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Burnt Weed Smoke Can Enhance Plant Growth: A Proper Weed Management

Shaiphali Saxena

Department of Botany, Government Post Graduate College, Manila, Almora, Uttarakhand, India

ABSTRACT

Weeds are serious issue around the world causing crop yield reduction in agricultural fields. However, several studies proclaim the uses of weed plant species as plant growth enhancer because of their unique phytochemical composition present in smoke when pyrolysed. This idea has been inspired by the discovery of karrikins, a class of smoke elicitors that cues the seedling germination in several plant species. The present review is mainly aimed towards the application of weed-derived smoke to regulate the plant growth in positive manner. Smoke-water prepared from pyrolysed weed emerged out as more powerful in promoting the plant development of agriculturally and medicinally. The smoke technology can be one of the useful management strategies in future with cost-effective and environmental friendly inputs.

***KEYWORDS**: Management, medicines, plant germination, smoke, weeds*

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INTRODUCTION

When agriculture started breathing in ancient time, the flora was in ferality and had a valued status.As humans began the plant cultivation from wild, his biasness towards plants increased and they categorized the flora into cultivated (plants of use) and weeds (plants of no use) (Scott 2010).The scientists from different world patches define the weeds in various ways in either ecological or plant science aspects that is not admissible by all scientists. But according to Aldrich and Kremer (1997), weeds were described in pertinent mode that "the plants originated in natural habitat, evolved in response to that habitat and then interfere with associated crops" (Rana and Rana 2016). Different strategies are being adopted for weed management in different nations such as physical (mulching, burning, hand removal, hay making and tilling), biological (use of insects and pathogens), chemical (herbicides) and cultural (crop rotation and manipulation in farming practices) control.

Contrariwise, another perception of weeds has also been observed by various researchers. Some literatures depict the beneficiary utilization of weeds like in agro-forestry, fuel-making, ornamentals, medicines, etc. (www.environment.gov.au/). New findings on weeds suggest the utilization of burnt weed-derived smoke to stimulate germination in several plant seeds (Acceiaresi and Asenjo 2003). About 20 years back, ecologists attracted towards seed germination *via* smoke after forest fire. It was 2004 when Garwin R. Flematti and co-workers proposed smoke-derived compounds as seed sprouters (Halford 2010). The prime compound of smoke responsible for seed germination was recognized chemically as 3-methyl-2H-furo[2,3-c]pyran-2-one (a butenolide) and commonly referred to as karrikinolide (KAR_1) (Imran *et al.* 2014).Also thefive other analogs of karrikins have been distinguished (KAR_2, KAR_3, KAR_4, KAR_5 and KAR_6)depending upon the presence and absence of methyl group on butenolideskeleton (Nelson *et al.* 2012). Moreover, Australian researchers De Lange and Bowsher (1990) are credited for the karrikin discovery when they ecologically studied *Audouiniacapitata* (threatened fynbos plant) and noticed the ability of smoke in eliciting seed germination. However, Parija*et al.* (1940)from Indiaalready observed the recovery of winter paddy seed dormancy *via* smoke that dates 50 years back fromDe Lange and Bowsher study (Pandey*et al.* 2013).

Study Purpose

Notably, the present review is emphasized on enlightening the utilization of burnt weed-derived smoke in different aspects such as plant germination, ethno botany, medicines, etc. just to reflect their beneficiary traits as a proper management strategy.

Materials and Methods

The present review information focusing upon use of weed smoke aqua-solution in plant growth has been compiled by consulting various sources like Google Scholar, Research Gate, Elsevier, PubMed, Academia Edu, NCBI, Springer, etc.

1. Role of Weed-derived Smoke in Plant Germination

The seed emergence of *Achnatherumoccidentalis* (SierraNevadaneedlegrass) and *Achnatherumhymenoides*

(Indian ricegrass) enhanced when treated with direct sagebrush-derived smoke given through sieve (1 m. height) for 1 min. Similarly, sagebrush-derived smoke significantly increased the leaf elongation rate, above and underground biomass and shoot to root mass ratio in *Achnatherumoccidentalis* (SierraNevadaneedlegrass), *Leymuscinereus* (basin wildrye) and *Hesperostipacomata* (needle-and-thread grass); leaf number in *Bromustectorum* (cheatgrass), *Festucaidahoensis* (Idaho fescue), *Achnatherumoccidentalis* (Sierra Nevada needlegrass) and *Hesperostipacomata* (needle-and-thread) after 1 min treatment (Blank and Young 1998).

