# Effect of Micronutrient Loading, Soil Application, and Foliar Sprays of Organic Extracts on Grain Legumes and Vegetable Crops under Marginal Farmers' Conditions in Nepal

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## Abstract

*Various methods of micronutrient supplementation such as nutrient loading through priming water, soil application of micronutrient fertilisers, and foliar spray of cattle urine or stinging nettle (Urtica dioica L) extracts were evaluated on chickpeas, field peas, mung beans, cucumber, broad-leaf mustard, and radishes under farmers' management conditions in the Terai and hills of Nepal. Soil analysis showed that the soils were low to medium in boron and zinc with moderately acidic reactions. In chickpeas, soil application of borax at 20 kg ha$^{-1}$ and zinc sulphate at 14 kg ha$^{-1}$ gave significantly higher yields over the control treatment. Similarly, loading 0.05% sodium molybdate through priming solution and soil application of molybdenum at 0.5 kg ha$^{-1}$ (sodium molybdate at 1.22 kg ha$^{-1}$) resulted in an increase in nodulation and yield in both chickpeas and mungbeans. Four to five foliar sprays of cattle urine diluted to 20% with water increased field pea and chickpea yields by 27 and 11%, respectively. In a different set of on-farm trials, six to 10 foliar sprays with a 20% solution of stinging nettle extract at 15-day intervals increased seed yield of broadleaf mustard, radishes, and peas by 31, 18, and 14% respectively over the control treatments. In a similar study on cucumber, over 50% increase in fruit yield was observed after spraying of nettle extract. There is further scope for research for developing efficient methods of applying micronutrients and exploring the use of plant extracts for invigorating crop growth and increasing yield under marginal conditions.*

## Introduction

The sustainability of Nepalese agriculture is in jeopardy. Soil fertility is declining as a result of degradation of the natural resource base, depletion of soil organic matter, high rates of soil erosion, increased cropping intensity, and inadequate replenishment of soil nutrients (Carson 1992; Joshi and Pandey 1996; Sherchan and Gurung 1996; Tripathi et al. 1999; Vaidya et al. 1995). Application of farm-yard manure (FYM) is the traditional way of supplying plant nutrients and thereby sustaining crop productivity. However, the farmer's capacity to apply sufficient manure is curtailed due to declining numbers of livestock, which in turn is the result of deforestation and cultivation of marginal land previously used for grazing (Carson 1992; Schreier et al. 1995). In the western hills of Nepal, Tripathi (1999) found most of the soil samples were acidic (pH 3.7-6.5), and 33% of samples were low in organic carbon (OC), 6% in total nitrogen (N), 8% in available phosphorous (P), 35% in exchangeable potassium (K), 87% in boron (B), and about 20% in zinc (Zn), manganese (Mn), and copper (Cu).

Integration of diverse strategies is essential for the sustainable replenishment of soil nutrients and thus for sustaining crop productivity. These include improvement in farm-yard manure preparation and handling, green manuring, legume intensification in the cropping systems, crop rotation, stall feeding of livestock through the expansion of fodder planting, and supplementation of additional nutrient requirements through chemical fertilisers (Carson 1992; Joshi and Ghimire 1996; PAC and ICIMOD 1994). Foliar application of plant nutrients has proved to be an effective approach for correcting nutrient deficiencies and increasing the efficiency of supplemental use of nutrients (Tagliavini et al. 2002; Dixon 2003). However, the use of chemical fertilisers is limited due to inaccessibility in the remote hilly areas and the fact that many farmers across all ecological regions of the country are too poor to afford them. Thus a search for appropriate technological options for crop nutrition suitable for small and marginal farmers is essential.

Recently, supplementary approaches to crop nutrition, such as nutrient loading through seed priming and foliar feeding with organic sprays, have received growing interest because of their suitability for small and marginal farmers. There are a few empirical studies that furnish ample evidence of the effectiveness of plant extracts as plant growth promoters (Fuglie 2000; Malaguti et al. 2002).

