10. The usefulness of urine

Urine has been used as a valuable plant food for centuries in many parts of the world, particularly in the Far East. It is surprising therefore that nearly all the urine produced in the West and in Africa goes to waste and is lost to agriculture. Each of us passes about 1.5 litres of urine every day - and almost to the last drop, it is either flushed down a toilet or enters a deep pit latrine. The fact is that urine is a very valuable product - in several ways. It contains a lot of nitrogen and also phosphorus and potassium in smaller quantities, nutrients which are very valuable to plant growth. Simply put, urine is too valuable to waste.

The nitrogen found in abundance in urine is good for plant growth because it helps to build protoplasm, protein and other components of plant growth. It certainly promotes leafy growth. Leaves become more numerous, go greener and larger and more fleshy with urine application. Phosphorus is important in the root formation, ripening of fruits and germination of seeds, although the percentage of phosphorus compared to nitrogen in urine is low. Potassium is also essential for promoting good fruit (and flower) development. Plants differ in their requirements, but overall plants fed with some urine grow better than plants which never come into contact with urine. Urine is particularly valuable for grasses like maize and leafy green vegetables, and onions, which respond to the high nitrogen content of urine.

Urine as a plant food

When applied to the soil the urea (a small organic molecule) in urine changes into ammonia ions which can be transformed into ammonia gas, which can evaporate and be lost or, in the soil, can be converted by autotrophic bacteria (*Nitrosomonas*) into nitrite ions and then *Nitrobacter* into nitrate ions which can be taken up by the plant. The conversion is thus dependent on these bacteria being in the soil. The process takes place in less than two weeks and often within a few days. It is the nitrogen in the nitrate and the ammonia ions which are available to plants, thus the urea in urine must be transformed before it becomes useful as a "plant food." The nitrite ions, present during the conversion, can be toxic to plants, but the period is brief and normally there is little effect on plant growth.

The proportion of useful plant nutrients in urine will vary a little. According to Wolgast (1993) one litre of urine contains 11gms nitrogen, 0.8 gms. phosphorus and 2 gms. potassium. That is a ratio of NPK of about 11:1:2. If 500 litres of urine are produced by each person per year, that amounts to the equivalent of 5.6 kg nitrogen, 0.4 kg phosphorus and 1.0 kg potassium. The actual amounts of these minerals will vary from one person to another and also from country to country depending on the national diet. The more protein consumed, the more nitrogen is excreted. Thus in dealing with urine as a potential supplier of plant nutrients, one must accept that it has a very high, but variable level of nitrogen (and also common salt). The ratio of the main plant nutrients (NPK) is approximately 11:1:2, which is not ideal for growing most plants, especially in the early stages of their growth.

Most vegetable fertilisers in Southern Africa contain more phosphorus than nitrogen. In an assessment of 10 garden fertilisers available in Zimbabwe, the combined ratios of NPK amount to N = 98 points, P = 174 points and K = 125 points a ratio of very approximately 1:2:1. Compound vegetable fertilisers often have a ratio of 2:3:2 for NPK. Ammonium nitrate is quite often applied separately as a "top dressing" once the plant is established. The recommended fertilisers for maize provide more phosphorus than nitrogen in the ratio 1:2:1 at

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the planting or seedling stage and then ammonium nitrate at a later stage once the roots have been established and the plant is secure and meaningful vegetative growth has already taken place. The high phosphorus content of these chemical fertilisers not only reflects the needs of the plant at an early stage of their life, but also that most soils in Africa are very deficient in phosphorus. 70% of natural soils tended by rural farmers in Zimbabwe are very deficient in phosphorus. It is interesting that studies in China show that the daily output of phosphorus in the faeces is greater than in the urine.

The balanced array of nutrients present in eco-humus is thus ideal for the early growth of plants with more phosphorus in relation to the other major nutrients, compared to urine. Later on urine can be applied as a liquid plant food during the main vegetative period of growth to supply extra nitrogen. Nitrogen loving plants like maize and green leafy vegetables are particularly responsive.

