

NATURAL AND SYNTHETIC UREASE INHIBITORS AND THEIR ROLE IN AGRICULTURE: A REVIEW**Dr. Usha Kiran***

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ABSTRACT

There are many compounds which can block the activity of enzyme urease and improves soil fertility as well as plant growth. Urease is an enzyme found in soil and also in plant residues, it perform break down of urea into ammonium with the help of water and this process termed as hydrolysis of urea. High soil pH and residue environments may causes rapid hydrolysis of urea resulting accumulation of ammonia than ammonium ion. These all processes are responsible for the loss of fertilizer nitrogen to the atmosphere; therefore inhibition of urease activity is prerequisite. In this regards researchers confirmed urease inhibitory activity of many synthetic and natural compounds which can be used for improving soil fertility and plant growth. Phosphoramidates, quinines, thioureas, benzothiazoles and coumarin derivatives, etc. are some synthetic compounds can be used as urease inhibitor. Similarly Garlic, Onions, Leek, Cabbage and *Brassica oleraceae*, etc. can be used as natural urease inhibitor. Currently urease inhibitor used in agriculture practice and scientific aspects of this area yet to be explored in all dimensions, considering this present article summarizes various aspects on natural and synthetic urease inhibitors and their role in agriculture.

KEYWORDS: Agriculture, Botany, Urease, Soil, Nitrogen.**INTRODUCTION**

The use of urease inhibitors is common agricultural practice now days to improve the growth and development of plants. The urea is common fertilizer used as source of nitrogen, the urea rapidly hydrolyzed by urease enzyme which results losses of nitrogen to the environment. Therefore urease inhibition is required to acquire maximum fertilizing benefits of urea and nitrogen. The researchers put great efforts towards the finding of novel urease inhibitors and many of them practicing currently in agriculture field.^[1-4]

The activity of urease enzyme converts urea to ammonia that can be lost to the atmosphere as a gas. Sometimes this loss is rapid and significant, and reduces availability of nitrogen for plant growth. Generally it is assumed that around 50% of nitrogen of fertilizer lost to the atmosphere under the drastic condition where urease activity is optimum. The urease inhibitors prevent hydrolysis of urea thus protect against ammonia volatilization and maintain level of Nitrogen in the urea for fertilization. Urease inhibitors break down with time and protect against ammonia losses especially from the fertilizers applied on surface of the soil. The activity of urease and urease inhibitors depends upon the temperature and climatic conditions.^[5-7] The use of urea

as fertilizer and its hydrolysis by urease enzyme also causes some disadvantages as mentioned below.

1. Their excessive use may increase environmental pollution.
2. Formation of gaseous (NH_3 , CO_2 and NO) or ionic pollutants from the hydrolysis of urea.
3. Water pollution and lower N recovery by crops.

The uses of urease inhibitors can reduce such types of lose and restrict above mentioned disadvantages associated with utilization of urea as fertilizers.

Function of Urease

Urease is a nickel-dependent enzyme which catalyzes hydrolysis of urea into ammonia and carbon dioxide. This enzyme is widely distributed in nature and found in bacteria, fungi, algae, yeasts, plants and animal waste, etc. Urease causes hydrolysis of urea that provides NH_3 which further converted to ammonium (NH_4^+) in soil solution and significant amounts of nitrogen may get lost to the atmosphere by volatilization.

Urease Inhibitors

Urea analogs may acts as urease inhibitors since they compete with urease active site. Urease inhibitors help to maintain environmental balances and improve nitrogen content in soil. The efficacy of urease inhibitors may

vary according to the condition of soil and climatic conditions. The typical activity of urease enzyme and its

inhibition is depicted in **Figure 1**.

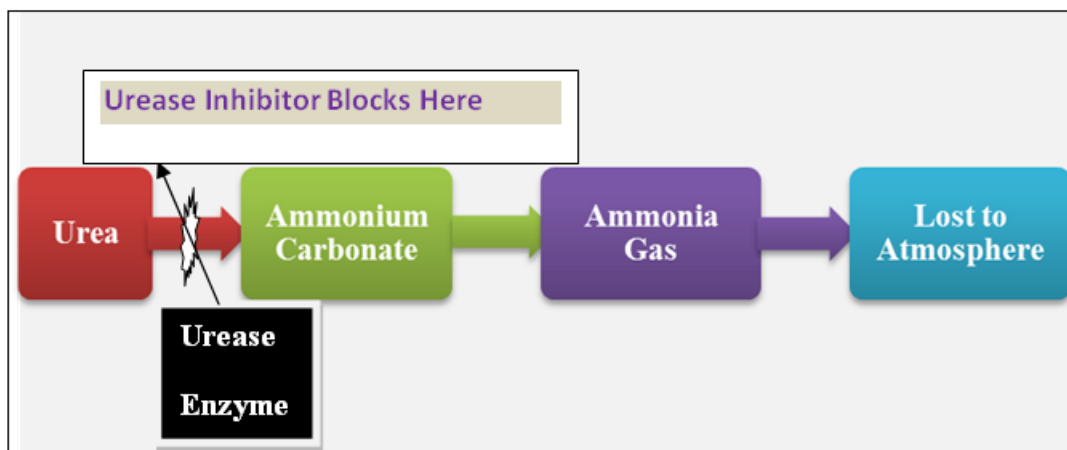


Figure 1: Activity of urease enzyme and its inhibition.