In this paper, we present the results of on-farm studies of the effects of nutrient loading through seed priming, foliar sprays of cattle urine and nettle extract, and integrated use of organic and inorganic nutrient sources in marginal rice fallows in the Terai and maize-based cropping systems in the hills of Nepal since 2001. The study of nettle extract spray on vegetables has been completed and the studies of nutrient loading and integrated plant nutrient management studies are still in progress. This paper presents excerpts of the findings of studies completed so far.

## Materials and Methods

Studies were carried out on-farm on rainfed rice fallows, i.e., land that remains fallow after the rice harvest in October-November until the next planting of rice in June-July, in Kapilbastu, Saptari, and Jhapa districts in the Terai. Studies were also carried out on land in maize-based systems in the Myagdi and Dadeldhura districts in the hills of Nepal. The organisation FORWARD conducted these studies in collaboration with the district agricultural development offices (DADO) of the respective districts. With the facilitation of FORWARD staff, farmers were actively involved in the trial implementation and evaluation at standing crop and post-harvest stages. Joint monitoring of standing crops was carried out by a multidisciplinary group of scientists that encouraged on-site dialogue between farmers and scientists. The data obtained from the trials were compiled and analysed using Excel, Minitab, and MSTAT C packages.

### Molybdenum loading through seed priming of chickpeas

The chickpea trials were carried out on farmers' fields in rainfed rice fallows in the winter of 2003/04 with five replicates per district. The trials were planted between early November and early December 2003. In Kapilbastu, there were five treatments: (i) planting of normal seeds (farmers' practice), (ii) seed priming with plain water; (iii) seed priming with plain water plus *Rhizobium* inoculation; (iv) seed priming with 0.5% solution of sodium molybdate

(Mo loading) plus *Rhizobium* inoculation; and (v) seed priming combined with *Rhizobium* inoculation but with sodium molybdate added to the soil at 500g molybdenum (1220g sodium molybdate) per hectare. The same treatments were used in Saptari and Siraha, except that the trial with soil application of sodium molybdate was omitted and thus there were only four treatments. The trials were replicated five times across the farms. The treatments were applied on the chickpea variety KAK 2 with a seed rate of 80 kg $ha^{-1}$ and plot size of $75m^2$ per treatment.

Prescribed crop protection measures included seed treatment with Thiram at 2g $kg^{-1}$ of seed, pre-flowering preventive sprays with Bavistin against botrytis grey mould (BGM) disease, and other protection measures as needed. Other management and input levels were left to the farmers for their own practice.

### Molybdenum loading through seed priming of mung beans

The trials were carried out on farmers' fields in rainfed rice fallows. There were two treatments: (i) seed priming with plain water and (ii) seed priming with a 0.5% solution of sodium molybdate. Treatments were laid out in paired plots of 100 $m^2$ with eight replicates per district. The treatments were applied on mung bean variety NM 94 with a seed rate of 30 kg $ha^{-1}$.

The crop was planted in rows at spaces of 40x10 cm. Planting took place from the third week of March to the first week of May 2004. Plant protection measures were followed as required. Since the mung bean does not have synchronous maturity, pod picking of up to three times was suggested. Other aspects of management and input levels were as per farmers' practice. Relevant agronomic parameters, biotic and abiotic stress, and root nodulation count of 10 sample plants at the flowering stage, were recorded regularly by field staff.

### Cattle urine spray on chickpeas and field peas

The trials were carried out on farmers' fields in rainfed rice fallows. Trials were conducted separately on chickpeas and field peas and involved paired comparison of urine-spray versus no-spray plots replicated three times in each district. Crops were planted from early November to early December 2003 immediately after the rice harvest. Cow or buffalo urine diluted four times with water was sprayed at 15 day-intervals from one month after the crop emerged. Thus, the crop received two to three sprays with urine for peas and three to five sprays for chickpeas. The spray volume was approximately 450 l $ha^{-1}$. The variety used was KPG 59 for chickpeas and E-6 for field pea trials with a seed rate of 60 kg $ha^{-1}$ in both cases. Management common to both treatments included seed treatment with Bavistin at 2g $kg^{-1}$ of seed. Other management and levels of input were as per farmers' practice. Observations were recorded on yield parameters and pest incidence.

