The Pharma Innovation Journal 2018; 7(10): 383-386

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(10): 383-386

www.thepharmajournal.com
Received: 03-08-2018
Accepted: 04-09-2018

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Organic mulch as a temperature regulator& its effect on growth and oil productivity of Japanese mint: A review

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Abstract
Mulching is the covering the soil surface around the plants with an organic or synthetic material to create amiable conditions for the plant growth, development and proficient production. So, mulching is a simple act that can cause big benefits, insulates soil to protect soil organisms and plant roots from extreme weather. A nice and thick layer of mulch retards the weeds in two ways; firstly by covering the soil thoroughly and then depriving weed seeds of light needed for their germination. Secondly, uncovered soil is perfect place for weed seeds to land and germinate; thus by covering the bare dirt with mulch, most of the weeds do not germinate. Significant quantities of rice residues are produced in the rice growing countries like India. Moreover, the adoption of mechanized farming has resulted in leaving a significant amount of rice straw in the field after harvesting the grain. Thus, there is enormous potential of recycling crop residues in the crop production systems. Use of rice straw mulching for weed control in different crops is possible as it breaks down quickly thus helps to heat up the soil, which is beneficial for germination of mint during initial stages of growth. Hence, weed control coupled with yield enhancements by rice straw mulching would be beneficial in integrated plant management systems, while minimizing the impact of agrochemicals; which is an important concern in current agricultural activities This review will overview the importance of paddy straw mulch in growth and productivity of herbage and oil yield in Japanese mint, also in respect to enhancement of soil health and improvement in germination and weed control.

Keywords: Japanese mint, mulch, temperature regulator, herb yield

Introduction

Japanese mint (*Mentha arvensis* L.) is uppermost commercial and chief essential oil bearing crop [27]. The aerial parts of the herb on distillation produce essential oil containing a massive number of aroma chemicals. Corn mint is a source of natural menthol and other constituents like mint terpenes, menthone, isomenthone, methyl acetate, etc which are widely used in the pharmaceutical, cosmetic, food and flavor industries [28]. Menthol mint occupies primary position and contributes more than 80 percent of total production of essential oil in Punjab and is cultivated on an area of 15000 hectares [3]. Fresh green herb of menthol mint contains 0.5 to 0.8 percent of oil, which is natural source of natural menthol (70 to 85 percent) and number of terpenoids of economic importance. Chand, *et al.*, [7] discovered the major constitutes in Japanese mint oil: menthol, p- menthone, L- menthol, (+)- isomenthol, neomenthol, methyl acetate, and series of other trace compounds,. Although percent proportion of various constitutes vary considerably according to genetic makeup, topographic & environmental constrains and growth stage of the crop [14]

Use of mulches for the production of crops is thousands of years old practice. Mulches typically function by arresting light or creating environmental conditions which can prevent germination or checking weed growth shortly after germination. However, innumerable benefits are often obtained including: increased earliness, moisture conservation, temperature regulation of the root zone and above-ground growing environment, reduced nutrient discharge, altered insect and disease pressures, and, in some instances, reduced soil compaction or improved soil organic matter [13].

Mulch makes micro climatic conditions favorable through buffering the low soil temperature for emergence and early crop growth. Application of mulch also plays various benefits through smothering the weeds by cutting light penetration, maintaining moisture, ameliorating the microbes and nutrient dynamics in the soil which ultimately favours the crop yield, Yadav, *et al.*, [30] and Ram, *et al.*, [22]. Guenther [9] advised from field experiments to produce bushy plants, since most of the menthol is produced in the leaves and the time of planting plays crucial role in vegetative infrastructure development through manipulation in prevailing climatic conditions at different growth stages of the crop. Akhtar, *et al.,* [1] advocated bright sun light with 30 °C day temperature created favorable climatic conditions for superior production of leaf, stem and dry matter despite night temperature at various growth stages of corn mint. In view of these above explanation appropriate literature pertaining to various aspects have been reviewed under the following headings:

Improved soil health

Understanding the physical properties of soil is crucial for describing and enhancing goodness of soil in order to maximizing productivity for each soil/climatic condition. This forecasts that soil must be sustained for fetching higher crop yields. Hence, without maintaining the soil physical conditions, the genetic potential of a crop cannot be realized even if all the other needs are satisfied. Undoubtedly, if these soils are managed properly for good physical health, the yield potential of different crops can be boosted significantly [25].