Also, according to Hill (1997) an excess of nitrogen can reduce the uptake of vital elements like potassium, which is an essential nutrient for healthy plants. Hill also explains that if you fill the plant transpiration stream with a salt and only a fraction gets used, then other more important nutrients may get blocked. The uptake of too much phosphorus may block potassium, whilst excess calcium locks up boron (Hill, 1997). It is not uncommon for magnesium to be deficient where chemical fertilisers provide lots of potassium. The answer to all these problems is to try to accomplish a balance of nutrients in the soil. It is also accepted that unless plants have plenty of humus in the soil, they cannot take up the minerals even if available, especially in drier conditions, a conclusion arrived at by Bromfield (1949) as well as Hill (1997) and many others.

The functions of nitrogen, phosphorus and potassium are interlinked. If large amounts of nitrogen are used, this will cause extra leaf and stem growth, but this growth response will cause the plant to demand extra phosphorus and potassium from the soil. Extra that is to the amount which would have been needed without the nitrogen application. Also nitrogen cannot be efficiently used by the plant unless potassium is there in a proper N/K ratio. Thus deficiencies in phosphorus and potassium show up if too much nitrogen is applied. Nitrogen is a primary growth nutrient, but without the accompaniment of adequate phosphorus and potassium the growth is unhealthy, more liable to pest attack and disease. Potassium in particular is needed to bring about a balance and ensure that the extensive plant structure is formed of healthy and efficient tissues. This imbalance is perhaps not so serious in short lived plants like lettuce (and green vegetable like spinach and rape and covo). But where the plant has to grow for a full season and eventually produce a seed or fruit crop, these derangements caused by unbalanced nitrogen become serious. Apart from the danger of pest attack and disease, the overstressing of the tissue building function leads to delay in the other functions of the plant and the seed formation or fruit ripening stages are held up.

According to Hopkins (1945) anybody wishing to demonstrate this by personal experience should see how much is lost by giving one or two tomato plants in a row, applications of soluble nitrogen in the late (European) summer. Further leaf and shoot formation will occur but the existing fruit will delay their yellowing and reddening until the autumn sunshine has departed. The fruit yield is thus reduced.

Thus a good balance of nutrients is required for the best plant growth, with generally more phosphorus being required at first in relation to the other major nutrients and then more nitrogen and potassium required later. Adequate amounts of potassium are particularly

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necessary for crops like tomato, potato and also fruit trees. Too much nitrogen can block this vital element. So care is required in the overzealous application of urine.

The balance of nutrients available in urine can be influenced by various means. The addition of plants and other materials to form a liquor which is allowed to ferment in urine, can change the balance. Thus the fermenting of comfrey leaves in urine is known to increase the proportion of potassium in relation to nitrogen (Hill, 1997) – see description in gardening techniques. It is also possible that the peels of fruits like banana, which are known to be high in phosphorus, potassium, calcium, magnesium and sulphur and citrus peels, known to be high in phosphorus and potassium, if allowed to ferment in urine, may readjust the balance of nutrients (a possibility which has yet to be tested). Diluting the lower fraction of urine which has been allowed to sediment out (with the salts containing phosphorus being held in the sediment) may also adjust the balance of nitrogen and phosphorus increasing the phosphorus in relation to nitrogen. But the simplest answer lies in preparing the soil well first with humus and compost, and then feed later with urine in the amount required for specific plants.

Methods of collecting urine

By far the simplest method of collecting and storing urine is for men to urinate in bottles when they visit the toilet. There are several other methods which can be used - the “desert lily” concept is one - where a funnel is mounted over a plastic drum in some position which allows the passing male to urinate in privacy. The simplest are funnels mounted over 20 litre plastic containers. Piping, fittings and containers should be made of plastic - the urine is very corrosive – metal will corrode badly. The urine diverting pedestal is also another suitable method for collecting urine. These pedestals are commonly used in ecological sanitation projects all over the world. There are variants which allow for squatting as well as sitting. The urine diverting pedestal has a pipe which can be used to convey urine into a storage vessel like a 20 litre plastic drum. Care must be taken to ensure than faecal matter does not enter the urine section. Pedestals mounted over removable buckets can also be used to collect urine - they are useful for women. “Potties” filled at night in the bedroom can also collect urine – a well established method. Urine collectors can also be made which fit into conventional flush toilets, the urine being decanted into plastic bottles. Once the urine is collected - it is stored in plastic containers which are capped before use or processing.