### Integrated plant nutrient management of chickpeas

The trials were carried out on farmers' fields in rainfed rice fallows and included the following six treatments:

1. farmyard manure (FYM) at 5t $ha^{-1}$
2. FYM at 5t $ha^{-1}$ + cattle urine spray (4 times dilution with water) at 450 l $ha^{-1}$
3. FYM at 5t $ha^{-1}$ + cattle urine spray + boron (borax 20 kg $ha^{-1}$)
4. FYM at 5t $ha^{-1}$ + cattle urine spray + zinc (zinc sulphate 14 kg $ha^{-1}$)

5. FYM at 5t $ha^{-1}$ + cattle urine spray + boron + zinc
6. control (without any fertilisers).

There were two replicates at each farm. Each experimental unit had an area of 50 $m^2$. Chickpea variety KPG 59 was used with a seed rate of 60 kg $ha^{-1}$. The trial planting lasted from early to late November in the 2002/03 and 2003/04 winter seasons. Prescribed management included seed treatment with Bavistin at 2g $kg^{-1}$ of seed, pre-flowering preventive spray with Bavistin against BGM disease, and other protection measures as required. Other management factors were as per farmers' practices.

Farmyard manure was applied to all treatments except the control at 5t $ha^{-1}$ during land preparation; soil application of borax at 20 kg $ha^{-1}$ and zinc sulphate at 15 kg $ha^{-1}$ was applied prior to seed sowing; spraying of cattle or buffalo urine at 20% concentration (1 part urine to 4 parts water) was carried out at 15-day intervals until harvest with approximately 450 l $ha^{-1}$. The observations were mainly focussed on yield-related parameters.

### Nettle extract spray

On-farm trials were carried out on radishes, broadleaf mustard, peas, and cucumber in farmers' fields in maize-based cropping systems in the western and far-western hills of Nepal in 2001/02. The treatments included spraying of nettle extracts at various concentrations and fermentation levels as given below.

1. 10% solution of fresh nettle extract in water
2. 20% solution of fresh nettle extract in water
3. 10% solution of fifteen-day fermented nettle extract in water
4. 20% solution of fifteen-day fermented nettle extract in water
5. 10% solution of fresh nettle extract in cattle urine
6. 20% solution of fresh nettle extract in cattle urine
7. Cattle urine at 20% concentration
8. Water as a control

The treatments with cattle urine were only applied to cucumber. Nettle extracts were obtained by three different methods: (i) by grinding fresh nettle leaves and stems in water, (ii) by fermenting chopped nettle leaves and stems in water, and (iii) by grinding fresh nettle leaves and stems in cattle urine. For fresh extraction of nettle sap, the required amount of nettle leaves and stems (by weight) was ground with a mortar and pestle with an equal amount of water and the content then strained to remove floating particles. For the fermented extraction, the required amount of chopped, fresh nettle shoots with leaves was steeped in an equal amount of water in a plastic bucket and covered for 15 days. After steeping, nettle extract was obtained by squeezing and straining the content first through a mosquito net and then through a double layer of muslin cloth. Both fresh and fermented extracts thus obtained were considered to be 100% in strength (stock solution) and sprayed immediately after dilution with water at 10 and 20% strengths at 500 l $ha^{-1}$. About 1 l stock solution was obtained from 1 kg fresh weight of nettle shoots.

Radishes, broadleaf mustard, and peas were sown from early October to early November 2001 and cucumber was planted in the second week of March 2002 at the recommended spacing. Six sprays for peas and cucumber and eight to ten sprays for seed crops of broadleaf mustard and radishes were applied at fortnightly intervals starting three weeks after crop emergence. Considering a farm as a replication, the trials were replicated four to five times per location.

