Cow Urine: As a Soil Amendment/Conditioner

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ABSTRACT

It is generating growing interest as one of the leading alternatives in agro- chemistry, with traditional elixirs like cow urine among them. As a complex liquid, it consists of various biological materials such as urea, creatinine, ammonia, enzyme, minerals and hormone that make it critical to agriculture. Besides the nitrogen, phosphorus and potassium, cow urine contains several additional minerals that are essential for plant health and soil fertility. Furthermore, it has some living proteins like enzymes and hormones, which promote plant growth and development and bacteria in the ground. Farmer sprays cow urine on leaf during biodynamic and organic farming, or they make compost with cow urine. They understand the fact that the cow's urine helps in breaking down of the soil's structure, making nutrients accessible, while also developing the beneficial microorganisms. The cow urination in the soil highlights its relevance as a sustainable alternative to the other common fertilizers in farming practice. It is a useful organic substitute for sustainable agriculture and additional investigations should be done to establish its effective use, dose, and impact on soil health and crop production.

Key words: cow urine, organic farming, sustainable agriculture, plant health, soil fertility.

1. Introduction

Majority of Indians earn through the agricultural sector where they are based and hence serves as a primary economic sector in India (Pathak, 2009). India's ever-increasing population implies that adequate supply of the food grains should also increase. In this regard, the expansion of food grain output would ensure adequate food supply for an incremental population (Lal, 2013). In achieving this objective, there should be higher doses of fertilizers that will use non-renewable energy to do so (Elahi *et al.,* 2019). Nevertheless, excessive use of non-renewable energy during fertilizer production negatively impacts the environment and causes more greenhouse emissions (Snyder, *et al.,* 2009). It is also worth noting that fertilizer use may bring about soil degradation and water contamination which will be detrimental if not managed effectively (Lal, 2015). Thus, India must look into environmentally friendly methods of agriculture and other options of non-polluting power so as not to undermine the environment in the quest to feed its increasing population (Omer, 2008). The topic of soil sustainability, soil health degradation, and pollution issues overall have brought newfound interest to the use of organic manures (Mason, 2003). Organic manure not only maintains crop yields, but it directly and indirectly affects the availability of soil nutrients by improving its physical, chemical, biological, and microbiological character as well as the efficiency of the inputs used (Bhatt *et al.*, 2019).

Man has relied on livestock over a long time period while the community-based farming provides a more favorable option (Mueller *et al.,* 2015). Gomutra, or cow urine, which has many medicinal constituents making it a valuable substance for herbs and farming purposes (Mohanty *et al.,* 2014). It is a natural solution composed of organics, uric acid, sodium, manganese, carbolic acid, calcium, iron, among others. Such mix of it is supposed to possess antimicrobial, antifungal, and antibacterial features that can be used in traditional medicine and even some agriculture (Bajaj *et al.*, 2022).

Traditionally, cow urine is known to possess curative power based on its special constitution. This is why it has been used in Ayurvedic treatment of several maladies like skin disease, stomach complications, to name just a few of them (Dhama *et al*, 2005). Besides, it helps in cleansing the body for total good health.

Cow urine is an organic compound which is used as an organic pesticide and a natural fertilizer for the farming sector (Choudhary *et al.,* 2017). It can be successfully used when properly diluted for pest protection and enhancing soil fertility. The fertility of this material is high, in terms of nutrition, leading to improved soil porosity and microbial action (Choudhary *et al.,* 2017).

Cow urine, which is environmentally friendly, has become an important issue owing to its positive contribution in the agricultural sector (Mohanty *et al.*, 2014). The application of it in place of synthetic fertilisers and pesticides is generally considered being organic and natural towards the environment unlike their counterparts which are known to pose great dangers to both the ecosystems and human life (Siddique *et al.*, 2014).

With many countries searching for greener and natural farming methods, the idea of cow urine as an agent of organic farming and alternative medicine becomes more appealing (Dhama et al, 2005). However, research and experiments continue with an aim to comprehend and exploit the entire potential which this natural product has, from traditional medicine to modern farms.

2. Chemical Composition of Cow Urine

Water, urea, creatinine, ammonia, enzymes, minerals and hormones formulate cow urine. These elements make up this fertilizer, containing primary nutrients of nitrogen, phosphorus and potash in nature. Cow urine is one of the best enhancers of plant and soil conditions due to its composition (Devasena and Sangeetha, 2022).

Urine is the principal route of nitrogen (N) excretion, with a nitrogen concentration ranging from 2 to 20 g N L^{-1} in cattle urines (Bristow et al., 1992). With a higher dietary content, urine-N might rise by 40-53% of dietary N in some cases (Betteridge *et al.,* 1986). This shows that the annual averages of an N excretion for a year could be ranging from 180 to 250 Kg N ha^{-1}, giving 1000 kg N ha^{-1} under urination patches (Richards and Wolton, 1976; Jarvis and Pain, 1990; Haynes and Williams, 1993). These other traces make up approximately 13-46% of N eliminated with urea as the major constituent (50-93%) in cows' urine.

