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ITK based Organic Formulations in Crop Production: A Review

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ABSTRACT

Indigenous Technical Knowledge (ITK) has been crucial in agriculture for many generations as farmers have gained this knowledge through their experiences and observations. Recently, there has been an increasing interest in using ITK-based organic formulations for crop production, which are made from locally available organic materials and have proven to be effective in promoting plant growth and controlling pests and diseases. This paper seeks to provide a comprehensive overview of the current understanding of ITK-based organic formulations in crop production, including various types, compositions, and applications. It also examines the benefits and challenges of using ITK-based organic formulations while providing suggestions for further research in this area.

Key words: *Indigenous Technical Knowledge(ITK), Panchagavya, Jeevamrut, Beejamrita, Neemastra.*

Introduction

Chemical farming is a common practice among farmers in our nation. This method involves the utilization of chemical fertilizers and pesticides to cultivate crops. Due to the rising population and food demand, farmers were left with no choice but to adopt this approach in order to enhance crop yield. Nevertheless, chemical farming has adverse impacts such as soil degradation, biodiversity reduction, and heightened greenhouse gas emissions. Overuse of synthetic fertilizers and pesticides results in significant nutrient exhaustion in the soil, leading to decreased productivity of land over time. These chemicals also lead to water pollution as they leach into nearby rivers or groundwater systems through runoff during rainfall events. Chemical farming practices may increase crop yields initially but fail to account for the long-term effects that can harm not only the environment but also human health. Overreliance on chemical inputs contributes significantly to climate change-induced events such as droughts or floods that further degrade soils' fertility levels (Thorat and More, 2022).

The rise in health consciousness amongst the populace in recent times has led to a surge of interest towards sustainability within the Indian agricultural sector. Organic farming has gained popularity, with consumers increasingly demanding sustainably produced food. However, organic farmers face significant challenges when it comes to crop protection against pests and diseases. In response to this need, ITK based organic formulations have emerged as an effective way of promoting sustainable agriculture. ITK stands for Indigenous Traditional Knowledge, which refers to knowledge gained over generations by indigenous communities through observation and experimentation. The use of ITK based organic foliar formulations in crop production has shown great potential in improving plant health and productivity while reducing reliance on conventional chemical fertilizers that can

harm both human health and the environment (Priya *et al.,* 2019; Biswas and Das, 2022). This approach represents a significant departure from traditional farming methods that rely heavily on synthetic inputs such as pesticides and chemical fertilizers. By adopting this innovative method, farmers can reduce their environmental footprint while also creating healthier crops with higher yields.

The use of organic mixtures like Panchagavya, jeevamrut, Beejamruta can enhance plant growth and yield. These mixtures can alter soil properties when applied as a basal dose over a prolonged period. As insecticides, Brahmastra, agneyastra and neemastra are effective and can eradicate pests during the initial stages of larvae development while also hindering their feeding. Farmers have developed many such organic formulations based on ITK, but a significant number of these mixtures lack documentation and scientific evidence.

Composition of ITK-based Organic Formulations

The ingredients used in ITK-based organic formulations differ based on the particular formulation and the accessibility of materials in that area. While some formulations maintain the basic ingredients, farmers may also add other materials. For instance, panchagavya uses cow dung, cow urine, curd, milk and ghee as main ingredients; however, Tamil Nadu farmers tend to include coconut water and bananas to their mixture. Similarly, farmers from Maharashtra and Uttar Pradesh add jaggery and herbal extracts such as neem, amla and brahmi to their formulations (Gawade *et al.,* 2007).

Effect of Organic Formulations on Growth and Yield: Panchagavya

Panchagavya, an ancient Indian preparation made from cow urine, dung, milk, curd, and ghee is one such remedy that has attracted attention as an effective organic fertilizer. The use of panchagavya as a natural plant growth enhancer dates back to Vedic times when farmers used it extensively to improve soil health and boost crop productivity. This unique mix contains essential nutrients such as nitrogen (N), phosphorus (P), potassium (K), sulfur (S), magnesium (Mg), calcium (Ca) along with various micronutrients. The application of Panchagavya has been shown to have a positive impact on crop growth and yield through its various nutrient contributions and soil conditioning properties.