Collecting and storing urine in bottles is the easiest way for men. On the left urine stored in discarded two litre milk bottles. A funnel placed over a 20 litre plastic container is also effective if well placed in some private location. It is a type of “desert lily.”

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On the left a 10 litre bucket is placed beneath a pedestal which helps women to collect urine. On the right a urine collector shaped from a plastic bucket is used to collect urine from a standard flush toilet.

Storage

Urine can be stored in bottles (2 litre plastic milk bottles for instance) or containers for long periods provided they are well capped and the ammonia is not allow to escape. Deposits of the phosphorus and magnesium salts will be deposited however on the base and side walls of the container. It is possible to place a small flexible tube through the side wall of a 20 litre plastic container and allow the phosphorus laden sediments to settle out. Decanting the upper half may produce a product which as a higher proportion of nitrogen in relation to phosphorus. Shaking and stirring the remaining urine in the lower half of the container may produce a liquor with a higher proportion of phosphorus, released from the sediments of calcium phosphate and magnesium ammonium phosphate, once stirred and shaken. Once stored, urine usually turns darker. The exact constituents of urine vary from one person to another.

Uses of urine in agriculture

There are at least five ways of using urine for the benefit of agriculture. These are:

1. **Urine applied to soil without dilution before planting**
2. **Urine applied to soil without dilution near the young plant, followed by watering**
3. **Urine applied to soil - diluted with water – to the growing plant**
4. **Urine as an "activator" for compost.**
5. **Urine as a medium for fermentation of plant residues**

1. Urine applied to soil without dilution before planting

Urine can be applied without dilution to the topsoil of vegetable beds during the preparation stage, before planting. Later, after several weeks the vegetables are planted and watered normally and their growth will be enhanced. During the months after urine application, soil bacteria convert the urea into ammonia, then into nitrite and finally into nitrate which the plant can absorb. Heavy rain can flush the nitrates away, a risk also with some potassium salts, although to a lesser extent. The far less soluble salts of phosphorus tend to hold their place in the soil far better.

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2. Urine applied to soil without dilution near the young plant, followed by watering

Urine can also be applied without dilution to the soil near a plant and then diluted with either further applications of water or with rain water. Most plants will die if undiluted urine is applied directly to the roots of plants in the soil, so the urine must be applied to the side of the plant. Dilution in some form with water is required if applied directly to plants. Also some of the nutrients in urine are not immediately available to the plant as "food" - they must be converted first. As has already been discussed, nitrogen for instance, must be converted from urea into ammonia, then to nitrite and finally into nitrate salt which is available to the plant. Fertile soil, containing a higher number of beneficial soil bacteria are more effective at converting the urine than poor sandy soils which contain fewer bacteria. For this reason urine is best applied to soil containing humus. If diluted urine is added to a very poor soil on a prolonged basis, particularly sandy soil, the young plants will gain the nutrients and grow better than on poor soil without urine (see later maize trials), but the plant growth will never equal that on poor soil to which humus has been added. So if the soil is really poor, it is best to add humus first to get the best effects of urine.

3. Urine as a liquid plant food - diluted with water

Perhaps the most obvious way of using urine is to dilute it with water and apply the mixture to the soil in which plants are growing directly. The urea must go through the same conversion as it does when applied without water - so the effects of urine/water application are not immediate.

The age of the plant and the condition of the soil are important. If the soil is poor and sandy for instance - the application of urine may stunt plant growth and even kill off the young plants even when diluted with water. So care is required. Where the soil is more humus like, then the urine can be applied with greater success. Humus application to sandy soil - seems to be very important if urine is going to be used effectively.

