

# Effect of High and Low-input Nutrient Systems on Soil Properties and their Residual Effect on Sweet Corn.

## II. Residual Effect

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### 1 Introduction

The concern with view to the productivity and sustainability of agro-ecosystems leads to the formulation of new approaches to soil management as expressed by the reduced chemical input (RIC) (KIRCHNER et al. 1993) and Low Input Sustainable Agriculture (LISA) (GRUBINGER, 1992). These concepts are strengthening the cultural background that implies the recycling of wastes in the soil and are consistent with the "Sustainable Development" as enunciated by the Brudtland Commission (WCED, 1987), and with the recycling philosophy widely accepted as one of the major concern of industrialised societies.

Recycling organic wastes through agricultural land application is an old practice that has received renewed interests in recent years due to the water pollution concern and the need for low cost disposal of large quantities of municipal organic wastes. These organic wastes are potentially valuable resource of essential plant nutrients and may also serve as natural soil conditioner due to its high content of organic matter. The beneficial effects of sludge to plants may be greater than can be accounted for by nutrient contents in

sludge. For example, HUE, 1987 reported that Desmo-dium introtum, an Al-sensitive forage legume produced three times more dry matter in sludge treated acid Ultisol (pH 4.7) than the same soil treated with Ca(OH)<sub>2</sub> (pH 5.6) (other nutrients were maintained at adequate levels). This suggests that sludge derived organic molecules can detoxify Al and some of these organics may be growth stimulants.

The present investigation was carried out in pot experiment to elucidate the residual effect of organo top (a purified city waste) and mineral fertilises on the growth and mineral content of sweet corn.

### 2 Materials and Methods

Following the sorghum (HS 9) crop in the main experiment, the residual effect of organo top and other mineral fertilisers (N K S) was evaluated using sweet corn as a test crop under green house conditions. The physico-chemical properties of the soil, the fertility status, main treatments and characteristics of the orano top fertiliser are outlined in section I. After harvesting the sorghum crop, the roots were removed from the pots in order to avoid an allelopathic effect. The soil was pulverised with the help of an electric agitator for better aeration. At moisture content of field capacity, 10 seeds of sweet corn (cv. *Gauco*) were put and after establishment only one plant was retained in each pot. The crop was irrigated with de-ionised water when required. The crop was harvested at flowering stage. The samples were oven dried, milled to fine powder and were analysed for N (Kjeldahl), P (Auto-analyser), and K and Mg (Flame emission photometer).

The experiment was conducted in a randomised block design with 4 replications and data were statistically analysed using the SAS package.

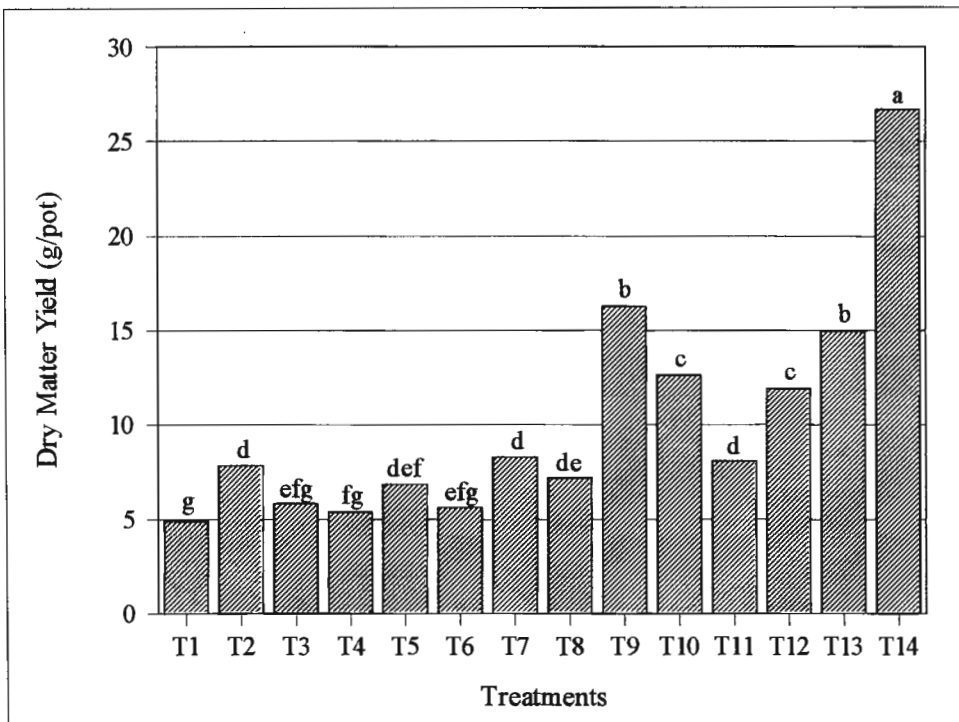


Figure 1: Residual effect of N K S and organo top fertilisation on dry matter yield of sweet corn (values having the same letters are not significantly different at the 0.05 level by Duncan's multiple range test)