A study conducted by (Kumar and Singh, 2020) discovered that panchagavya can boost productivity by promoting the growth of roots, stems, branches, and leaves. The researchers also observed an improvement in various associated and other quality parameters which ultimately led to better overall yield characteristics. In their study (Shekh *et al.,* 2018) found that using 5 tons per hectare of farmyard manure resulted in increased yields of both pods and haulms. Additionally, a foliar spray containing 3% panchagavya was also effective in increasing yields for summer ground nut. According to (Swarnam *et al.,* 2016) findings, the foliar application of 3% Panchagavya resulted in an overall increase in plant height and number of branches across all stages of plant growth. Additionally, a considerable rise was observed in the average fruit yield, with an output of 824.7g per plant compared to the control group's yield of 330.1g per plant. As per the study carried out by (Sudhakar *et al.,* 2011), the application of panchagavya through foliar spraying has been found to have a noteworthy effect on maize crop productivity. The highest yield of maize was achieved when the full recommended dose of fertilizers (RDF) was applied and three sprays of 3% Panchagavya were administered at different stages of the crop's growth (20, 40, and 60 days after sowing).

In a field experiment conducted by Rakesh *et al.* (2017), the impact of Panchagavya on the growth and yield of Abelmoschus esculentus cv. Arka Anamika was investigated. The outcomes revealed that the application of Panchagavya positively impacted crop growth and yield through its various nutrient contributions and soil conditioning properties. Specifically citing how it remedied modern chemical agriculture issues due to being an organic farming remedy for curing ills associated with modern chemical agriculture. Patel *et al.,* (2013) supported these findings by concluding that panchagavya had a significant influence on plant height along with stem girth diameter increases along improved vegetative traits such as increased leaf area index leading to more effective photosynthetic activity where there was higher oil-content production consequently resulting in better yields.

Jeevamrut

Jeevamrut is an organic solution made from cow dung and urine along with other ingredients like jaggery and gram flour. It is prepared by mixing these ingredients together and allowing them to fer-

ment for several days. The solution that is produced consists of advantageous microorganisms such as Nitrogen fixing and P-Solubilizing bacteria, fungi, and protozoa. These microorganisms play a crucial role in enhancing soil health by decomposing organic matter into nutrients which can be assimilated easily by plants. Jeevamrut has an acidic property with a pH value of 4.93 and serves as an excellent source of both macro and micro nutrients including N (1.97%), P (0.172%), K (0.29%), Mn (47 ppm) and Cu (50 ppm). (Kumar *et al.,* 2021).

The application of Jeevamrut has demonstrated remarkable advantages in enhancing the development and production of crops. According to Rathore *et al.* (2023) the use of fermented liquid organic nutrient formulations (FLONFs) such as jeevamrut can significantly contribute to the soil dehydrogenase enzyme activity, phosphatase enzyme activity, and urease enzyme activity (25.5 moles PNP h^{-1} g^{-1} soil) leading to higher yields and soil longevity in crops like brinjal. A study was performed by Patel *et al.* (2021) which demonstrated that the utilization of jeevamrut at a quantity of 500 liters/ha in conjunction with irrigation at 30 and 45 days after sowing resulted in noteworthy enhancements to both growth indicators and yield attributes for summer pearl millet.

The grain yield increased up to 4393 kg/ha while the straw yield was recorded as high as 7567 kg/ha. Moreover, Somdutt *et al.* (n.d) revealed that the use of jeevamrut can enhance plant growth and yield by improving soil health, thereby increasing nutrient availability in crops. This suggests that utilizing this organic fertilizer could be an effective way to boost crop yields without resorting to harmful chemicals. Furthermore, Dhomne *et al.,* (2021), conducted a field experiment with pigeonpea where they applied jeevamrut through soil application at different stages of growth. The researchers discovered that the utilization of soil application at a rate of 500 L per hectare, in addition to plant growth regulators, led to notable enhancements in various growth parameters such as plant height, leaf area per plant, total dry matter production per plant, and yield/yield attributes. The results indicate that there is considerable potential for using jeevamrut as an alternative option over chemical fertilizers since it offers multiple benefits such as enhancing soil health and providing nutrients needed for optimal crop development.