Sparg*et al.* (2006) treated *Zea mays* cv. PAN 6479 kernels with aerosol smoke (~28 °C) derived from *Heteropogoncontortus*at 30, 60 and 90 min intervals. The seed germination (%) and seedling vigor (mm) were highest (97.5 and 5987, respectively) at 90 min interval when pre-soaked in water for 180 min. The root and shoot lengths (mm) were highest (≈35 and ≈8) at 30 min interval when kernels were rinsed after aerosol smoke treatment.

Therice seeds exhibited maximum germination (96.7%), root length (7.63 cm), concentration of Ca^{2+} (25.6 µg/g) and K^{+} (53.4 µg/g), chlorophyll '*a*' (3.53 µg/g), carotene contents (>500 µg/g), total nitrogen (280.14 µg/g) and total protein contents (153.68 µg/g) at 50 mMNaCl stress when primed with *Bauhinia variegata*smoke-water solution (1:500 conc); while root fresh weight (0.17 g) and shoot fresh weight (0.307 g) at 50 mMNaCl stress; chlorophyll '*b*' (8.37 µg/g) at 150 mMNaCl stress when primed with *Cymbopogonjwarancusa*smoke-water solution (1:500 conc) (Jamil*et al.* 2014).

Similarly, Malook*et al.* (2014)investigated two rice seed varieties (Shaheen Basmati and Basmati-385) by priming in*Bauhinia variegata* (1000x and 5000x v/v) and *Cymbopogonjwarancusa* (500x and 1000x v/v) smoke-water solution under non-saline and NaCl stress (50, 100 and 150 mM). The maximum seed germination (100% at C-500+50 mM) and cell membrane stability (40 µs/cm at C-1000+150 mM) were shown by B-385; maximum root length (≈9.0 cm at B-5000+50 mM), shoot length (>7.0 cm at C-1000+50 mM), root fresh weight (0.4 to 0.5 g at C-1000), shoot fresh weight (0.28 g at C-500) and shoot dry weight (0.03 g at C-1000+150 mM) by S. Basmati. However, both varieties exhibited equal root dry weight (0.02 g at B-1000+150 mM), electrolyte concentration (2.55 mg/L Ca^{2+} and 26.05 mg/L K^{+} at B-5000+50 mM), total nitrogen (4.13 g/g at C-1000) and total protein contents (25.82 g/g at C-500 and C-1000, respectively).

Aslam*et al.* (2015)reported the application of smoke water (100x, 500x, 1000x, 3000x, 5000x and 10000x dilutions) from six weeds (*Avenasativa*, *Asphodelustenuifolius*, *Phalarisminor*, *Partheniumhysterophorus*, *Scandixpecten-veneris* and *Galiumtricornutum*) upon wheat seed growth at 12, 24 and 36 hrs. The overall seed germination (%) was maximum (≈100%) in1000x, 3000x, 5000x and 10000x dilutions of smoke-water of all weed species at 12, 24 and 36 hrs. The maximum root length (cm) was between 24 to 25 at 1:500 conc.of*S. pecten-veneris*, 1:1000 conc. Of *A. sativa* and *A. tenuifolius*, at 1:5000 conc. of*G. tricornutum* and *P. hysterophorus*, and at 1:10000 conc. Of *P. minor*. The maximum shoot length (cm)was >12 at highest concentration (1:10000) of all weed species. The highest root fresh weight (g) was ≈1.1 at 1:500 conc. Of *P. minor* and *S. pecten-veneris*, at 1:1000 conc. of*G. tricornutum* and *P. hysterophorus*, and at 1:5000 of*A. tenuifolius*. The maximum shoot fresh weight (g) was >0.9 at 1:1000 conc. of *P. hysterophorus*. The root and shoot dry weight were almost negligible (≈0.1) at all smoke-water concentrations of all weed species.

Furthermore, aerosol-smoke derived from mixture of plant species including *Cynodondactylon* was applied on wheat under conditions of 25% and 52% relative humidity, 405±7.5 µmol/m²-sec mid-day photosynthetic photon-flux density, and 23±2.5 °C temperature. The aerosol smoke significantly enhanced shoot length (11.7%), shoot fresh weight (1.4%) and shoot dry weight (0.5%) at 1 hr; root length (2.9%) and relative water content (17.3%) at 2 hrs; root fresh weight (0.10%), leaf area (81.9%) and membrane stability index (14.6%) at 3 hrs; while total chlorophyll content (16.4%), soluble sugars (1.7%), proline content (1.1%) and free amino acid (0.4%) at 4 hrs treatment, thus, enhancing physiological, biochemical and morphological parameters (Iqbal*et al.* 2018).