### 3 Results and Discussion

#### 3.1 Dry Matter Yield

Figure 1 demonstrates the residual effect of mineral and organo top fertilisation on the biomass production of sweet corn. It is observed that in comparison to the control, the yields of corn are significantly higher under full dose treatment (T<sub>2</sub>), which may be attributed to higher amounts of total and mineral N left in the system after sorghum crop. The beneficial effects of organo top are strongly evident by large yield increases in plants grown on organo top amended soils as compared to control and mineral fertilised soil. It may be calculated that corn yields was increased by 180 per cent in full dose treatment (T<sub>2</sub>) in comparison to control. The comparison between the mineral and organo top treated soils is well demonstrated by relative yields in figure 2. As compared to reference treatment T<sub>2</sub>, the increase in the yields is stated to be 108, 61 and 3 per cent where organo top alone was applied (T<sub>9</sub>-T<sub>11</sub>). When organo top was blended with different proportions of mineral N, the increases were 52, 91 and 241 per cent at T<sub>12</sub>, T<sub>13</sub>

and T<sub>14</sub>, respectively, in comparison to control. On the other hand, none of the mineral fertiliser treatment could overtake the reference treatment T<sub>2</sub>. The perusal of the data also indicates that crop yield decreases with decrease in organo top application rates. Comparing the treatments T<sub>12</sub> and T<sub>13</sub> where mineral fertiliser has been blended with organo top, it emerges that yield is significantly higher in treatment T<sub>13</sub> where organo top has been applied in higher proportion than treatment T<sub>12</sub>. The crop attained the high-