Beejamrita

The use of beejamrita has been significant for farmers since ancient times as one of their traditional methods. This organic mixture, which consists of cow dung, cow urine, water, lime, and soil, helps promote plant growth while also providing protection against harmful pathogens from the soil and seeds. Beejamrita is prepared using cow dung (5 kg) that is wrapped in cloth and soaked overnight in a bucket filled with 50 liters of water. The following day, the dung in the cloth is squeezed and dipped repeatedly in the water. Additionally, 5 liters of cow urine, a small amount of soil, and 50g of calcium chloride are included in this solution. Several studies have investigated the effects of Beejamruta on crop yield and growth.

Beejamrita solution contains various advantageous microorganisms including nitrogen- fixing bacteria, phosphorus-solubilizing agents, actinomycetes, and fungi (Devakumar *et al.,* 2014). Dhomne *et al.* (2021) found that Beejamrita can increase the nutrient availability in soil by promoting microbial activity. This increased microbial activity leads to improved nitrogen fixation and phosphate solubilization which ultimately enhances plant growth. Similarly, Nirmale and Ulape (2020) found that "Beejamrita" contains beneficial microorganisms that enhance nitrogen fixing capabilities while also protecting plants from harmful pathogens present in both soil and seeds. Additionally, it was demonstrated in this research that the application of Beejamrita enhances the accessibility of vital nutrients within the soil, resulting in a notable enhancement in crop yield. Shyamsunder and Menon (2021) further supported these findings by showing how Beejamrita improves soil health through enhancing microbiological activities leading to better nutrient cycling resulting in enhanced plant growth capacity.

Effect of organic formulations on crop pest and disease management: Neemastra

Neemastra is an ITK based organic pesticide that offers an environmentally friendly and sustainable alternative to synthetic chemical pesticides used in agriculture. To prepare neemastra, 5 kg of ground neem leaves are combined with cow dung and urine in a plastic drum or earthen pot containing 50 liters of water to make neemastra. The solution should be stirred 5-6 times a day with a wooden stick while fermenting in the shade for 24 hours. If preparing

neemastra during winter, fermentation should be extended to 48 hours. After filtering the solution using a cotton cloth, it is diluted in 100 liters of water and used for plant spraying purposes (Abhishek, 2021).

Neemastra has proven to be effective in controlling a wide range of pests and diseases affecting crops without harmfully impacting non-target organisms, the environment or human health. Biopesticides like Neemastra play a vital role in the agriculture production process and are increasingly being adopted as part of integrated pest management systems due to their numerous advantages over synthetic pesticides (Thirumurthy and Mol, 2020). Neemastra works by inhibiting the growth and development of pests, interrupting their feeding behavior and reducing fecundity among other mechanisms (Stoney and Hughes, 1998). In addition to its pest control properties, Neemastra has been found to be a good fertilizer and soil conditioner when used in combination with other organic materials (Verma, 2015).

Brahmastra

The name of this pesticide comes from the Sanskrit words "Brahma", meaning divine, and "astr" meaning weapon. It is believed that in Indian mythology, the Brahmastra was a potent weapon that was employed to fight against malevolent forces. To prepare the solution, begin by combining 10 liters of locally sourced cow urine and crushing 3 Kg of neem leaves in a mud pot. After adding the neem pulp to the water, include 2 Kg pulps each of sitafal (custard apple) leaves, papaya leaves, pomegranate leaves pulp, and guava leaves or guava pulp. Boil this mixture five times before filtering it through a muslin cloth. Ferment the solution for 24 hours before using it as a spray on trees to control sucking pests, pod borer, fruit borer and other similar pests. For field use mix two liters of brahmastra in every 100 liters of water or use a two percent spray.

