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Effect of crude edible and non-edible oils on plants growth, yield and quality: A review

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Abstract

Introduction: Now a days, traditionally the organic edible and non-edible oils are used as a fertilizer for farming to get high quality yields with low cost per crop.

Methods: Crude edible and non-edible oils which were extracted from some seeds, nuts, cereal grains and fruits by using traditional, solvent extraction and machine extraction methods.

Results: Oils contain sufficient amount of macro and micro elements which justify its suitability in agro-industrial uses. In order to reduce the production cost by minimizing or utterly eliminating the use of chemical fertilizers, decreasing environmental hazards, improve soil structure, promote leveraging agriculture and obtain high yield quality crops. Some plant oils, neem and mustard oils were highly effective in reducing disease incidence.

Conclusion: Recently farmers are adopting the practice of application of crude edible and non-edible oils from ground nut, rice bran, cotton, neem, mustard and pongamia etc to get good growth and higher yield with better quality in some of the horticultural and agricultural crops.

Keywords: Organic edible oils, non-edible oils, growth, yield and quality

Introduction

Application of inorganic fertilizers may increase crop yields and using rate is rapidly increasing day by day. But the imbalanced and excess use of inorganic fertilizers degrades the soil and the environment [24]. A lot of organic substances, crude oils have been found effective in the maintenance of soil and plant health thus giving positive results for growth, yield and quality of different crops. Oils vary in their toxicity according to the content of low-boiling compounds, unsaturated compounds, aromatics and acids. Crude oils are a complex mixture of hydrocarbons together with organic compounds and a potential source of fertilizer due to richness of minerals and nutrients [7]. However, chemical fertilizers and pesticides decreased soil fertility and caused health problems to the consumers. Due to adverse effects of chemical fertilizers, interest has been stimulated for the use of organic manures [20]. Oils were highly effective in reducing major fungal diseases and number of minor diseases.

Traditionally the organic edible and non-edible oils are used as a fertilizer for farming to get high quality yields with low cost per crop [43]. Oils were found to be effective in the maintenance of soil and plant health to produce higher quality yields. Vegetable oils are a group of fats that are derived from some seeds, nuts, cereal grains and fruits. Vegetable oils are mainly triacylglycerols (92–98%), polar lipids (phospholipids and galactolipids), monoacylglycerols, diacylglycerols and minor amounts of free fatty acids and polyisoprenoids [23]. Recently farmers are adopting the practice of application of crude edible and non-edible oils from ground nut, rice bran, cotton, oil palm, neem and pongamia *etc* to get good growth and higher yield with better quality in some of the fruit crops [16].

Effect and movement of oils in the plants

Oils creep and penetrate into the tips, where the growing tissues are located [13]. After penetrating, oil may travel within the plant of intercellular spaces and also in the vascular system. Oils are distributed through the vascular system and parenchyma, and that viscous oils penetrate tissues more slowly and less uniformly than the lighter ones. Where oil is applied in small amounts eg: as an emulsion, recovery would be faster rather than larger amounts [28] found that the leaves of young beans and peas which were grown in oil-treated sand showed positively significant results than plants which were grown in normal soil. Oils spread more in the intercellular spaces than in the vascular system of potato, onion, and cucumber stems [46]. Different oils showed different effects on different plants based on viscosity and toxicity varies with the type and amount of oil and with the species of plant.

Some times the same oil may have different effects upon different plants. Some may increase the yield and quality of the crops, some oils showed significant impact on reducing the fungal pathogens. 0.75% of crude oil in soil improved the growth and root nodule development in soybean [12]. Oils may also act physically by absorbing light wave lengths that are essential for photosynthesis. Leaf drop and twig dieback was observed in non-oil sprayed citrus [37].

The saturated oil sprays were used for controlling a major fungus disease leaf-spot of bananas and a number of minor diseases, the action of the oil is on the host physiology rather than directly on pathogen. Banana plants that were grown in full sunlight became susceptible to the disease, whereas shaded or oil-sprayed plants were resistant. It seems likely that susceptibility was 'connected with high sugar concentrations in the host and oils might thus inhibit photosynthesis and reduced the host's sugar content [10].

Different types of oils

Ground Nut Oil

Groundnut seed (*Arachis hypogea*) also known as peanut and earthnut, is the most common oil nut grown as an annual crop. It is grown principally for its edible oil and protein rich seeds.