Obviously more mature vegetables can cope with a higher concentration of urine and water than young seedlings. The nitrite stage of urine conversion is actually toxic to plants. If seedlings of plants like tomato, rape and spinach are watered constantly with urine diluted with water (both 3:1 and 5:1 water/urine mix) the growth of the seedlings will be retarded, compared to identical plants which are irrigated with water only. The young plants may not die, but their growth is much slowed down. Thus the constant daily application of urine, even when diluted with water is not recommended. Remarkably, plants stunted by an overzealous application of water/urine will later recover when water alone is applied. Perhaps this is because the excess nitrogen can be flushed out and the soil itself has built up a reserve of basic nutrients (like phosphorus and potassium) which can then be used by less stressed plants. It is possible that in flushing out the nitrogen levels are much reduced leaving more phosphorus, which binds better with the soil, which is what the roots need to grow.

A range of dilutions of urine with water seems to work. A simple recipe which seems to work well for many plants is to use urine diluted three parts of water (3:1). This dilution appears to be well tolerated by plants from seedling stage, provided that the treatment is interspersed with regular normal watering. Such a mix is applied once, twice or even three times per week (see later) for use on a variety of vegetables and crops. To repeat, the application works if all other irrigation is applied using water only. Thus the initial water/urine treatment is diluted much further by more watering. Plants cannot sustain constant watering with the 3:1 mix

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alone. The build up of salt (NaCl) and nitrogen would be too great and lead to stunting or death of the plants. The results of plant trials show that this mix of water and urine will considerably enhance the growth of green leafed vegetables when applied twice or three times during a week, interspersed with normal watering at all other times. For increased economy of urine the rate of application can be reduced to once or twice a week application of 3:1 or the dilution can be can be changed to 5:1 with reduced effect.

This dilution method is the one practiced by the writer and with much success. In practice a 2 litre bottle of urine is diluted with three or five times the amount of water in a 10 litre bucket. This water is drawn out with a jug which holds 0.5 litres of the mix and is applied to the vegetables in 10 litre containers, twice a week. This is an ideal recipe for growing vegetables in 10 litre buckets or cement basins. The soil in the container can be selected beforehand to give the best results. A mix of composted soil and leaf mould is ideal.

Examples of successful vegetable production in containers.

Vegetables like covo, rape, spinach and several other green leafy vegetables can adapt to a wide range of urine applications when applied to containers provided that water is also applied liberally. In fact in the case of vegetables and other plants grown on containers, which hold a relatively small volume of soil, it will always be necessary to apply water regularly to sustain plant health, since the volume of water held in the soil is small. On a hot day, the plants will wilt easily, and require frequent watering. With such a constant throughput of water, diluted urine can be applied as frequently as 3 times per week. For use on containers, urine can be diluted with water at the rates of 3:1 or 5:1 and applied once, twice or three times a week. Where there is a large throughput of water in containers it is best to apply in small doses more often then bigger doses less often. Experience has shown that provided fresh water is added to the basin frequently, green vegetables can withstand the 3:1 and 5:1 applications without harm. Generally the rate of growth of green vegetables is in proportion to the amount of urine applied. However in the longer term, a build up of salt occurs, and there may be an excess of nitrogen which will inhibit the uptake of potassium.

For these reasons it is wise to empty the containers of soil treated with urine and remove them to a compost site where the soil can be mixed with other composts and soils and watered without urine application. Thus the soil can be restored and invigorated.

A good standard procedure for green vegetables like rape and spinach growing in 10 litre containers is to apply a 3:1 mix twice a week for the first month, with intermediate watering. Reduce this to a 5:1 mix twice a week for the second month with intermediate watering. From then on apply a 5:1 mix once per week with intermediate watering.

For tomatoes grown in buckets only apply diluted urine after the first small fruits appear. Then apply 0.5 litres of 5:1, once per week with wood ash (add a tablespoon per week to the bucket soil and watering in).

Also for longer term onion (6 months to harvesting) in basins, apply a 3:1 mix twice a week for the first month, with intermediate watering. Reduce this to a 5:1 mix twice a week for the second month with intermediate watering. From then on apply a 5:1 mix once per week with intermediate watering.

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Preparing the urine/water mix


General equipment required for applying urine. Various buckets, watering can, rubber gloves and 0.5 litre jug for dispensing the mix. Supply of urine (in 2 litre plastic bottles). A 5:1 mix can be made with 2 litres of urine and 10 litres water. A 3:1 mix can be made with 2 litres of urine and 6 litres of water.


