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Influence of Sesbania Rostrata on Soil Properties and Yield of Onion

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Abstract- The study was carried out in Government Seed farm Vavuniya from June 2012 to September 2012 by Random Completely Block Design (RCBD) with nine treatments and three replicates to study the role of *Sebania rostrata* in relation to soil properties and to evaluate the suitability of Sesbania and inorganic fertilizers on the yield of onion. The green manure (*Sesbania rostrata* and *Crotalaria juncea* (sunhemp)) were incorporated into the soil before 14 days of planting by manually. Onion bulb(Vethalam variety) was planted fourteen days after incorporation of organic material with spacing of 10 cm x 10 cm in a plot size of 1m x 1m. The treatments' T2 – T9 plots were fertilized with urea, *Sesbania rostrata* and sunhemp and it's combinations at the equivalent of 6.21g total N per m^2 (Department Recommendation). Plants were irrigated once in 4 days as farmer practiced. The soil samples were collected for analysis after harvesting to measure the pH, EC, CEC, organic matter content, No3- N and NH4 – N. Total yield per plot were collected. Statistical analysis was carried out using SAS package (version 9.0) and mean separation was done by Dunkan's mean separation. Incorporation of green manure significantly increased soil organic matter content and CEC. Combination of Sesbania and inorganic fertilizer and sunhemp & inorganic fertilizer ensure same yield as inorganic fertilizer along. But sunhemp does not withstand water logging condition and also produce nitrogen lesser than sesbania. Hence incorporation of sesbania as green manure with inorganic fertilizer is good alternative methods to improve soil fertility and obtain good yield. Nitrate leaching to below root zone can be reduced by combination of organic and inorganic N fertilization. This study revealed that the application of inorganic N fertilizer combined with green manure of *Sesbania rostrata* and *Crotalaria juncea* is a viable alternative method to reduce nitrate pollution in ground water and obtain more or less same yield as inorganic fertilizer along. *Sesbania rostrata* can be cultivated in any types of field but *Crotalaria juncea* is not suitable for water logging field.

Index Terms- Sesbania rostrata, soil properties, green manure, inorganic fertilizer

I. INTRODUCTION

Nitrate contamination of ground water has become a serious problem in northern part of Sri Lanka where intensified agriculture is being practiced (Nagarajah et al., 1988). Incorporation of *Sesbania rostrata* is the one ways to improve soil properties and minimize nitrate leachate in soil. My previous leaching column study showed Nitrate losses were less in green manure(Sesbania, Sunhemp & Gliricidia) added soil than inorganic fertilized (urea) soil. The field study could be carried out to confirm the finding to implement the findings in farmers field. *Sesbania rostrata* is a green manure crop, which has nodules both on the stem and root. A green matter yield of 15 to 20 t/ha equivalent to 150-180 kg N/ha is obtained within a period of 8 to 10 weeks. *Sesbania rostrata* is producing nearly double amount of nitrogen per hectare compare to *Crotalaria juncea*. Therefore incorporation of *Sesbania rostrata* is important to improve soil properties and reduce nitrate losses and reduce the cost for inorganic fertilizer and cultivation. Hence, the use of *Sesbania rostrata* is both economically and environmentally friendly. The main objectives of the research were to study the role of *Sesbania rostrata* in relation to soil properties and to evaluate the suitability of green manures and inorganic fertilizers on the yield of onion.

II. MATERIALS AND METHODS

The study was carried out in Government Seed Farm production unit Vavuniya from June 2012 to September 2012 by Random Completely Block Design (RCBD) with nine treatments and three replicates. The green manure *(Sesbania rostrata* and *Crotalaria juncea*) were incorporated into the soil before 14 days of planting by manually (Figure 1.0). Onion bulb(Vethalam variety) was planted fourteen days after incorporation of green manure with spacing of 10 cm x 10 cm in a plot size of 1m x 1m. The treatments' T2 – T9 plots were fertilized with urea, *Sesbania rostrata* and *Crotalaria juncea* and it's combinations at the equivalent of 6.21g total N per m^2 ((Recommendation for onion crop by the Department of Agriculture, Sri Lanka). Plants were irrigated once in 4 days as farmer practiced. The treatments of field experiment were T_1 No N fertilizer application, T2 Urea 50%N (31.5 kg N/ha) T_3 Urea 100%N (62 kgN/ha) T4 Urea 150% N (93.5 kg/N) T5 Urea 50%N + *Ssbania rostrata* 50%N (62 kgN/ha) T6 Urea 50%N + *Crotalaria juncea* 50%N (62 kgN/ha) T7 Urea 50%N + *Sesbania rostrata 25 %N* + *Crotalaria juncea* 25%N(62 kgN/ha) T8 Urea 25%N + *Sesbania rostrata 75%N*(62 kgN/ha) and T9 Urea25%N + *Crotalaria juncea 75 % N* (62 kgN/ha).