Observations on both vegetative and reproductive parameters and crop response to biotic and abiotic stresses were recorded regularly. Since the major objective of the study was to observe the effect of nettle extract on suppression of crop diseases, special attention was paid to scoring *Alternaria* blight of broadleaf mustard and radish, and powdery mildew of peas and cucumber. Disease scoring was started when the diseases were noticed and continued at 15-day intervals until maturity for broadleaf mustard, radishes, and peas, and at weekly intervals until fruit harvest in the case of cucumber. The percentage leaf infection from the dates of observations were used to calculate the area under disease progress cure (AUDPC). The AUDPC was calculated using the following formula (Shaner and Finney 1977) in Microsoft Excel 2000.

$$AUDPC = \sum_{i=1}^{n} (Y_{i+1} + Y_i)\ 0.5\ (T_{i+1} - T_i)$$

Where,
$Y_i$ = per cent infection at $i^{th}$ date
$T_i$ = date on which the disease was scored

Those treatments showing lower AUDPC values are considered superior.

## Results and Discussion

### Effect of molybdenum loading on chickpeas

The results of the five replicates in Kapilbastu district (Table 1) and two replicates in Saptari district (Table 1), gave a very clear indication that seed priming with 0.5% solution of sodium molybdate, and soil application at 1220g $ha^{-1}$ enhances root nodulation in chickpeas. In Kapilbastu, soil application of sodium molybdate was significantly better in terms of both grain yield and root nodulation. However, the results did not show any clear effect on grain yield and related parameters for rhizobial inoculation or seed priming with sodium molybdate solution.

In Saptari, data were only available from two trials. However, subjective interpretation of the data shows that chickpeas responded well to seed priming, rhizobial inoculation, and sodium molybdate loading. The treatment with a combination of rhizobial inoculation and sodium molybdate loading produced the highest yield and highest scale of nodulation. The increments in yield over the control treatment were of the order of 33, 36, and 113% in seed priming, rhizobial inoculation, and combination of rhizobial inoculation and molybdenum loading treatments, respectively.

Nutrient loading through seeds could be a viable technological option for poor farmers in Nepal. However, this needs further verification with more replicates before recommendations can be made.

Table 1: **Comparative performance of seed priming with plain water and molybdenum loading of chickpeas in Kapilbastu district during the cropping season 2003/04 †**

| Treatments | Final plant stand | Pods per plant | Seeds per pod | Grain filling % | Plant height | Grain yield (t ha$^{-1}$) | Nodulation score (1-5) ‡ |
|---|---|---|---|---|---|---|---|
| **Kapilbastu** | | | | | | | |
| Farmers' practice | 13.5 | 34.2 | 1.05 | 61.7 | 42.75 | 0.25ab** | 1.25 |
| Seed priming in water | 11.0 | 24.8 | 1.0 | 78.7 | 42.5 | 0.20b | 1.40 |
| Rhizobial inoculation | 16.5 | 31.25 | 1.05 | 59.57 | 38.75 | 0.21ab | 1.60 |
| Rhizobium + Mo loading | 14.0 | 28.95 | 1.17 | 67.57 | 46.00 | 0.15b | 1.90 |
| Mo soil application | 15.0 | 45.75 | 1.30 | 58.3 | 49.75 | 0.34a | 2.40 |
| F test (0.05) | NS | NS | NS | NS | NS | * | * |
| CV% | 19.82 | 49.71 | 14.04 | 23.8 | 13.09 | 35.47 | 21.72 |
| SE | 1.38 | 8.20 | 0.07 | 6.95 | 2.87 | 40.64 | 0.185 |
| **Saptari** | | | | | | | |
| Farmers' practice | 9 | 25.8 | 1.3 | 54.0 | 2.05 | 0.22 | - |
| Seed priming in water | 11 | 29.65 | 1.2 | 56.5 | 2.35 | 0.29 | 31 |
| Rhizobial inoculation | 12 | 29.3 | 1.1 | 55.5 | 2.85 | 0.30 | 36 |
| Rhizobium + Mo loading | 13 | 31.6 | 1.3 | 56.0 | 3.00 | 0.47 | 113 |