Extraction of oil: To remove the oil content from the groundnut seed, the process known as oil extraction²⁹. Groundnut oil extraction technologies involve machines that are developed to carryout sub-processing operations involved in traditional groundnut oil extraction. These machines are; shelling, roasting, de-skinning/winnowing, milling and kneading machines. Also, there are machines that are developed to extract groundnut oil from the just shelled groundnut seeds, such as hydraulic press and screw press. The oil content of the seeds is between 45% and 55% depending on the variety [44, 47].

Composition of oil: Groundnut seeds contain 48–50% oil and 26–28% protein. Oil has a rich source of minerals vitamins and fatty acids, Oleic acid, a monounsaturated fatty acid, and linoleic acid, a polyunsaturated fatty acid, account for 75–80% of the total fatty acids [30]. Ground nut oil consists of minerals and nutrients and has higher shelf life and would also be used in industrial applications [5]. Crude groundnut oil contains 2.82% of free fatty acids, 5.53% of phospholipids, concentration of copper 0.37 mg/kg and concentration of iron 3.98 mg/kg² which might be helpful to maintenance of soil and plant health thus giving positive results for growth, yield and quality of different crops as an organic fertilizer.

Utility of oil: Helpful to the maintenance of soil and plant health thus giving positive results for growth, yield and quality of different crops as an organic fertilizer.

Rice Bran Oil: Rice bran is a cuticle that present between rice seeds and rice husk, and it is produced during milling process as the main by-product [15].

Extraction of oil: Which is extracted from the hard outer brown layer of rice called chaff (rice husk). There are several techniques used for the extraction of the RBO, but solvent extraction using hexane is the most popular used conventional method for commercial extraction. Non-conventional techniques for the oil extractions and utilization such as supercritical carbon dioxide extraction, subcritical water

extraction, enzyme-assisted, ultrasonic-assisted and microwave-assisted processes can be use produce oil [21].

Composition of oil: The rice bran composition varies depending on rice types, processing method and climatic conditions [22]. Rice bran comprises of 12–22% oil, 11–17% protein and 6–14% fiber [39]. Rice bran oil (RBO) contains important fatty acids such as linoleic and linolenic acids with 38% monounsaturated, 37% polyunsaturated, and 5% saturated fatty acids. A component of rice bran oil is the antioxidant γ -oryzanol, at around 2% of crude oil content [45]. Thought to be a single compound when initially isolated, it is now known to be a mixture of steryl and other triterpenyl esters of ferulic acids [32] and also significant to the relatively high fractions of tocopherols and tocotrienols, together as vitamin E. Rice bran oil is also rich in lipids, nutrients and minerals [15], thus it might play a role in plant growth and development and it has high potential to be used as an organic fertilizer for better quality yields. The leaves of young beans and peas which were grown in oil-treated sand showed positively significant results than plants which were grown in normal soil [27].

Utility of oil: Play an important key role in plant growth and development and it has high potential to be used as an organic fertilizer for better quality yields.

Mustard Oil

In India, rape seed mustard is an important source of edible oil followed by ground nut [34]. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop

Extraction of oil: A fatty vegetable oil resulting from pressing the seeds, which are crushed by using some specialized machinery and equipment designed for oil extraction purpose. Grinding and distillation are two common practices that are involved during the process of extracting mustard oil. After the seeds have been crushed, the oil must be taken through a process where it is closely examined for impurities and separated accordingly. Extraction of mustard oil produces 37% oil, and the rest are cakes, the mustard oil cake contains 7% of oil. Quality of enzyme-extracted mustard oil was better with respect to color and odor than commercial expeller-extracted and Soxhlet-extracted oils [41].

Composition of oil: The characteristic pungent flavour of mustard oil is due to allyl isothiocyanate. Mustard oil has about 60% monounsaturated fatty acids (42% erucic acid and 12% oleic acid); it has about 21% polyunsaturated fats (6% the omega-3 alpha-linolenic acid and 15% the omega-6 linoleic acid), and it has about 12% saturated fats⁴. Mustard oil cake contains 7% of oil, which has high amount of secondary micronutrients in addition to N, P and K @ 5.1-5.2, 1.8-1.9, 1.1-1.3%, respectively [8]. Mustard oil and its cake might also supply sufficient amount of S, Zn and B for the growth of rice plants [25]. Organic fertilizer is a good alternative source of organic substrate may have important effects on the growth and yield of strawberry [36]. Application of organic fertilizers recognized as an effective means of improving soil structure, enhancing soil fertility [20].