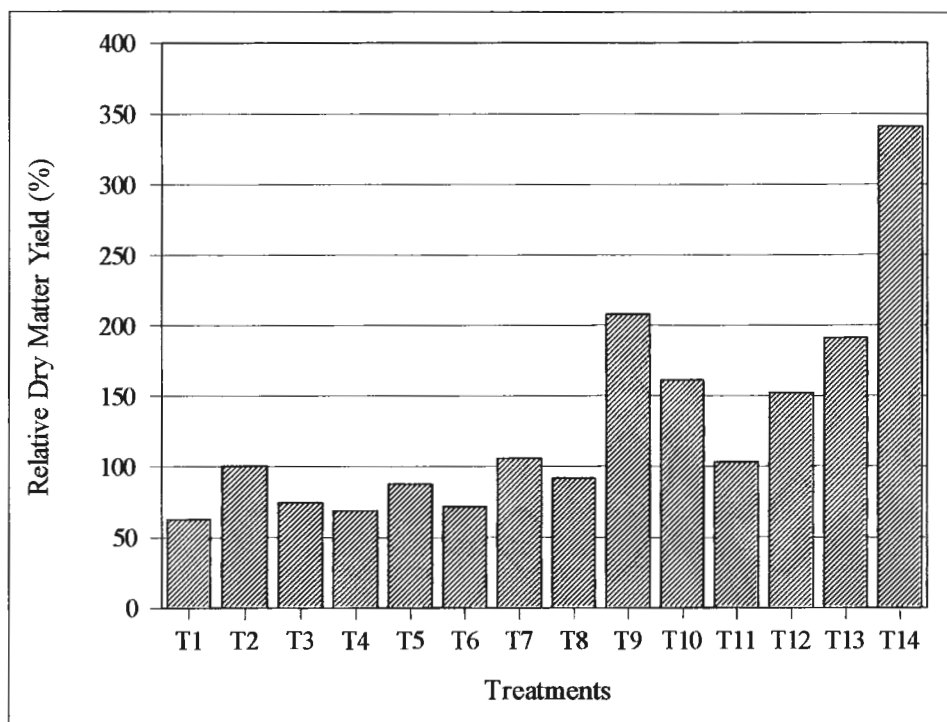


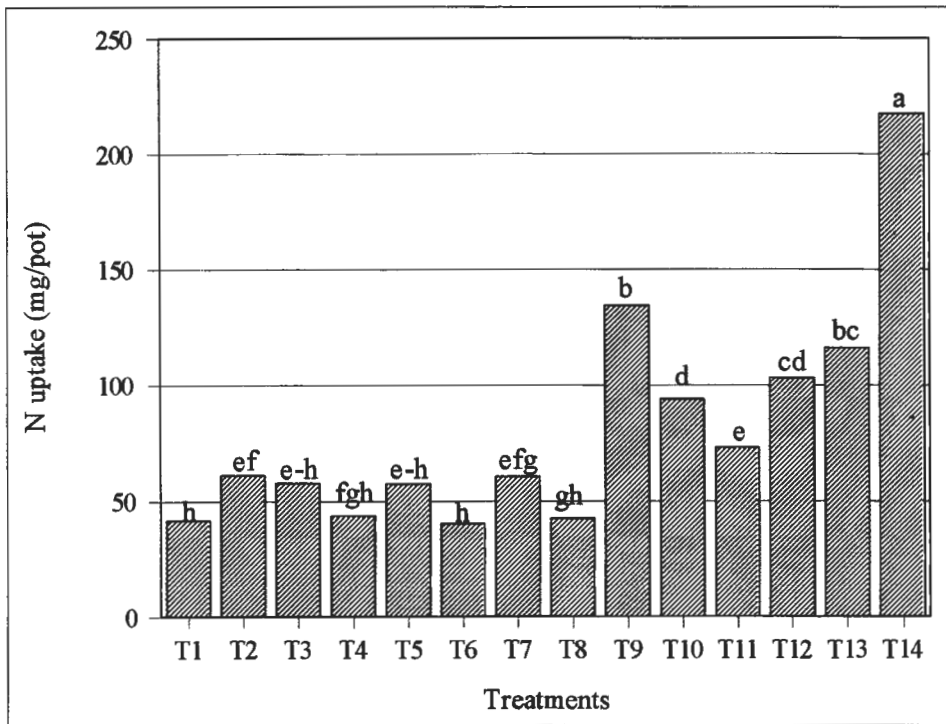
Figure 2: Residual effect of N K S and organo top fertilisation on dry matter yield of sweet corn (relative to T<sub>2</sub>)

Table 1: Residual effect of N K S and organo top fertilisation on tissue nutrient Concentration of sweet corn

Treatments	N (%)	P (%)	K (%)	Mg (%)
T <sub>1</sub>	0.85 bcd	0.54 a	0.76 cde	0.35 ab
T <sub>2</sub>	0.78 def	0.45 bc	1.21 ab	0.23 ef
T <sub>3</sub>	0.99 a	0.51 ab	1.16 b	0.28 b-e
T <sub>4</sub>	0.81 c-f	0.47 ab	0.89 c	0.31 bcd
T <sub>5</sub>	0.85 bcd	0.41 cd	1.30 a	0.25 c-f
T <sub>6</sub>	0.71 f	0.51 ab	1.15 b	0.27 c-f
T <sub>7</sub>	0.73 f	0.38 de	0.79 cd	0.21 f
T <sub>8</sub>	0.59 g	0.46 ab	1.15 b	0.24 def
T <sub>9</sub>	0.83 b-e	0.31 f	0.56 g	0.31 abc
T <sub>10</sub>	0.74 ef	0.33 ef	0.65 efg	0.36 ab
T <sub>11</sub>	0.90 abc	0.40 cd	0.78 cd	0.31 bcd
T <sub>12</sub>	0.87 bcd	0.32 ef	0.63 fg	0.31 a-d
T <sub>13</sub>	0.77 def	0.30 fg	0.71 def	0.38 a
T <sub>14</sub>	0.92 ab	0.24 g	0.74 def	0.25 c-f

(Values within the column followed by the same letter are not significantly different at 0.05 level by Duncan's multiple range test).

est yield in treatment T<sub>14</sub> where highest doses of organo top and ADK have been applied. This resulted in considerable higher concentrations of available N in the rhizosphere. The results are supported by Thakur (1995) who reported increased grain yield of maize with increasing residual N. But Sarkar et al. (1993) did not observe any yield difference in maize followed by wheat fertilised with 0-100 kg N ha<sup>-1</sup>. So far as organic fertilisation is concerned, Mench et al. (1994) reported that yield of corn stalks was numerically less than the control in sludge treated soils but the decrease was not statistically significant.