Temperature regulator

Soil temperature plays prominent role in crop production; the temperature fluctuation is too much in India. It goes down up to 0-2 °C in winters and in summer it raises up to 50 °C [11]. Application of mulch effectively buffers the both the extremes of soil temperature by keeping the soil surface cooler in hot months and warm in winters. However, the extent to which soil temperature is reduced or increased depends upon the type and amount of mulch, soil moisture and nature and extent of crop cover.

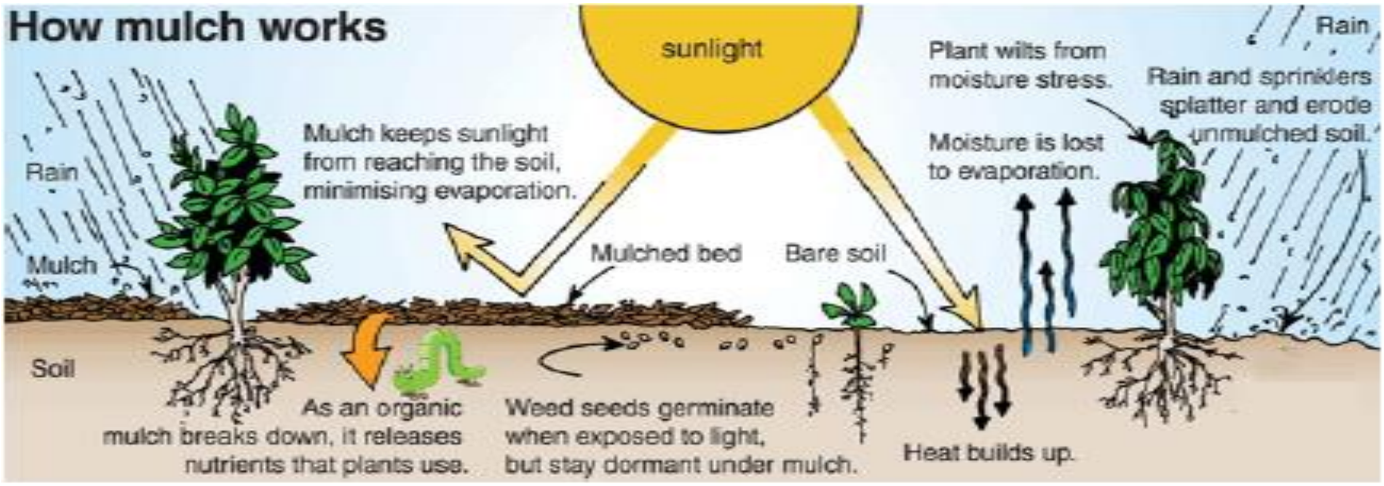

Fig: Influence of mulch on soil and plant.

Prihar, *et al.,* [18] reported that during the first few weeks after sowing of maize, use of paddy straw mulch @ 6 t/ha lowers down the maximum soil temperature by 3-6 °C at the 10 cm depth while the minimum soil temperature remains unchanged. Similar, effect of straw mulch on soil temperature was reported by Bansal, *et al.,* [4] and Mehta and Prihar [16]. Organic mulch was beneficial in conserving soil moisture and lowering down the soil temperature, resulting in higher vegetative production [11].