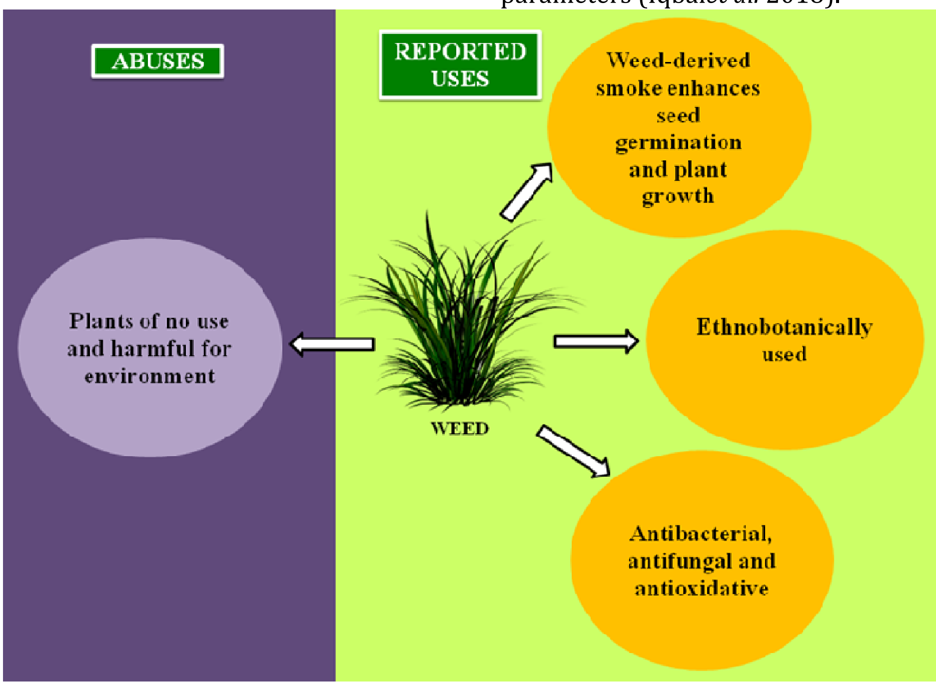

Figure 1: Schematic of reported uses and abuses of weeds plant species

2. Medicinal Uses

The smoke derived from *Zorniaglochidiata* is used to keep spirits away in Uganda tribes (Pennacchio*et al.* 2010). The emanations from burning of mixture ofweeds such as *Cyperusscariosus*roots, *Citrulluscolocynthis* fruit, *Ervatamiadivaricata* whole plant, *Ficusreligiosa* stem bark, *Peganumharmala* fruit, *Valerianawallichii* root, *Mimulusmoschatus* flower in '*havansamigri*' (herb mixture religiously offered to fire in India) help alleviating airborne bacteria (Nautiyal*et al.* 2007). The smoke liquid derived from pyrolizing*Etlingerabrevilabrum* leaves exhibited antioxidant (radical scavenging and β-carotene bleaching activities), antifungal (against *Candida albicans* and *Candida parapsilosis*) and antibacterial (against *Aeromonashydrophila*, *Bacillus thuringiensis*, *Enterobacteraerogenes*, *Enterococcus faecalis*, *Escherichia coli*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Shigellasonnei*, *Staphylococcus aureus*,*S. epidermidis* and *Vibrio parahaemolyticus*) potential (Mahdavi*et al.* 2018).

Conclusion

The above mentioned information infers that weeds other than their harmful impacts can be preferred as useful seed sprouters because of their unique phytochemical composition imbibed in pyrolysed smoke, which can be exploited as natural plant growth regulator. Liquid-smoke with variable dilutions proved itself better than aerosol smoke in enhancing seed germination and plant growth. This may be because of the presence of water, which is considered as a prime source of seed germination by hydrating the seed enzyme machinery and thus mobilizing the seed reserves for embryo development. Besides, the active compounds existing in weed-derived smoke can be practiced in remedial and antimicrobial preparations (Figure 1).