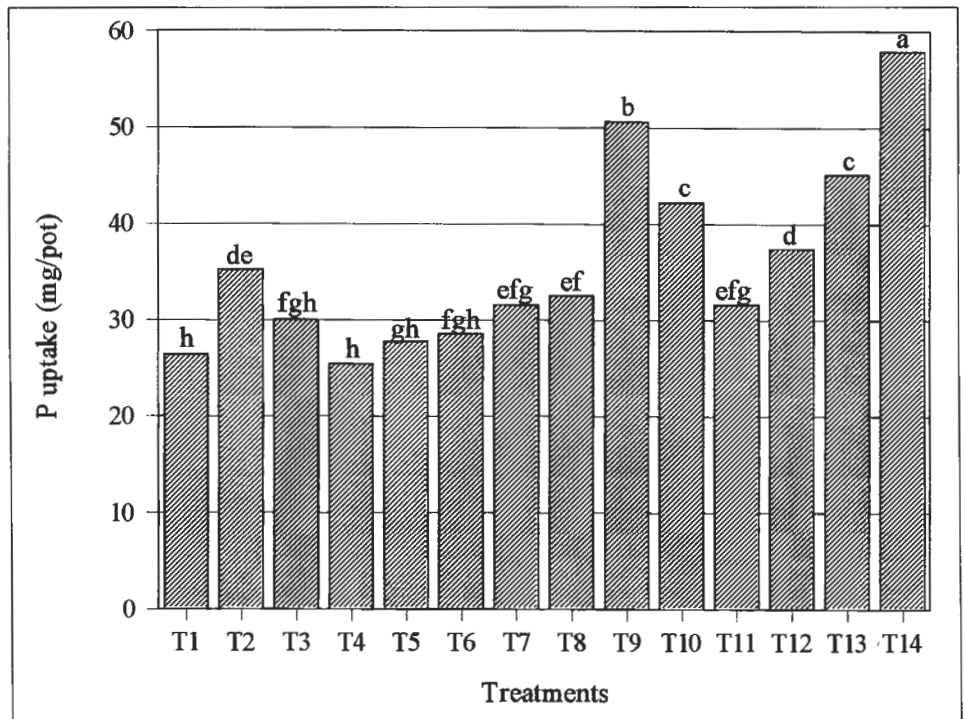
**Figure 3:** Residual effect of N K S and organo top fertilisation on N uptake of sweet corn (values having the same letters are not significantly different at the 0.05 level by Duncan's multiple range test)

organo top fertilisation, the N uptake decreases significantly with decreasing organo top levels which is due to corresponding decrease in yield levels due to reduced rates of fertilisation. Highest uptake value is being observed in treatment T<sub>14</sub> which is a result of both higher N concentration and yield. The N uptake of organo top related treatments (T<sub>9</sub>-T<sub>14</sub>) is significantly higher in comparison to control or mineral fertiliser treatments irrespective of their levels (T<sub>2</sub>-T<sub>8</sub>). Comparatively higher yields under organo top fertilisation are preliminarily responsible for this phenomenon.

### 3.2 Nutrient Concentration and Uptake

The P content of corn was significantly lower in full dose and moderate levels of K and S treatments in comparison to control. This is due to dilution effect as the yield under these treatments was significantly higher than control. The P content of organo top related treatments was significantly lower in comparison to miner-

The tissue concentration of N P K and Mg has been presented in table 1. It is evident from the data that the N content of corn is not highly influenced by either kind of fertilisation in comparison to control. Under mineral fertilisation, the N content is significantly lower under the influence of low doses of N K and S in comparison to moderate levels. The N uptake (figure 3) in full dose treatment T<sub>2</sub> is significantly higher in comparison to control. This is attributed to significantly higher yields, as N concentration of tissue does not differ significantly. The N uptake in moderate levels of N K S is statistically at par with full dose treatment (T<sub>2</sub>) but at lower levels the uptake is significantly lower than T<sub>2</sub> and at par with their moderate level and control as well. In case of



**Figure 4:** Residual effect of N K S and organo top fertilisation on P uptake of sweet corn (values having the same letters are not significantly different at the 0.05 level by Duncan's multiple range test)

al treatments barring few exceptions. Yield was related to the P content in the corn tissue and lowest P concentrations were observed at maximum yield (T<sub>14</sub>). So far as P uptake (figure 4) is concerned, it is significantly lower in N and K related treatments (T<sub>3</sub>-T<sub>6</sub>) in comparison to full dose treatment (T<sub>2</sub>) which is statistically at par with S treatments (T<sub>7</sub> and T<sub>8</sub>). The P uptake in organo top (T<sub>9</sub>-T<sub>14</sub>) treatments was significantly higher in comparison to mineral treatments (T<sub>2</sub>-T<sub>8</sub>) and control due to higher yields.