Cows that are put on protein-free diet produce lower amount of hippuric acid compared to animals that are put on low protein and normal diet (Tamminga, 1992). HA also varies according to pasture maturity. Denoted as HA, a product of the coupling between benzoic acid (BA) and glycine has antibacterial and detoxify attributes (Chesson *et al.*, 1999). Some soil microbes that are able to metabolize it may also contribute towards increasing soil pH as well as urea hydrolysis and ammonia volatilization which could increase nitrogen emissions (Doak, 1952; Whitehead *et al.,* 1989). Increasing HA contents from 3% of total nitrogen to 9% in synthetic urine resulted in a more than 50% reduction of accumulated N_2O emissions (Kool *et al.,* 2006). Additional experiments were carried out to reinforce speculations that BA induced the reduction (van Groenigen *et al.,* 2006).

In cattle, concentration of S and K^+ is affected by diet and urine represents principal excretion pathway (Ward, 1966). Urinary-S represents a combined set of organic and inorganic compounds showing an increase in the level of inorganic sulfate as S intake increases (Fron *et al.*, 1990). Urine magnesium, calcium concentrations are normally within range while only 12 – 22 % and 3 % of the consumed are excreted in urine respectively (Hutton *et al.*, 1965, 1967; Safley *et al.*, 1984). The majority of sodium is excreted in urine while chloride constitutes 20 – 50%, and bicarbonate, up to 70% (Haynes and Williams, 1993). Boron, on the other hand, and iodide are mostly excreted through urine (Owen, 1944; Miller *et al.,* 1965; Green and Weeth, 1977; Barry, 1983). Majorly, phosphorus (P) is excreted in dung with less than 0.1 g of P L-1 usually presented as urine (Betteridge *et al.,* 1986; Wu *et al.,* 2000; Knowlton and Herbein, 2002).

3. Effects of urine on soil chemistry

3.1. Soil moisture and pH

Application of cow urine increases the soil moisture content, thereby reducing moisture evapotranspiration at a rate of 5 Lm^{-2} (Williams and Haynes, 1994; Bol *et al.,* 2004), respectively. After having deposited the urine, the top 20-40 mm of soil will see an incremental increase of one to three pH units attributed to major proportion of the urinary urea remaining enticed in these surface soil layers (Doak, 1952; Sherlock and Goh, 1984; Haynes and Williams, 1992; Shand *et al.,* 2002). Generally, the soil pH reverts to its normal level after two or three months, although it may remain raised for a much greater period if NH_3 volatilization and nitrification are restricted by cold temperatures or dry weather conditions (Holland and During, 1977; Sherlock and Goh, 1984; Somda *et al.*, 1997).

3.2. Nitrogen availability

When urine deposits in the soil, it raises mineral nitrogen concentration up to 40 g N kg^{-1} (Haynes and Williams, 1992; Williams and Haynes, 1994). The most important form of nitrogen is urea-N in urine which is converted into ammonium (NH_4^+-N) and subsequently vaporised as NH_3-N. The rest of the NH_4^+-N are nitrified and forms nitrate NO^{3-} -N that is able for its denitrification. The results show that dinitrogen gas (N_2-N), nitrous oxide (N_2O-N), but neither urea nor nitrate moves downwards by macropore flow or leaching (Haynes and Williams, 1993; Clough *et al.,* 1998). Plants take up and assimilate both, NH_4^+-N and NO^{3-}–N, while, between 22–78% of urea-N is retained in plant biomass, and about, 20–30%, in the soil, organic Soil characteristics determine urinary-N fate with a higher recovery observed with sandy loam soils (Clough *et al.,* 1998; Leterme *et al.,* 2003). However, soils with high sand contents might be less available to plants or soil microbes/fungi.

3.3. Carbon availability and soil organic matter

Soil carbon content can increase due to urinary compounds, increased soil pH, and the release of organic intracellular solutes by soil microorganisms. The increased soluble carbon content has shown increases after urination but the persistence of dissolved organic carbon (DOC) may imply this C is not available to microbes. According to some studies 20-50% of urea derived C can be explain away several days after application of urine on the top 200 mm of soil, above ground plant material which is still growing; and even as emitted CO_2-C.Nonetheless, there is a dearth of studies on the effect of nutrient release at urine patches on the structure of the soil microbial community (Bol *et al.,* 2004; Petersen *et al.,* 2004).

3.4. Soil solution nutrients

The deposition of urine on soil adds nutrients to soil solutions either directly or indirectly. About a half of urine stays in the upper 100 mm of soil; the EC in the upper 25 mm zone of impacted soils registered a notable increase. Immediately following the deposit of urine, the ions in the soil solution correspond to those identified in the urine. During ammonification, the predominant anions are OH^- while, predominate cations are H^+ and NH_4^+ (Haynes and Williams, 1992; Williams and Haynes, 1994).