Future Prospects

Expending several dollars annually for eradicating weeds from natural habitats is very expensive in management field. Several positive aspects of the weeds (physiological, remedial, pharmacological, ethno botanical, etc.) should be investigated by researches for proclaiming a better management strategy against costlier eradication programmes. Another application of weed-derived smoke can be the germination enhancement of medicinally important plant species so that their product quality could be upgraded at commercial level. Further, smoke technique can lessen the use of synthetic fertilizers for improving seed germination and growth rate and minimizing germination time as the smoke-based applications evince advantages in terms of simplicity, cost-effectiveness and environmental health.

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References

[1] Acceiaresi, H. A. and Asenjo, C. A. (2003). Allelopathic effects of *Sorghum halepense* (L.) on *Triticumaestivum* (L.) seedling growth and above ground and below-ground biomass. Austral Ecol. 13: 49-61.

[2] Aslam, M. M., Jamil, M., Khatoon, A., El-Hendawy, S. E., Al-Suhaibani, N. A., Shakir, S. K., Malook, I. and Rehman, S. U. (2015). Does weeds-derived smoke improve plant growth of wheat. J Bio-Mol Sci. 3 (2): 86-96.

[3] Blank, R. R. and Young, J. A. (1998). Heated substrate and smoke: influence on seed emergence and plant growth. J Range Manage. 51 (5): 577-583.

[4] Halford, B. (2010). Seeds sprout in the ashes of forest fires, thanks to small molecules in smoke. Chem. Eng News. 88 (15): 37-38. https://pubs.acs.org/cen/science/88/8815sci3.html. (Accessed 11-Sep-2019)

[5] https://www.environment.gov.au/biodiversity/invasive/weeds/management/integrated.html (Accessed 05-Sep-2019)

[6] Imran, Q. M., Asaf, S., Jamil, M., Khatoon, A., Kamran, M., Falak, N., Khan, M. and Rehman, S. (2014). Plant derived smoke- the magical seed sprouter: a review from traditional to recent advancements. IJCBR. 1 (3): 11-27.

[7] Iqbal, M., Asif, S., Ilyas, N., Raja, N. I., Hussain, M., Ejaz, M. and Saira, H. (2018). Smoke produced from plants waste material elicits growth of wheat (*Triticumaestivum* L.) by improving morphological, physiological and biochemical activity. Biotechnol Rep. 17: 35-44.

[8] Jamil, M., Kanwal, M., Aslam, M. M., Khan, S. U., Malook, I. and Tu, J. (2014). Effect of plant-derived smoke priming on physiological and biochemical characteristics of rice under salt stress condition. Aust J Crop Sci. 8 (2): 159.

[9] Mahdavi, B., Yaacob, W. A. and Din, L. B. (2018). Phytochemical study of medicinal smokes from *Etlingerabrevilabrum* leaves. J Herb Med. 13: 52-62.

[10] Malook, I., Atlas, A., Rehman, S. U., Wang, W. and Jamil, M. (2014). Smoke alleviates adverse effects induced by stress on rice. Toxicol Environ Chem. 96 (5): 755-767.

[11] Nautiyal, C. S., Chauhan, P. S. and Nene, Y. L. (2007). Medicinal smoke reduces airborne bacteria. J Ethnopharmacol. 114 (3): 446-451.

[12] Nelson, D. C., Flematti, G. R., Ghisalberti, E. L., Dixon, K. W. and Smith, S. M. (2012). Regulation of seed germination and seedling growth by chemical signals from burning vegetation. Annu Rev Plant Biol. 63: 107-130.

[13] Pandey, R., Paul, V., Bhargava, S. C. and Dadlani, M. (2013). The earliest findings on the role of smoke as a germination cue were reported by P. Parija and co-workers from India. Curr Sci. 104 (7): 811-812.

[14] Pennacchio, M., Jefferson, L. and Havens, K. (2010). Uses and Abuses of Plant-derived Smoke: Its Ethno botany as Hallucinogen, Perfume, Incense, and Medicine. Oxford University Press.

[15] Rana, S. S. and Rana, M. C. (2016). Principles and Practices of Weed Management. Department of Agronomy, College of Agriculture, CSK Himachal Pradesh KrishiVishvavidyalaya, Palampur, 138.

[16] Scott, T. L. (2010). Invasive Plant Medicine: The Ecological Benefits and Healing Abilities. Simon and Schuster.

[17] Sparg, S. G., Kulkarni, M. G. and Van Staden, J. (2006). Aerosol smoke and smoke-water stimulation of seedling vigor of a commercial maize cultivar. Crop Sci. 46 (3): 1336-1340.