The K content of corn was highly influenced by mineral fertilisation. There existed a significant increase in K content of all treatments in comparison to control except T<sub>4</sub> and T<sub>7</sub>. On the other hand, organo top fertilisation absolutely did not bring any improvement over control. So far as K uptake (figure 5) is concerned, it is significantly higher in all mineral and organo top treatments in comparison to control except T<sub>4</sub>. Highest uptake values were observed in treatment T<sub>14</sub> probably caused by highest yield.

The Mg concentration values in control were significantly higher than other mineral fertiliser treatments except T<sub>3</sub> and T<sub>4</sub>, whereas in case of organo top treatments values were significantly closer to control. So far as uptake (figure 6) of Mg is concerned, all the mineral fertiliser treatments are statistically at par with control whereas the uptake in organo top treatments (T<sub>9</sub>-T<sub>14</sub>) was significantly higher in comparison to control and all other mineral fertiliser treatments. Results of Sakr et al. (1992) suggest that when maize was grown after wheat, tissue N P and K concentration were found to increase in waste treatments alone or in combination with

urea but K concentration of maize was decreased by the residual effect of urea only. Total nutrient uptakes were found highest in organic treatments.

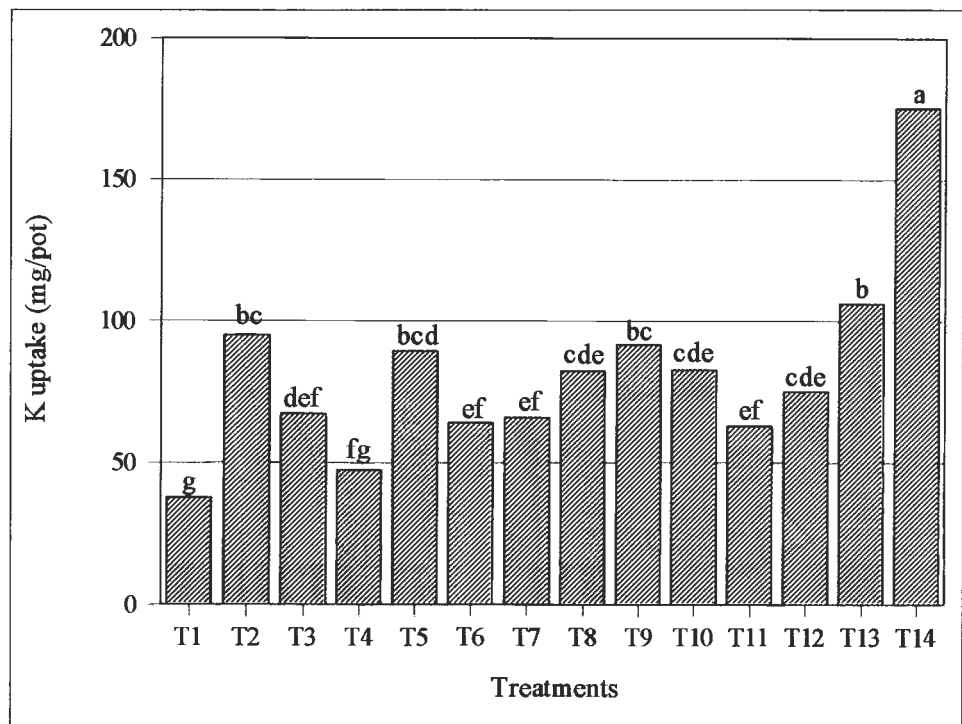


Figure 5: Residual effect of N K S and organo top fertilisation on K uptake of sweet corn (values having the same letters are not significantly different at the 0.05 level by Duncan's multiple range test)