This is accompanied by an increase in counter-ions for the same reason, such as $Ca^{2+}$and Mg^{2+}, which originate in the soils and are displaced by urine K^+, Na^+ and NH_4 or dissociated H^+ In due course leaching NO^{3-} takes up Ca^{2+}, Mg^{2+}, some K^+, and Na^+. Nonetheless, the concentrations of exchangeable K^+ may linger at a high level due to its strong absorption into CEC (Holland and During, 1977; Williams *et al.*, 1988; Williams *et al.*, 1990; Haynes and Williams, 1992; Williams and Haynes, 1994; Early et al., 1998).

Increased pH after deposition of urine boosts soil CEC ability to hold K^+ in those types of soils, which carry many pH dependent negative charged sites. However, SO_4^{2-} concentrations usually vary from 0.1 to 1 mg/kg depending on pH levels (Plante, 2007); higher pH values often correspond to urine patches. It is predicted that this could be attributed to an increase in aqueous solubilization of humic substances resulting from raised pH following application if cattle urine on pasture soil (Shand *et al.*, 2000; Shand *et al.*, 2002).

4. Role of cow urine in soil health

4.1. Nutrient Enrichment: As plant nutrition, cow urine is high in nitrogen and this is an important element. Cow urine when applied as manure on the soil provides nitrogen which plants can use at will, resulting in more vegetation and crop yield.

4.2. Soil Structure Improvement: The soil benefiting microorganism in cow urine can also improve the soil structure. Applied to the soil, it improves the soil texture, enhances its moisture storage and overall fertility with consequent benefits to plant root development and nutrient absorption by crop plants.

4.3. Soil Microbial Activity: The cow urine also contains some useful bacteria which help in increasing the soil-dwelling microbes. These can decompose soil organic matter leading to increased availability of plant nutrients and improving upon the structure of soil. pH Regulation: Cow urine is alkaline and may neutralize the excess acidity in some soil types. This is because the plants are able to absorb enough nutrients which makes pH levels in the soil of utmost importance.

4.4. Pest and Disease Suppression: The natural insecticidal and fungicidal properties of some compounds found in cow urine. Cow urine acts as a biological pesticide when it is sprayed on plants as foliar, and in the soil through drenching.

5. Uses of Cow Urine in Agriculture

5.1. Organic Fertilizer: From cow urine, natural/organic fertilizer is also one way to make. One may mix this solution with water and use it for either soil application or as foliar spray. They are high in crucial nutrients, which enhance plant vitality and growth.

5.2. Soil Amendment: One could, for example create an efficient fertilizer by mixing cow urine with other organic materials like compost and vermicompost, it could improve soil texture, water holding capacity and crop nutrition.

5.3. Pest Control: A combination of cow urine plus neem oil and garlic has the potential for an efficient pest repellent or spray. The other benefit is that it protects plants from pests such as pesticides but not chemicals.

5.4. Disease Management: For instance, some diseases such as powdery mildew among others, are handled by applying a mixture of cow urine and water. It is an important factor that has helped to prevent fungal infections.

5.5. Biodynamic Farming: In biodynamics there is an approach that takes into account the relationship between soil, plants, and cow's urine in its whole sense in order to increase biodynamic health of the soils and plants during biodynamics preparations.

6. Application of cow urine as Soil Amendment

There are various organic compounds in cow's urine such as uric acid, sodium, manganese, carbonic acid, calcium, and iron, among others that are said to boost active life on earth. It is a blend which increases the supply of essential nutrients needed for growth of plants in the process, and also increases soil fertility at large. Nitrogen, phosphorous, and potash are some of these elements that constitute cow urine, acting as natural manure for the soil. This gives strength to the soil structure which in turn enhances vigour and yield of crops. Nevertheless, cow urine is very powerful on its subtle effect on the complex network of bacteria in the soil. It is also important in providing nutritive effect, stimulating growth of healthy bacterial flora. As a result, it stimulates growth of microorganisms for the well being of soils and vigorous plants.

Naturally occurring enzymes and hormones in cow urine lead to production of the stimulants. These compounds help to make plants tough so that they can withstand such adverse weather conditions, thereby increasing the number of yields obtained.

Biodynamic farmers utilize many resources in their farming portfolio including cow urine nowadays. These multi-beneficial effects on their crops have been made possible by its use as foliar sprays or ingredients of compost. Some farmers have become dependent less on synthetic fertilizers and pesticides by using cow urine in their soil management techniques

Cow urine is used in agriculture based on the principles of organic farming and sustainable logic. It is notable for the sustainability in agriculture because it helps the environment instead of worsening it by improving the quality of the plants' habitat. The versatile green medicine still drives many researches as well as application demonstrating its enormous powers for sustainable farming everywhere.

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