Urease enzyme in the presence of water breaks down urea into the volatilized ammonium. This causes loss of fertilizer Nitrogen to the atmosphere. Urease inhibitors block activity of enzyme urease and prevent this loss by inhibiting conversion of urea into the ammonia and volatilized ammonium ion. This helps to maintain fertilizer N in the urea form.^[8-10]

There are many synthetic and natural compounds which offer urease inhibitory activity as mentioned in **Table 1**.

Table 1: Some examples of natural and synthetic urease inhibitors.

Synthetic urease inhibitors	Natural urease inhibitors
N-(n-butyl) thiophosphoric triamide	<i>A. sativum</i>
N-(n-propyl) thiophosphoric triamide	<i>Allium cepa</i>
Phosphoramidates	<i>Allium porrum</i>
Hydroquinone	<i>Brassica oleraceae</i>
Quinones	<i>Brassica oleraceae</i>
Thioureas	<i>Citrus aurantifolia</i>
Benzothiazoles	<i>Glycyrrhiza glabra</i>
Coumarin derivatives	<i>Fagonia arabica</i>
Vanadium-hydrazine complexes	<i>Origanum vulgare</i>

Advantages of urease inhibitors

1. The urease inhibitors improve urea performance in agriculture.
2. The urease inhibitors mitigate pollutants associated with urea hydrolysis.
3. Improves availability of nitrogen for soil and plant.
4. Decreases emission of pollutant gases.
5. Control water pollution and also reduces excessive requirement of urea as fertilizer.
6. Environmentally safe additives for improving production of modern crop.

7. Protect soil microbiomes and reduce leaching.
8. Easy to use and wide range of availability.

SYNTHETIC UREASE INHIBITOR

The compounds like N-(n-butyl) thiophosphoric triamide (NBPT) and N-(n-propyl) thiophosphoric triamide (NPPT) are well known for their urease inhibitory activity. The synthetic molecules such as hydroquinone, phosphoramidates, thioureas, coumarins and benzothiazoles, etc. also possess potent urease inhibitory activity. Phenolic aldehyde derivatives, complexes with B, S, Cu and Zn, oxidized charcoal and ammonium thiosulfate, etc. also tested for their urease inhibitory potential.

✓ *Phosphoramidates*

The N-(butyl) thiophosphoric acid triamide belongs to the phosphoramidate category and is used as a urease inhibitor in agriculture.

✓ *Thioureas*

Benzoylthioureas showed urease inhibitory activity. It inhibits jack bean urease to different extents; this activity can be attributed to the capacity of benzoylthioureas to bind with the urease active site rather than allosteric sites. These derivatives were also found to be more thermo-stable in the soil, which makes them eligible candidates for the further development of novel urea-based fertilizers.

✓ *Benzothiazoles*

The inhibitory effect of benzothiazoles like 2-phenylbenzothiazole, 2-(4-nitrophenyl) benzothiazole, 2-(2-carboxyphenyl) benzothiazole and 2-(1,3-benzodioxol-5-yl) benzothiazole, etc. were tested successfully for their urease inhibitory activity. These derivatives inhibit jack bean urease significantly. They possess affinity towards the active site of the enzyme and also inhibited ureases present in Red Latosol soil.

✓ *Coumarin derivatives*

The coumarinyl pyrazolinyl thiomide inhibits urease activity in jack bean urease. The affinity of these derivatives to form hydrogen bonds with enzyme residues at the active sites contributed towards their urease inhibitory potential.

NATURAL UREASE INHIBITORS

Plant juices of *A. sativum*, *Allium cepa* and *Brassica oleraceae*, etc. acts as an urease inhibitors. *Glycyrrhiza glabra* is a common herb known for its ability to inhibit urease activity. The traditional Pakistan herb *Fagonia arabica* reported to be effective against urease hydrolysis. Extract of *Origanum vulgare* and *Vaccinium macrocarpon* also inhibits urease activity. Phenylpropanoid compounds obtained from various plant families also showed promising enzyme inhibition. Some examples of natural urease inhibitor tested for agriculture purpose are as follows.

- ✚ *Moringa oleifera*
- ✚ *Brassica rapa*
- ✚ *Ficus benghalensis*
- ✚ *Eucalyptus camaldulensis*
- ✚ *Parthenium hysterophorus*
- ✚ *Capsicum annum*
- ✚ *Camelia sinensis*
- ✚ *Camelia sinensis*

Desirable characteristics of natural Urease Inhibitors

- ✚ Should be eco-friendly
- ✚ Nontoxic
- ✚ Chemically stable
- ✚ Efficient at low concentrations
- ✚ Compatible with urea
- ✚ Costs effective

CONCLUSION

Urease is an enzyme found in soil and also in plant residues, it perform break down of urea into ammonium with the help of water. These all causes losses of fertilizer nitrogen to the atmosphere; therefore inhibition of urease activity is prerequisite. There are many compounds which can block the activity of enzyme urease and improves soil fertility as well as plant growth. Phosphoramidates, quinines, thioureas, benzothiazoles and coumarin derivatives, etc. are some synthetic compounds can be used as urease inhibitor. Similarly *Garlic*, *Onions*, *Leek*, *Cabbage* and *Brassica oleraceae*, etc. can be used as natural urease inhibitor. Currently urease inhibitor used in agriculture practice to improve the growth and development of plants. The urease inhibition is required to acquire maximum fertilizing benefits of urea and nitrogen.

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