Add the 2 litres urine first to a larger (20 litre) bucket, then add 10 litres water from the 10 litre bucket.


Apply to the containers from a 0.5 litre jug or similar container. Once or twice a week depending on duration of application. For shorter term (1 – 3 months) on green vegetables, twice a week with plenty of watering in between. For longer term (3 – 6 months) the mix should be applied once a week with plenty of watering in between (tomatoes and onion).

In some applications additional sources of nutrient are mixed in with the urine/water. Like extra phosphate or wood ash applied at the rate of 5gms per 0.5 litre charge of urine and water (5:1). The wood ash supplies extra potassium, particularly suitable for tomatoes.

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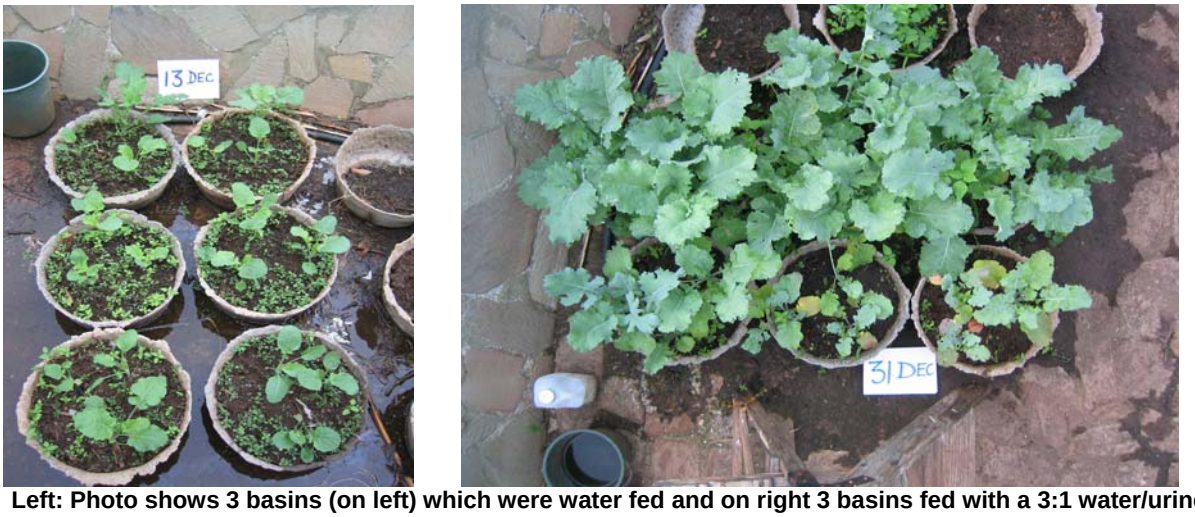
Mixing in extra wood ash to the jug. 5 gms (level tablespoon) ash per 0.5 litres of 5:1 application. The ash helps to make plants more healthy and is good for fruiting. In this case it is being applied to spinach in an experiment. This type of application is particularly good for tomatoes.

RAPE

Rape is one of the most popular vegetables grown in Zimbabwe. It is used a great deal in relish eaten with maize meal in combination with onion, tomato and meat. It responds well to being grown in containers which are fed urine diluted with water. In this trial, rape was fed diluted urine (3:1) twice a week. The urine application led to a 5 fold increase in harvest after 28days. This is an excellent response to urine.

Plant	**Liquid plant food**	**frequency of application**	**weight harvested**
Rape	water only	normal watering	160 gms (9 plants)
Rape	3:1 water/urine	0.5 litres 2 X per week	822 gms (9 plants)



Left: Photo shows 3 basins (on left) which were water fed and on right 3 basins fed with a 3:1 water/urine mix, twice a week. The effect only became noticeable after 10 days treatment. After 28 days water/urine application the effect is very noticeable (photo on right with water treatment below and urine treatment above. Some of the basins are obscured. Rape yield was increased about 5 times.