† Average of four replications ; ‡ Nodulation score on 1-5 scale; ** Means in the column followed by the same letter do not differ significantly by LSD at p=0.05

## Effect of molybdenum loading on mung beans

The results of seventeen replicates across three districts indicated that molybdenum loading could be a very promising option for farmers for enhancing nitrogen fixation through root nodulation and thereby increasing the yield of mung beans in the spring season. Both grain yield and root nodulation were significantly higher in the molybdenum-loaded treatment over the normally primed seeds (Table 2). Other growth and yield parameters did not differ significantly between treatments. Molybdenum loading through seeds can be a promising component of integrated plant nutrient management for mung beans and resulted in a 20% yield increase. It is a simple and low-cost technique and hence especially useful for poor farmers in Nepal.

Table 2: **Comparative performance of seed priming with plain water and molybdenum loading of chickpeas in Kapilbastu, Saptari and Jhapa districts in the spring season 2004†**

| Parameters | Mean of treatments | | Significance (P-value) |
|---|---|---|---|
| | Seed primed in plain water | Seed primed in sodium molybdate solution | |
| Days to 50% flowering | 37.2 | 37.2 | NS |
| Days to 50% pod set | 48.9 | 48.9 | NS |
| Plant population per sq. m. | 14.2 | 15.8 | NS |
| Number of pods per plant | 22.1 | 22.3 | NS |
| Number of unfilled pods per plant | 2.1 | 2.0 | NS |
| Number of grains per pods | 11.7 | 11.7 | NS |
| Plant height (cm) | 43.0 | 44.6 | NS |
| Days to first picking of pods | 61.6 | 62.1 | NS |
| Number of nodules per plant | 28.2 | 37.0 | ** (<0.01) |
| Grain yield (t ha$^{-1}$) | 0.45 | 0.54 | ** (<0.01) |

† Results of seventeen replicates across three districts

## Urine spray on chickpeas and field peas

Both chickpeas and field peas responded well to urine spray. In chickpeas, the urine sprayed plot produced a significantly higher yield ($p = 0.025$) than the control plot. Mean grain yield was 0.65t $ha^{-1}$ in the urine sprayed plot and 0.59t $ha^{-1}$ in the control plot, an approximately 11% increase in yield due to urine spray. The yield pattern of the treatments over all farms (replicates) is shown in Figure 1.

The treatments also differed significantly in terms of number of grains per pod ($p = 0.03$) and plant height ($p = 0.02$) with the mean values of 1.69 grains and 48.3 cm in urine sprayed plots and 1.62 grains and 46.9 cm in the control plot. There was no significant difference between the treatments for the percentage of unfilled and borer-damaged pods. This implies that the increase in yield due to urine spray could be because of nutritional supplementation rather than as a result of its pesticidal effects.

Similarly in field peas, paired t-tests showed a highly significant difference ($P = 0.001$) in yield between urine-sprayed and unsprayed treatments. The urine sprayed plots produced an approximately 28% higher mean yield (0.24t $ha^{-1}$) than the control plot (0.18 $ha^{-1}$). The yield pattern of the treatments over farms (replicates) is shown in Figure 2.

The results corroborate earlier findings that four sprays with sheep urine on Chinese cabbage increased yield by 82% over the control and by 24% over urea top-dress in the western hills of Nepal (Joshi 1992; Ghimire 1992).