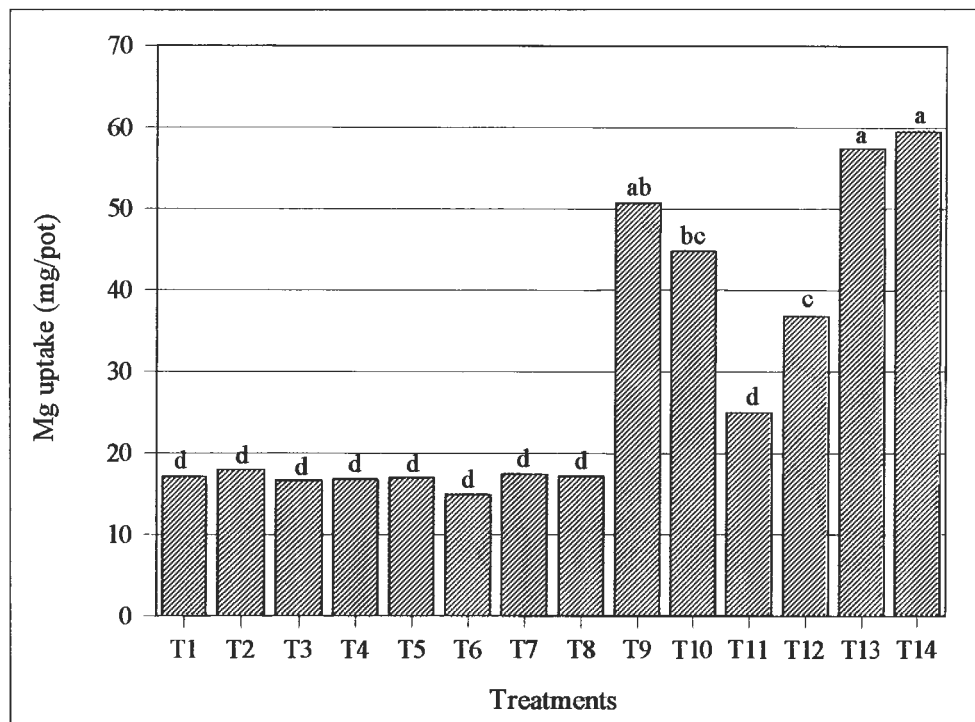


Figure 6: Residual effect of N K S and organo top fertilisation on Mg uptake of sweet corn (values having the same letters are not significantly different at the 0.05 level by Duncan's multiple range test)

### 3.3 Nutrient Use Efficiency

The nutrient use efficiency was defined as total uptake of nutrient divided by total biomass. The data pertaining to use efficiencies of N P K and Mg nutrients (total uptake of the nutrient divided by total biomass) are presented in table 2. The nitrogen use efficiency (NUE) of the corn grown on full dose treatment did not vary statistically in comparison to control. But under low levels of K (T<sub>6</sub>) and moderate and low levels of S (T<sub>7</sub> and T<sub>8</sub>), the NUE was significantly higher in comparison to control. Comparing full dose treatment (T<sub>2</sub>) with organo top related treatments, it was observed that all these treatments were statistically at par with full dose treatment but significant reduction existed at T<sub>14</sub>. This is due to higher amounts of N available in the growth medium.

In case of phosphorus use efficiency (PUE) it is observed that there was no significant change in use efficiency by corn in mineral treatments in comparison to control except in treatments T<sub>4</sub> and T<sub>7</sub> where it was significantly higher than control. It may also be noted that PUE in moderate and low levels of N K and S (T<sub>3</sub>-T<sub>8</sub>) did not differ significantly in comparison to full dose treatments (T<sub>2</sub>). On the other hand PUE in organo top related treatments (T<sub>9</sub>-T<sub>14</sub>) was significantly higher than all mineral treatments as well as control except a few odds.

The K use efficiency (KUE) in unfertilised corn plants (control) was significantly higher in comparison to other mineral treatments except T<sub>3</sub> and T<sub>7</sub>, which were statistically at par with control. The data also indicate that KUE in organo top related treatments (T<sub>9</sub>-T<sub>14</sub>) was significantly higher than all the mineral fertiliser treatments except T<sub>3</sub> and T<sub>7</sub>.

The Mg use efficiency (MgUE) in the mineral fertiliser treatments (except moderate and low level of N) was significantly higher in comparison to control. It is also noted that no significant difference existed among the mineral fertiliser treatments. So far as MgUE in organo top treated soil is concerned, significant improvement was observed only in treatment T<sub>14</sub> in comparison to control and all other organo top treatments were statistically at par.