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Left: The relative yields of water fed and water/urine fed rape grown on 10 litre basins after 28 days application. The plants have just been harvested for the first time. Right: the same plants almost a month later just before the second crop was harvested. Yellowing and mauve colour on some leaves begin to show after 2 months of urine application at this rate, indicating that the plants are beginning to weaken. This is probably due to over application of nitrogen from the urine. Longer trials like this provide the best indications of the most suitable water/urine treatment under these conditions. A weaker 5:1 application given to the plants once a week may be better in the longer term

Spinach

Spinach is another popular vegetable in Zimbabwe. Like rape, several harvests can be taken from the same plant over a period of several months. It is ideally suited for growing in containers which are fed diluted urine as shown below. During the first month, the urine application (3:1, twice per week) led to a 3.4 fold increase in harvest after 28days, compared to water fed plants. This is an excellent response to urine. During the second month the urine dose should be reduced to 5:1, twice a week and during the third month and after, the urine dose should be reduced further to 5:1, once per week. 0.5 litres of the diluted urine is applied to each basin per treatment. The plants are watered at all other times.

Plant	Liquid plant food	frequency of application	weight harvested
Spinach (22plants)	Water only	normal watering	741gms
Spinach (22plants)	3:1 water/urine	0.5litres 2 X per week	2522gms

Photos taken of the 16 basin spinach trial. Basins to the left of the green band are urine fed, those to the right water fed only. Photo on left taken on 3rd December 2003 on the first day of urine treatment. Photo on right taken on 31st December 2003, 28 days after first urine treatment. The effective of the urine treatment is very positive and very clear to see. Urine fed 3.4 times water fed.

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Left: The total collected harvest of urine treated spinach on the left and water treated spinach on the right after 28 days of urine treatment (3:1, twice per week). Right: plants fed water/urine during their second month are beginning to lag behind plants fed the 3:1 water/urine mix for the first time. The best yield however is being produced by plants shown on the four basins to the right, which have been fed only two applications of the urine water mix and then leaf compost liquor under a mulch of leaves. These signs show that if urine is to be used as a liquid plant food over a prolonged period, the dose should become weaker as the time is extended. For spinach – first month 3:1, twice a week; second month 5:1, twice a week; third month and thereafter 5:1, once per week. Extended trials show that the lower dose can maintain spinach output, once the soil has been well fertilised by prolonged and correctly applied urine treatment. 0.5 litres of the diluted urine is applied to each basin per treatment. The plants are watered at all other times. Spinach responds very well to this type of treatment.

Onion

Onions are well suited to growing in containers and also respond positively to the application of diluted urine. Onions do take a long time to grow, between 6 to 8 months being required between planting seedlings and harvesting. Seeds are best planted during January or February (for Southern Africa) and allowed to grow in seeds trays. They are transplanted into cement basins when about 4 – 6 weeks old. During this period they can be fed with leaf compost liquor. After transplanting, a weekly application of a urine/water mix (1:5) will help the onion considerably and can begin a week or two after transplanting. Onions need good supplies of nitrogen as well as phosphorus (in the early stages) and plenty of potassium later on. The application of wood ash will help. Planting on a mix of ***Fossa alterna*** humus will help, even better if mixed with compost. A good leaf mulch will help the supply of phosphorus and potassium. The application of leaf compost liquor will also help.

Up to ten onion can grow in a single 10 litre cement basin. Onion are first grown in seed trays, then transplanted to basins. These onion were fed a 3:1 water/urine mix, once a week. They were planted as seedling on 17th May and reaped about 6.5 months later on 27th October 2003. An average of 1 kg of onion was reaped from each of ten jars planted. The number of plants varied between 5 -9 plants at harvest with weights per basin varying from 0.7kg to 1.3 kg. The growth was improved by the application of a mulch made of leaves. This reduced weeds and also provided some nutrients as well as reducing water loss from the soil. The basin and urine method appears to suit onion.

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Some very good looking onion can be grown in cement basins with the help of a water/urine feed. Here two prize specimens! Onion seeds are best planted early in the year, late January or February being good times, so they can be transplanted into containers towards the end of the rains in April. The healthy onion on the right was harvested in early September after 6 months of water/urine treatment in a 10 litre cement basin. 0.5 litres of a 5:1 mix of water had been applied once a week for all that period together with intermediate watering. Such a result reveals the usefulness of urine as a plant food.