Although urine spray is effective in both field peas and chickpeas, it has some limitations for its applicability. Firstly, it is difficult to obtain enough urine to treat large areas. Secondly, farmers must adopt stall-feeding and make some investment for improvement of the animal stall to collect the urine, and this may deter poor farmers. Nevertheless, some ingenious farmers have already adopted the practice of using urine sprays on vegetable crops.

## Integrated plant nutrient management of chickpeas

Only the results of the 2002/03 season are analysed and presented in this paper, as the trials in 2003/04 succumbed to BGM and pod-borer. Analysis of variance of grain yield showed a significant difference ($p = 0.03$) due to treatment. In Jhapa and Kapilbastu there was a clear response of the crop to nutrient supplementation of the soil. However, the response was not as evident in Saptari. It was realised during joint monitoring that there were some limitations to the selection of a suitable site for the trial in Saptari. However, on average, all fertilised treatments had higher yields than the unfertilised check treatment.

The percentage of unfilled pods was significantly lower ($p = 0.018$) in boron-supplemented treatments, with 9-11% damage compared to 23.5% damage in the control treatment. In the rest of the treatments, the percentage of abnormal pods decreased with increased supplementation of nutrients by 21, 17 and 14% in FYM, urine spray, and zinc supplied treatments respectively.

Mean yields of different nutrient supplementation treatments are shown in Figure 3. Treatments with boron application and combined application of boron and zinc produced the highest mean yields of 1.3t $ha^{-1}$ and 1.2t $ha^{-1}$ respectively. The control treatment was the lowest yielder (0.6t $ha^{-1}$).

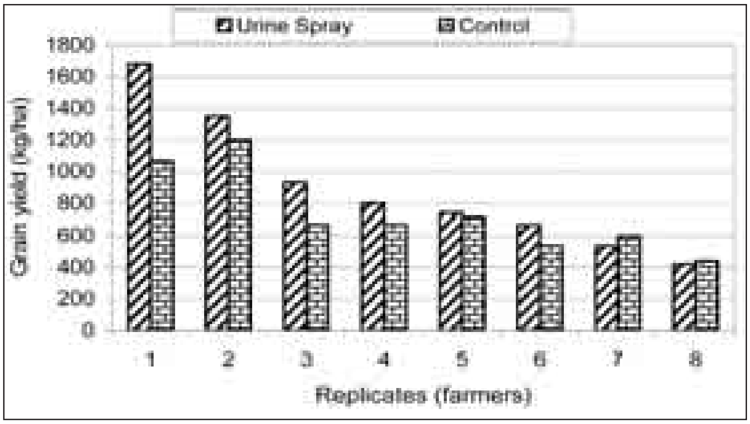


Figure 1: **Effect of cattle urine spray on grain yield of chickpeas in rice fallows in Kapilbastu, Saptari, and Jhapa districts, 2002/03 winter season**

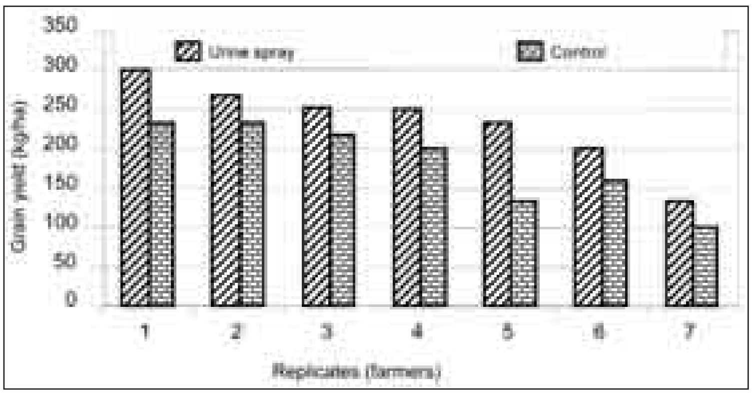


Figure 2: **Effect of cattle urine spray on grain yield of field peas in rice fallows in Kapilbastu, Saptari, and Jhapa districts, 2002/03 winter season**