Bragagnolo and Miclniczuk [7] reported that surface application of wheat straw at 7.5 t/ha reduced the maximum soil temperature from 37.1 to 28.6 ^{0}C and increased the soil moisture content by 10 percent. However, as the plant grow this reduction in temperature reduced because of shading. Hanks, *et al.,* [10] found that reduction in soil temperature with application of straw mulch might be because of corresponding reduction in net radiation received by soil surface. Mc Calla and Army [15] observed that soil temperature in mulched plot reached a maximum point in a clear day at around 1 to 2 pm and lowest at around 5 pm during summer season.

Plant growth and development

The growth rate of most of the plants is more sensitive to soil temperature than the aboveground ail temperature [6]. Soil temperature affects the plant growth in several ways viz. soil micro-organisms show maximum growth and activity at optimum range of temperature, the biological processes for nutrient transformations and soil nutrient availability are also controlled by the soil temperature and soil moisture [5]. Walker [30] reported that one degree Celsius difference in soil temperature in the range of 12 to 35 ^{0}C induced changes in growth and nutrient behavior of maize to the extent of 30-40 percent. Application of mulch also having positive interaction with fertilizer N use efficiency and from the same study 41 and 46 percent higher fertilizer N use efficiency was investigated with paddy straw and citronella waste mulch as compared to control, respectively. Ram and Kumar [20] further studied that under subtropical conditions, citronella distillation waste mulch was very potent for the sprouting of mentha suckers. Singh [26] at Ludhiana reported that mulch application of improve the number of stools per unit area, dry matter and nitrogen uptake by crop considerably whereas plant height and leaf to stem ratio did not vary significantly. Ram, *et al.,* [19] reported significantly higher plant height and leaf area index in menthol mint with application of 7.0 t/ha sugarcane trash mulch as compared to no mulch plots at Lucknow.

Herb yield, oil yield and oil content

Fresh herb yield is generally taken as an index to measure the total assimilates accumulated in the process of photosynthesis during whole crop growing period. Khera *et al.,* [11] depicted ten percent increase in herb yield of Japanese mint with application of 5 t/ha straw mulch as compared to without mulch treatment at PAU, Ludhiana. Similarly, Sandhu, *et al.,* [23] found nine percent increase in herb yield of mentha with application of straw mulch at PAU, Ludhiana. Dry herb yield increased by 17 and 31% with paddy straw and citronella distillation waste, respectively over untreated. Essential oil yield also significantly increased due to mulching [17]. Saxena and Singh [24] at Pant Nagar obtained significantly higher dry herb yield of menthol mint with 5 t/ha sugarcane trash mulch as compared to no mulch treatment. However, application of mulch did not influence chemical composition of the essential oil in Japanese mint. Singh and Saini [27] observed that application of straw mulch reduced the weed biomass and increased fresh herbage and oil yield of *M. arvensis*. under subtropical conditions, citronella distillation waste mulch should be applied after the sprouting of suckers throughout the planted crop period to obtain higher yields of herb and essential oil from the planted as well as the regenerated crop harvests [19].

Quality of oil

Constitute of oil depends upon both climatic and biological factors. Some studies showed the reduction of pulegone to menthone which is precursor of menthol results in high grade oil. Application of mulch did not cause any harmful effect on the biosynthesis of menthol in the plants. These findings were supported by Ram, *et al*., [19] and they observed minute improvement in the menthol content with application of organic mulch @ 7t/ha over control at first and second harvest of the crop. Singh [26] also observed non significant differences in mulch and without mulch treatment on physical properties viz. specific gravity, optical rotation and refractive index of corn mint oil. Similarly, chemical properties like acid, ester and saponification value did not show significant difference with application of mulch in same study.

Conclusion:

Paddy straw mulch is beneficial for germination and emergence of suckers as it increases soil temperature during early growth stages while later during hot summers, it helps in lowering down the temperature up to 1-2 °C. Also, paddy straw mulch results in enhancement of herbage yield coupled with weed control.

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