TOMATO

Tomato seedlings will grow in unmixed neat ***Fossa alterna*** humus, but grow better in a 50/50 mix of the humus and garden/leaf compost. The addition of the leaf compost makes the final mix more crumbly and well drained. The soil should be rich in phosphorus to start to help the plants grow sturdy roots and early shoots. When growing in containers most hungry feeders (like tomato, onion and other vegetables) will require additional feeding and in organic farming this is often supplied in liquid form. Diluted urine can be useful, if applied with care with the addition of wood ash (to enhance potassium) and also liquid feed from composting leaves. However diluted urine should not be applied until the flowers have formed and the early small fruit is starting to grow. If too much nitrogen is given (such as with too much urine application), the leaves will grow abundantly with less fruit production. After fruiting has begun more nitrogen (from urine) and particularly potassium (from wood ash) can be applied for the best yields. Tomatoes do require a lot of attention and special treatment to do their best. For more information on growing tomatoes using recycled human excreta, look at the chapter on gardening techniques.

Growing tomatoes in bags and buckets

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More examples of plants grown with the help of urine


Young mulberry cuttings once established respond well to a dose of 5:1 water and urine weekly (0.5 litres per plant). The same applies to the mint plant on the right growing in a 10 litre bucket.


Passion fruit also responds very well to the application of urine and water. In a 30 litre pot this passion fruit is fed with 1 litre of a 5:1 mix of water and urine weekly. The petrea tree is also fed a 5:1 mix of urine and water (10 litres every month).


Celery also responds well to a 5:1 mix of urine and water (0.5 litres per container weekly). This large radish was fed in the same way.

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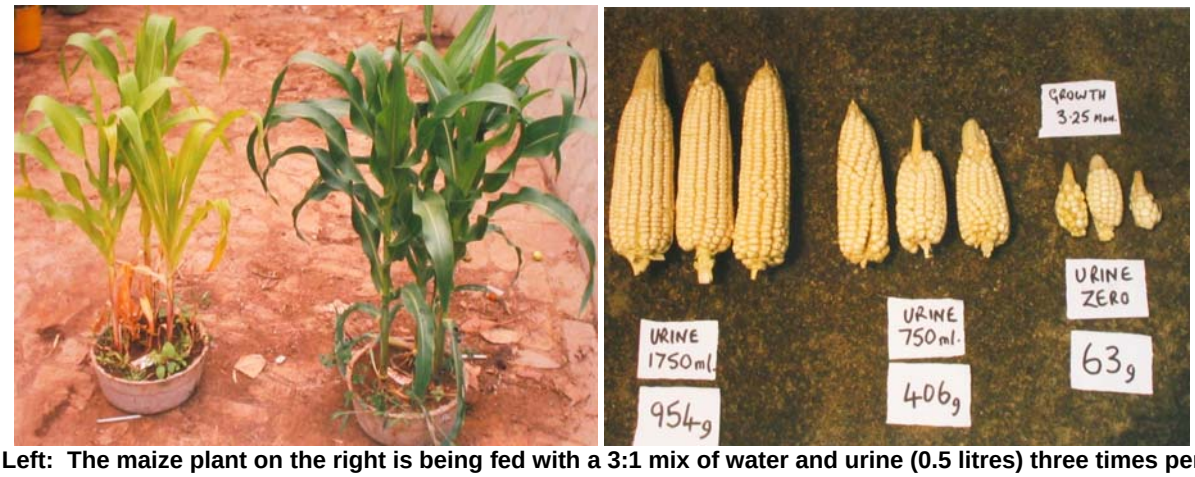
MAIZE

Urine can have a significant effect on maize growth. In the fields urine can be applied neat to soil before planting in beds. It can also be applied neat in hollows made near the growing plant. Neat urine applied to maize fields at the rate of 100mls per plant per week and then diluted with rain water, led to increases of cob weight between 28 and 39% compared to watered fed plants only in trials on the Marlborough vlei in Harare (See bibliography Ecological Sanitation in Zimbabwe vol. IV)

Maize trials on the fields using urine.