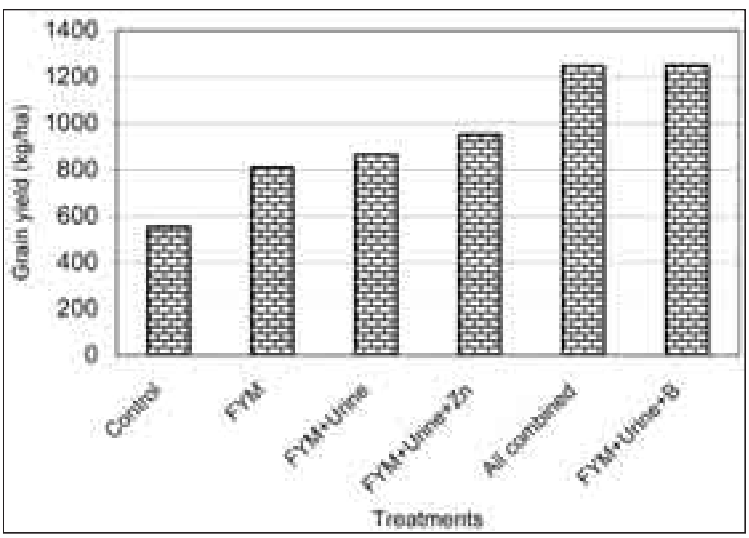


Figure 3: **Grain yield means of various nutrient management treatments in chickpeas**

It is clear that supplementation with boron contributed substantially to increasing the yield of chickpeas, while there was a moderate response to the application of farmyard manure and zinc. The trial will be repeated with more replicates for further verification of these findings.

### Nettle extract spray in broad-leaf mustard, radishes, peas, and cucumber

Nettle sprayed plots, especially at higher concentration (20%), had a lower incidence of foliar diseases and higher yield for all test crops. There was a marked effect of nettle extract on the suppression of *Alternaria* blight (*Alternaria* spp.) on broadleaf mustard and radishes, and of powdery mildew (*Erysiphe polygoni*) on peas and cucumber. The control plot had a significantly higher AUDPC value (Table 3) and an increase in concentration of the spray had more effect on disease suppression, as reflected by the lower AUDPC value. This may be because of the fact that the stinging nettle contains a number of active phytochemicals with fungicidal properties (USDA-ARS-NGRL 2002).

Table 3: **Effect of nettle extract on foliar disease development of broadleaf mustard (BLM), radishes, peas, and cucumber in the Western and Far -western hills of Nepal, 2001/02**

| Treatments | Area under disease progress cure (AUDPC) | | | |
|---|---|---|---|---|
| | BLM† | Radish† | Peas† | Cucumber# |
| Fresh nettle extract in water (20%) | 86.79 | 55.70 | 106.29 | 60.48 |
| Fresh nettle extract in water (10%) | 105.74 | 59.00 | 125.81 | 124.04 |
| Fermented nettle extract in water (20%) | 99.25 | 54.40 | 112.18 | 41.37 |
| Fermented nettle extract in water (10%) | 111.83 | 59.20 | 132.97 | 99.73 |
| Fresh nettle extract in urine (20%) ** | - | - | - | 29.86 |
| Fresh nettle extract in urine (10%) ** | - | - | - | 64.99 |
| Urine spray (20%) ** | - | - | - | 36.52 |
| Control (water spray) | 125.33 | 63.00 | 195.91 | 156.89 |
| P-value | 0.00 | 0.00 | 0.03 | 0.01 |
| CV% | 10.25 | 7.45 | 46.92 | 38.58 |

† means of nine replications across two sites ; # means of two replications; ** treatment applied only to cucumber

Table 4 shows the average yields of the test crops in the trial. There was a significant difference between the treatments in seed yield of broadleaf mustard (p = 0.02). Although the treatments stood at par for seed yield of peas and radishes and fruit yield of cucumber, in all cases there were higher yields in nettle-treated plots over the control. Moreover, there was a general tendency towards higher yields with higher concentrations of the nettle extract spray. The results show that a 20% solution of fermented nettle spray gave the consistently highest seed yields with increases in broadleaf mustard of 31.4%, radishes 18.5%, peas 14.6%, and cucumber 102% over control treatments.

