	0.924856
T_6-Smoke water 12% (16 hrs)	0.025548	0.028977	35.66667	0.979609
T_7-Smoke water 0.5% (18 hrs)	0.025921	0.028082	35.33333	0.966393
T_8-Smoke water 1% (18 hrs)	0.025426	0.028973	35.66667	1.062683
T_9-Smoke water 2% (18 hrs)	0.025055	0.027954	35.16667	0.950345
T_{10}-Smoke water 5% (18 hrs)	0.024528	0.028195	35.5	0.984329
T_{11}-Smoke water 10% (18 hrs)	0.025126	0.028088	36	0.939016
T_{12}-Smoke water 12% (18 hrs)	0.024677	0.027968	35	0.93524
Grand mean	0.0254	0.028184	35.47436	0.979537
SE(d)	0.000491	0.000575	0.359050663	0.05323
SE(m)	0.001772	0.00016	0.359050663	0
CD at 5%	0.001	0.001	NS	0.02
Note: Each value mean of 3 replications and NS=Non-Significant				

CONCLUSION

It was concluded from the present study that the seeds of Linseed (*Linnum usitatissimum* L.) (LCK-9312) treated with T_2-Smoke water 1% with 16 hours showed significant increase in growth, yield and yield attributing traits. Therefore, seed treatment with Smoke water 1% with 16 hours was found more productive and Eco-Friendly. This

study suggesting that smoke technology can be helpful in enhancing germination of seed, improve growth and healthy seed.

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