Numerous studies have been carried out in recent times regarding the impact of brahmastra as a pesticide and its effectiveness. According to Patel *et al.* (2019), "Brahmastra at 20 per cent was found highly effective in suppressing the sucking pest's viz., aphid, leafhopper, thrips and whitefly followed by Agniastra and Neemastra at 20 per cent" in a study on the the/ effectiveness of various biological pesticides in controlling the infestation of sap-sucking insects on Bt cotton is being evaluated. Brahmastra was found to be effective in controlling pests in castor, as it conserved a high population of coccinellids, spiders and Microplitis coccons (Kumar and Sarada, 2020). Brahmastra 5% has shown efficacy against the *Leucinodes orbonalis* (Shoot and fruit borer) in brinjal (Sood *et al.,* 2023). According to Kavita *et al.* (2023), Brahmastra had a variable repellence rate of 20.8-82.3% in the 'No choice' test and 10.4-70.4% in the 'Choice' test on *Plutella xylostella* up to four hours after adult release under laboratory conditions.

Agneyastra

Agneyastra is a form of organic pesticide that has been developed to offer an environmentally safe alternative to chemical pesticides for use in organic farming. This pesticide takes its name from the Sanskrit language, where "Agneya" translates to fiery, and "astra" means weapon. The composition of Agneyastra may differ depending on the recipe or manufacturer, but it usually comprises organic elements like cow urine, cow dung, neem leaves, chili peppers, garlic, and onion. These components are known for their ability to combat pests and diseases in crops due to their insecticidal and fungicidal properties. To prepare agneyastra combine 10 liters of nearby cow urine with crushed tobacco leaves, green chili, and garlic in an earthen pot. Mix in 5 kilograms of neem leaves pulp and boil the solution thoroughly five times. Leave it to ferment for approximately 24 hours before straining it using a muslin cloth. The resulting mixture is diluted in water and sprayed on crops.

According to Gandhi *et al.* (2020), Agneyastra showed 66.67% repellent activity against neonate larvae of *Helicoverpa armigera*. According to the study conducted by Shiwani *et al.* (2022), feeding inhibition of Agneyastra against the third and sixth instar larvae was observed as 6.44 and 8.62% respectively. Kumar and Sarada (2020) research findings indicate that pesticides used in rainfed castor cultivation have drawbacks such as development of resistance among insects leading to decreased effectiveness over time. This emphasizes the need for exploring other alternatives like Agneyastra. Additionally, Agneyastra showed no adverse effects on plant growth or yield, indicating that it is a safe product to use for pest control. This result is consistent with the findings of Badiyala and Sharma (2021), who concluded that natural farming practices do not affect crop yields negatively.

Benefits of ITK-based Organic Formulations

ITK-based organic formulations in agriculture have advantages over synthetic inputs. These formulations use ITK and organic materials like plant extracts, animal manure, and compost. They enhance soil health and boost plant growth by improving soil structure, fertility, and water-holding capacity. They also promote natural pest control mechanisms and boost plant immunity thereby reducing pests and diseases incidence. ITK-based organic formulations are environmentally friendly, do not contain harmful chemicals, and contribute to sustainable agriculture and environmental protection.

ITK-based organic formulations are cost-effective in the long run, improving soil health and plant growth while reducing the need for chemicals and the risk of crop losses. They can be made with local materials and used by farmers in different regions. ITK-based organic formulations are sustainable and effective for agricultural production, supporting soil health, plant growth, and environmental protection.

Challenges and Limitations

Using ITK-based organic formulations in crop production has the potential for significant benefits. However, their adoption is limited by several challenges. The lack of scientific validation is a major challenge since there is a need for more research to validate the efficacy and safety of these formulations, despite reports of their effectiveness. Another challenge is the lack of standardization in preparation and application methods across regions. This variability can affect their effectiveness, making it necessary to standardize these processes to ensure their efficiency.

Conclusion

ITK-based organic formulations have the ability to significantly contribute to sustainable crop production by lessening the environmental effects of crop production and encouraging sustainable agricultural techniques. Nevertheless, additional investigation is required to substantiate their usefulness and safety, and to determine the most efficient formulations for particular crops and pests or diseases. It is also necessary to standardize the creation and implementation of these formulations in order to guarantee their effectiveness. In general, organic formulations based on ITK offer a hopeful strategy for managing pests and diseases in crops while promoting sustainable agricultural practices.

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