Utility of oil: Good alternative source of organic substrate may have important effects on the growth and yield. Improving soil structure and enhancing soil fertility. Oil has a

potential source of sufficient amount of Sulphur, Zinc and Boron for the growth of the plants.

Cotton Oil

The cotton plant is a shrub native to tropical and subtropical regions around the world, including the India, Americas and Africa. Cotton tree is often called silk cotton tree containing non edible oil in its seeds.

Extraction of oil: The cotton seeds were cleaned to separate from dirt and grounded to obtain powder so that maximum particle exposure was got for extraction of oil. About 100 g of powder were extracted with ANALAR petroleum ether (B.p 40 °C - 60 °C) in a soxhlet apparatus for 72h. The extract was first filtered and then vacuum distilled to remove solvent completely.

Table 1: Organic edible and non-edible oils extraction method, composition and utility

Organic oils	Extraction methods	Composition	Utility
Groundnut oil	Traditional extraction, Machine extraction and kneading machines [29].	Minerals, vitamins, 2.82% of fatty acids [30], oleic acid, linolic acid, 5.53% of phospholipids, 0.37 mg/kg of copper and 3.98 mg/kg of iron [2, 5].	Helpful to maintenance of soil and plant health thus giving positive results for growth, yield and quality of different crops as an organic fertilizer.
Rice bran oil	Solvent extraction by hexane, super critical carbon dioxide extraction, sub critical water extraction and microwave assisted extractions [21].	Ferulic acids [32], 11-17% protein, fatty acids [39, 45], linolic acid, γ -oryzanol, lipids, nutrients and minerals.	Play a role in plant growth and development and it has high potential to be used as an organic fertilizer [27] for better quality yields.
Mustard oil	Grinding and distillation, Expeller extraction, Soxhlet extraction [41].	Fatty acids, micro and macro nutrients such are S, Zn, B [25], N: 5.1- 5.2%, P: 1.8 -1.9% and K: 1.1-1.3% [8].	Good alternative source of organic substrate [36] may have important effects on the growth and yield. Improves the soil structure and soil fertility [20].
Cotton oil	ANALAR petroleum ether in soxhlet [40].	Fatty acids, macro and micro nutrients [38].	Potential source of bio-fertilizer due to richness of minerals in the form of plant nutrients [6].
Neem oil	Solvent extraction by hexane [19] and cold pressing.	Source of phytochemicals, fatty acids [11], macro and micro-nutrients [42].	Beneficial to crop management to get higher quality yields [42] and disease free, when used as a fertilizer, manure and pesticide.
Pongamia oil	Cold pressing and solvent extraction [33].	Tryglycerides and nutrients [33].	Preventing larval penetration and gall production in the roots [35] and Beneficial to crop management to get higher quality yields [17].

The color of the extracted oil was chocolate maroon [40]. Oil extracted from the seeds of this plant is used as energy source as well as it was found to be rich in all plant nutrients [6].

In order to reduce the production cost by minimizing or utterly eliminating the use of chemical fertilizers, decreasing environmental hazards, improve soil structure [9] promote leveraging agriculture and obtain high quality crops, cotton seed oil cake getting importance due its rich mineral contents. Cotton seed oil cake was assessed and it was found to be a potential source of bio-fertilizer due to richness of minerals in the form of plant nutrients [6].

Composition of oil: Generally consists of 70% unsaturated fatty acids (18% monounsaturated, and 52% polyunsaturated), 26% saturated fatty acids. When it is fully hydrogenated, its profile is 94% saturated fat and 2% unsaturated fatty acids³⁸ (1.5% monounsaturated, and 0.5% polyunsaturated). Besides that it is rich in macro and micronutrients and minerals. It might show an impact on maintenance of soil health, environment and increases the soil fertility nature. Thus, it could play an important role as an alternative method for supplying nutrients to the growing plants to confront many constraints, which have been raised such as their adverse impacts on the public health, environment, increasing the production cost and deterioration of soil fertility by using chemical fertilizers [9]. Now a days, various researchers consider the utilization of organic and bio-fertilizers as promising alternative nutrition. Organic fertilization provides the means for stabilizing soil fertility (especially in newly reclaimed soils) converting nitrogen in less soluble form is the main advantage of organic fertilizers compared to chemical fertilizers [6].