Growing maize in containers

Maize is rarely if ever grown in containers, but the effect of the growth of maize in containers when fed urine is stunning. Maize plants are hungry feeders and like a lot of nitrogen The application of a 3:1 mix of water and urine, once or twice or even three times a week on maize grown in 10 litre containers is particularly effective. For small scale maize or sweet corn production, this method may have application. It is also an effect way of demonstrating the effect of converting the nutrients held in urine into vegetative growth of valuable plants.



Left: The maize plant on the right is being fed with a 3:1 mix of water and urine (0.5 litres) three times per week. The maize on the left is irrigated with water only. The difference is striking. Right: Urine treatment also improves maize cob yield significantly. The total yield of cobs from maize planted in three 10 litre basins is shown. On the left the maize was fed 1750mls urine per plant over the 3.5 month growing period, resulting in a crop of 954 gms. A reduced crop resulted from reduced input of urine (middle). Maize plants on the right were irrigated with water. This is a very high rate of urine application, but one happily accepted by the maize plants in the containers which were irrigated frequently with water to keep the maize plants healthy.

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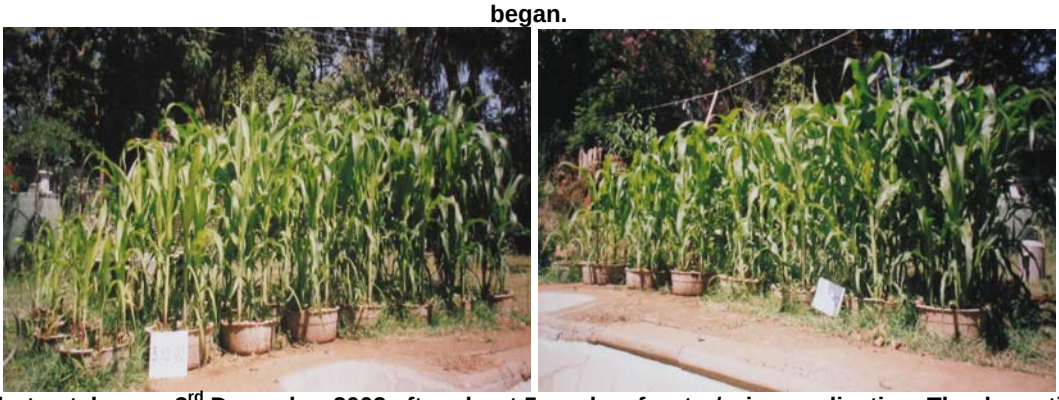
A experiment with maize grown in containers

24 ten litre cement basins filled with relatively poor topsoil were planted with maize seedlings on 30th October 2002 and watered for a week. The application of varying concentrations of a water/urine mix then began.



Photos taken on 3rd December 2002 after about 5 weeks of water/urine application. The dramatic differences in growth rate of plants is easy to see – water treatment only on extreme left and maximum urine treatment on extreme right with intermediate applications between. Vigorous growth of maize can be seen with the highest urine application on the right. The maize was harvested on 30th January 2003.

Part of the maize harvest

Part of the total harvest showing the effect of urine treatment on maize growth in basins. The maize plants held in basins which were fed only water produced a pathetic yield as what nutrients were available were quickly used up by the maize. However where diluted urine was applied, the growth of maize was considerably enhanced in proportion to the amount of urine added.

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The complete maize harvest

A single photo shows the effect of different amounts of urine applied to maize plants over a 3 month period. On the left (U1) the plants have been fed a 3:1 water/urine mix three times per week (125 mls per plant per week). This has led to a mean cob weight of 211 gms. The 3:1 mix was applied to the U2 group once a week (40 mls per plant per week) and has led to a mean cob weight of 169 gms. A 5:1 mix was applied to the U3 group once a week (27 mls per plant per week) and has led to a mean cob weight of 138.2 gms. A 10:1 mix was applied to the U4 group once a week (15 mls per plant per week) and has led to a mean cob weight of 62 gms. Those plants fed water only produced a mean cob weight of only 6 gms. 99.4% of the total cob mass shown in this photo is derived from the nutrients provided by the urine.

Maize – Africa's most important crop

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