The nettle extract spray could have multiple effects on crops including disease suppression, nutrient supplementation, and hormonal activities. It is reported that nettle leaves are rich in calcium (Ca) (5,940-33,0000 ppm), magnesium (Mg) (860-8,600 ppm), nitrogen (N)

| Table 4: Effect of nettle extract on seed yields of broad leaf mustard (BLM), radishes, and peas and fruit yield of cucumber in the western and far-western hills of Nepal, 2001/02 | | | | |
|---|---|---|---|---|
| **Treatments** | **Seed yield (t/ha)** † | | | **Fruit yield (t/ha)** # |
| | **BLM** | **Radish** | **Peas** | **Cucumber** |
| Fresh nettle extract in water (20%) | 4.79 | 1.09 | 5.20 | 23.65 |
| Fresh nettle extract in water (10%) | 4.51 | 1.39 | 4.94 | 23.75 |
| Fermented nettle extract in water (20%) | 5.25 | 1.07 | 5.74 | 27.50 |
| Fermented nettle extract in water (10%) | 4.33 | 1.05 | 5.41 | 21.53 |
| Fresh nettle extract in urine (20%) ** | - | - | - | 22.64 |
| Fresh nettle extract in urine (10%) ** | - | - | - | 22.29 |
| Urine spray (20%) ** | - | - | - | 15.80 |
| Control (water spray) | 3.99 | 0.92 | 5.01 | 13.61 |
| P-value | 0.02 | 0.49 | 0.19 | 0.35 |
| CV% | 11.45 | 12.22 | 15.72 | 29.56 |

† Means of nine replications on two sites ; # Means of two replications ; ** Treatment applied only on cucumber

(10,000-55,0000 ppm), sulphur (S) (1,200-6,665 ppm), silicon (Si) (1,170-6,500 ppm), chlorine (Cl) (2,700 ppm), iron (Fe) (44-418 ppm), potassium (K) (6,700-37,220 ppm), and dozens of active chemical compounds (USDA-ARS-NGRL 2002). Therefore, the sprays made from nettle leaves are rich foliar fertilisers that invigorate plant growth and improve their disease resistance (GCA 2002; Peterson and Jensen 1985, 1986; Diver 2004). A study on the use of moringa leaf juice on various crops in Nicaragua showed similar growth-promoting effects, and it was found that one of the active substances contained in moringa leaves was zeatin, a plant hormone from the cytokine group, which was responsible for crop growth invigoration (Fuglie 2000). Malaguti et al. (2002) observed beneficial effects of leaf sprays based on seaweed extract on the quality and colour (red) intensity of apples. Whether nettle also contains such hormonal substances is an interesting issue for further research.

## Conclusion

In the context of small and resource-poor farmers in Nepal, recommendation of technologies based on high-cost external inputs have little practicality because farmers are unable to afford them. Farmers are aware of the problems of soil degradation, but are not technically or financially equipped to respond appropriately. The responses of crops to supplementation of plant nutrients are evident from the on-farm trials. A search for other supplementary nutrient management options suitable for small farmers is underway and some promising results are already in hand. Among the low-cost and/or local resource-based options for supplementing nutrients, use of cattle/buffalo urine and nettle leaf extracts for foliar feeding of crops have shown great promise. Preliminary results of molybdenum loading through the seeds of leguminous crops, such as chickpeas and mung beans are also encouraging. With further verification and fine-tuning of the state-of-the-art practices, micronutrient loading through seeds and foliar sprays with urine and locally available plant extracts could be promoted as supplementary nutrient management options to increase crop yields and food security for marginal farmers.

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