Table 2: Residual effect of N K S and organo top fertilisation on nutrient use efficiencies by sweet corn

Treatments	NUE	PUE	KUE	SUE
T <sub>1</sub>	118.22 efg	187.26 f	131.34 cd	291.48 ef
T <sub>2</sub>	128.30 b-f	223.10 def	82.43 e	442.12 ab
T <sub>3</sub>	100.83 h	194.37 f	86.58 e	356.26 b-e
T <sub>4</sub>	125.14 c-g	213.02 ef	116.52 d	329.29 def
T <sub>5</sub>	118.55 d-g	246.57 de	77.43 e	405.01 a-d
T <sub>6</sub>	144.48 b	197.82 f	87.26 e	379.10 bcd
T <sub>7</sub>	138.38 bc	262.83 cd	125.96 cd	475.65 a
T <sub>8</sub>	169.02 a	221.42 def	86.95 e	419.99 abc
T <sub>9</sub>	120.51 d-g	322.19 b	181.51 a	341.52 c-f
T <sub>10</sub>	135.14 bcd	299.79 bc	156.46 b	285.66 ef
T <sub>11</sub>	112.24 fgh	254.09 de	128.92 cd	325.71 def
T <sub>12</sub>	115.52 e-h	319.09 b	159.05 b	325.51 def
T <sub>13</sub>	129.10 b-e	332.24 b	141.16 bc	265.87 f
T <sub>14</sub>	109.42 gh	409.47 a	139.16 bc	416.75 abc

(Values within the column followed by the same letter are not significantly different at 0.05 level by Duncan's multiple range test).

### Summary and Conclusion

The land application of the sewage sludge to agricultural land is done on the pretext that it provides sound alternative to the problem of waste disposal and sustains soil fertility for longer period of times due to their organic nature. The sludges are a potentially valuable resource of essential macro and micronutrients to the plants and may also serve as natural soil conditioner due to its high content of organic matter. It has been widely reported that sewage sludge application to agricultural land increases crop production. In order to assess the residual effect of purified waste material (organo top) on crop performance, a green house experiment was conducted on sweet corn following sorghum. The beneficial effects of organo top are strongly evident by large yield increases in plants grown on organo top amended soils as compared to the control and mineral fertilised soil. Higher corn yields were obtained when higher proportions of organo top were blended with mineral fertiliser. While N and Mg concentration of corn tissue remained unaffected under the influence of organo top in comparison to mineral fertilisation, the concentration of P and K were relatively higher under organo top related treatments. The uptake of N P K and Mg elements was relatively greater under the auspices of organo top than mineral fertilisation, so was for P and K use efficiencies while N and Mg use efficiencies remained more or less unaffected.

## **Einfluss von intensiven und extensiven Nährstoff-Systemen auf Bodenmerkmale und Ertragsparameter von Zuckermais:**

### **II. Ertragsparameter und Nährstoffe**

Die Entsorgung von Klärschlämmen auf landwirtschaftlichen Flächen setzt neben einer Unbedenklichkeit hinsichtlich der Kontamination mit organischen und anorganischen Schadstoffen eine langfristige Erhaltung der Bodenfruchtbarkeit voraus. Aufgrund des hohen Gehaltes an organischer Substanz sowie des Gehaltes an essentiellen Haupt- und Spurennährstoffen können Klärschlämme eine wertvolle Ressource sein. So ist weitläufig bekannt, daß Klärschlammapplikationen die Ertragsleistung steigern können. In einem Gewächshausversuch wurde der Einfluß von konditioniertem Klärschlamm auf die Ertragsleistung von Körnermais als Folgefrucht von Hirse untersucht. Der Ertrag der mit Organo Top behandelten Varianten lag signifikant über dem der Kontrolle und mineralisch gedüngten Varianten. Die Kornerträge lagen in den organisch-mineralischen Varianten am höchsten. Unterschiede im N und Mg-Gehalt im Maiskorn waren zwischen den organisch und mineralisch gedüngten Varianten nicht signifikant, während die P und K-Gehalte in den Organo Top behandelten Gefäßen niedriger lagen. Die Nährstoffaufnahme (N, P, K und Mg) war in den organisch gedüngten Varianten relativ höher, wobei jedoch nur bei P und K auch eine höhere Nährstoffeffizienz festgestellt werden konnte.

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