Cottonseed oil may be considered beneficial, which has been used for centuries to control insect and mite pests [14]. More recently, cottonseed oil has been used to protect the trunks of apple trees from the apple clearwing moth, which burrows into the trees bark, potentially killing them [18]. This oil has been generally considered the most insecticidal of vegetable oils [14].

Utility of oil: Potential source of bio-fertilizer due to richness of minerals in the form of plant nutrients. The utilization of organic and bio-fertilizers are as promising alternative nutrition. Organic fertilization provides the means for stabilizing soil fertility (especially in newly reclaimed soils) converting nitrogen in less soluble form is the main advantage of organic fertilizers.

Neem Oil

Neem oil is a vegetable oil pressed from the seeds of the neem (*Azadirachta indica*), an evergreen tree which originates from the Indian subcontinent and is now valued worldwide as an important source of phytochemicals for use in human health and pest control [11]. It is the most important of the commercially available products of neem for organic farming and medicines.

Extraction of oil: The method of processing is likely to affect the composition of the oil, since the methods used, such as pressing (expelling) or solvent extraction are unlikely to remove exactly the same mix of components in the same proportions. The oil can be obtained through pressing (crushing) of the seed kernel both through cold pressing or through a process incorporating temperature controls 40 to 50 °C. Neem seed oil can also be obtained by solvent

extraction of the neem seed, fruit, oil, cake or kernel. A large industry in India extracts the oil remaining in the seed cake using hexane [19]. The neem oil yield that can be obtained from neem seed kernels also varies widely in literature from 25% to 45%.

Composition of oil: Neem oil has rich sources of biologically active secondary metabolites such as alkaloids, phenolics, and terpenoids [19]. Other components present include meliantriol, nimbin, nimbidin, nimbinin, nimbolides, fatty acids (oleic, stearic, and palmitic), and salannin control [11]. It has anti-bacterial, anti-fungal and anti-nematicidal properties and positive effect in combating several diseases in crop cultivation. Which are highly beneficial to crop management to get higher quality yields and disease free, when it might be used as a fertilizer, manure and pesticide, it might nourishes the soil and plants by providing all the macro and micro-nutrients, enriches the soil with organic matter but also lowers nitrogen losses by inhibiting nitrification, helps to eliminate bacteria responsible for denitrifying the soil, ideal for cash crops and food crops, thus, increases the yield [42].

15-30 ml of neem oil is added to 1 litre of water and stirred well, to this emulsifier is added (1ml/1litre). It is very essential to add the emulsifier and mix properly. This should be used immediately before the oil droplets start floating [3]. Formulations made from neem oil also find wide usage in organic farming, as it repels a wide variety of pests including the mealy bug, beet armyworm, aphids, the cabbage worm, thrips, whiteflies, mites, fungus gnats, beetles, moth larvae,

mushroom flies, leaf miners, caterpillars, locust, nematodes and the Japanese beetle [26, 31]. Neem oil also controls black spot, powdery mildew, anthracnose and rust fungi. This might be beneficial to the crops to minimize the diseases and improves the quality of the yields. 'Some plant oils viz., neem, castor and mustard showed significant inhibition of root-knot development caused by root-knot nematode *M. incognita* and population buildup of commonly occurring plant parasitic nematode on tomato. 'Nemin' was highly effective in reducing disease incidence. Root-knot development and nematode densities decreased and plant growth responses increased with increasing concentration of the test products [1].

Utility of oil: Beneficial to crop management to get higher quality yields and disease free, when used as a fertilizer, manure and pesticide. It has anti-bacterial, anti-fungal and anti-nematicidal properties and positive effect in combating several diseases in crop cultivation. Which are highly beneficial to crop management to get higher quality yields.

Pongamia Oil

Pongamia is a multipurpose leguminous tree containing non-edible oil grows widely in India [33]. Pongamia oil is derived from the seeds of the *Millettia pinnata* tree, which is native to tropical and temperate Asia. *Millettia pinnata*, also known as *Pongamia pinnata*. Other names for this oil include honge oil, kanuga oil, karanja oil, and pungai oil.

Table 2: Effect of application of organic edible and non-edible oils in Horticultural crops

Organic edible/non-edible oils	Crop	Method of Application	Effect
Rice bran oil	Beans and Peas	Soil	Oil treated plants showed positively significant results than non-treated [27].
Mustard oil	Strawberry	Soil	Better growth and yield [36].
Cotton seed oil	Apple	Soil	Protects the trunk of the tree from the crawling moth [18, 14].
Neem oil + Castor oil + Mustard oil	Tomato	Soil and Foliar	Reduces the disease incidence of Powdery mildew, Anthracnose and Rust fungi [26]. Improves the quality of yields [15].
Crude oil	Citrus	Foliar	Leaf drop and Twig back were observed in non- treated [37].
	Soya bean	Soil	Better growth and root nodule development [12].
Saturated oil	Banana	Foliar	Controlling of major fungal diseases, leaf spot and minor diseases [10].
Ground nut oil + Rice bran oil + Mustard oil	Ber Cv. Apple Ber	Soil	Improves the quality and yield. Reduces pest and disease incidence [17].
Cotton seed oil + Neem oil + Pongamia oil	Ber Cv. Apple Ber	Soil	Improves the quality and yield. Reduces the risk of Fruit fly and Anthracnose [17].
Pongamia oil + Neem oil + Chalmoga oil	Tomato	Soil	Proved effective in preventing Larval penetration and Gall production in the roots [46].

Extraction of oil: Oil extracted from the seeds by expeller pressing, cold pressing, or solvent extraction. The oil is yellowish-orange to brown in color.

Composition of oil: It has a high content of triglycerides, thus it would be used as energy source as well as in tanneries while, the by-product after extraction of oil was found to be rich in all plant nutrients [33].

Some organic oils, such as, karanj oil (*Pongamia glabra* Vent.), Chalmogra oil (*Hydrocarpus kurzii* (King) Warb.), polanga oil (*Calophyllum inophyllum* L.) and neem oil (*Azadirachta indica* A. Juss.) were tested separately as seed treatment, seedling root dip and treatment under pot culture as well as laboratory conditions to determine their efficacies on the infectivity of root-knot nematode (*M. incognita*) affecting tomato cv. marglobe. Oils of karanj, neem and chalmogra in higher concentration proved effective in preventing larval penetration and gall production in the roots of tomato [35].

Combination of edible oils viz., ground nut oil + rice bran oil + mustard oil @ 1.5 L each showed significant positive results on growth, yield and quality of Ber Cv. Apple Ber, followed by the combination of non-edible oils viz., cottonseed oil + neem oil + pongamia oil @ 1.5 L each, while control (non-treated) was effected with anthracnose and fruit fly [17].

Utility of oil: Preventing larval penetration and gall production in the roots and Beneficial for crop management to get higher quality yields.

Conclusion

Crude edible and non-edible oils, such are groundnut oil, rice bran oil, mustard oil, neem oil, pongamia oil and cottonseed oils have been found effective in the maintenance of soil and plant health thus giving positive results for growth, yield and quality of different crops. In order to reduce the production

cost by minimizing or utterly eliminating the use of chemical fertilizers, decreasing environmental hazards, improve soil structure to promote leveraging agriculture & horticulture and also to obtain high quality crops. Traditionally the organic edible and non-edible oil is used as a fertilizer for farming to get high quality yields with low cost per crop. Vegetable oils are a group of fats that are derived from some seeds, nuts, cereal grains and fruits. Vegetable oils are mainly triacylglycerols (92–98%), polar lipids (phospholipids and galactolipids), monoacylglycerols, diacylglycerols and minor amounts of free fatty acids and polyisoprenoids. Recently farmers are adopting the practice of application of crude edible and non-edible oils from ground nut, rice bran, cotton, oil palm, neem and pongamia *etc* to get good growth and higher yield with better quality in some of the fruit crops.

Future thrust

In the future works, application of crude edible and non-edible oils on different crops should be standardized. Instead of using chemical fertilizers, organic edible non-edible oils would be used as a fertilizer for farming to get high quality yields with low cost per crop. Chemical fertilizers might be produced better yield and quality but the effect would be on human health hazards. Each edible and non-edible oils are must be analyzed individually to check the nutrient status. In Andhra Pradesh, Godavari zone farmers have been practicing the culture of application of crude edible and non-edible oils, thus everywhere it could be practiced to get good growth and higher quality yields.

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