After 60 days onion was harvested in the net rows and measured total bulb yield. The soil samples were collected for analysis after harvesting to measure the pH, EC, CEC, organic matter content, No3- N and NH4 – N. NO_3-N in soil was determined by sodium salicylate method, NH4 – N was determined by Indophenols blue method and Organic matter content by the dichromate digestion Walkley & Black method,

(Dharmakeerthi *et al*., 2007). CEC of soil was determined by ionic replacement with 1M neutral ammonium acetate, followed by distillation and titration (Chapman, 1965)**.** pH and EC were determined by pH meter and electric conductivity meter respectively. Statistical analysis was carried out using SAS package (version 9.0) and mean separation was done by Dunkan's mean separation.

III. RESULT AND DISCUSSION

General characteristics of soil

The soil of the experimental site was classified as Reddish Brown Earth. Texture of the soil was sandy clay loam with low nitrogen and organic matter content (Table 1.0).

Properties of soil after incoporation of green manure

pH of soil varied from 7.3 to 7.9 and soil showed slightly alkaline nature and pH of green manure added soil was lesser than inorganic fertilizer alone (Table 2.0) . Incorporation of green manure reduced soil pH (Sangakkara, et. al 2006). Organic matter content of soil varied from 0.83 to 1.70. and incorporation of *Sesbania rostrata* and *Crotalaria juncea* significantly (P <0.001) increased soil organic mater content (Table 3.2). Soil organic matter is important to increase nutrient retain capacity and reduce leaching loss. Organic matter permits better aeration, enhances the absorption and release of nutrients, and makes the soil less susceptible to leaching and erosion (Sekhon and Meelu, 1994). CEC of soil varied from 24.2 to 32.8 and incorporation of *Sesbania rostrata* and *Crotalaria juncea* significantly (P < 0.0001) increased soil CEC. CEC of soil also important soil properties to increase nutrient capacity of soil and reduce nutrient loss from soil. Inclusion of organic matter is of primary importance in maintaining soil fertility, productivity and sustainability (Dick & Gregorich 2004). Incorporation of *Sesbania rostrata* and *Crotalaria juncea* with in organic fertilizer significantly increased NH4- N and No3 - N retention ability in top soil after onion cultivation than inorganic fertilizer alone. Hence it reduce the nutrient losses by leaching.

Yield of Onion under incorporation of Sesbania rostrata and Crotalaria juncea

Red onion yields of the treatments ranged from 24.7 to 27.9 t/ha (Figure 2.0) and those were higher than the average yield obtained by the farmers of the study area. The control showed a significantly (P<0.001) lower yield compared to the treatments. Yields of inorganic and combination of green manure and inorganic fertilized plots did not show any significant differences (Table 3.0). These results showed that the combined use of green manure and inorganic fertilizer is an effective soil N management strategy that can ensure high yields. Amujoyegbe et. al, (2007) reported that the use of combination of organic and inorganic fertilizer could increase crop yield and reduce the high cost of fertilizer to subsistence farmers in Nigeria. Combination of Sesbania and inorganic fertilizer and sunhemp & inorganic fertilizer ensured same yield as inorganic fertilizer along. But sunhemp does not withstand water logging condition and also produce nitrogen lesser than sesbania. Hence incorporation of sesbania as green manure with inorganic fertilizer is good alternative methods to improve soil fertility and obtain good yield. Use of green manure has the potential to increase maize yield in Limpopo province, South Africa (Jude 2011)

Nitrate Nitrogen in below root zone under *Sesbania rostrata* and *Crotalaria juncea* incorporation

Nitrate nitrogen content at 15-30 cm soil layer after harvesting of onion was significantly (P<0.0001)high in recommended inorganic N added plots and combination of inorganic N and green manure added plots than control(No N fertilizer application). Hence application of fertilizer increased nitrate nitrogen to the bottom layer (below root zone). But Nitrate nitrogen in below root zone was high in inorganic fertilizer application along than combination of inorganic N and green manure added plots. Highest amount of nitrate nitrogen was observed in T4 where highest amount of inorganic N (1 ½ Urea) added plot (Table 4.0). In thavashikulam area farmers apply fertilizer higher than recommended level of fertilizer. Hence excess amount of fertilizer cause ground water pollution(Loganathan 2011). Nitrate leaching from agricultural field is function of fertilizer rate (Bawatharani et. al, 2004). This study showed that nitrate leaching to below root zone can be reduced by combination of organic and inorganic N fertilization.

IV. CONCLUSION

This study revealed that the application of inorganic N fertilizer combined with green manure of *Sesbania rostrata* and *Crotalaria juncea* is a viable alternative method to reduce nitrate pollution in ground water and obtain more or less same yield as inorganic fertilizer along. *Sesbania rostrata* can be cultivated in any types of field but *Crotalaria juncea* is not suitable for water logging field.

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Sesbania green manure is added to field

Incorporation of Sesbania green manure

Onion bulb is in field

Onion crop is in field 3 WAP

Figure 01 Cultivation of onion under green manure application

Table 1.0 General characteristic of soil

Soil property	Content
pH	7.2
EC (ms)	1.1
bulk density(gm^{-3})	1.55
CEC	24.3
Organic matter %	0.88
Total N%	0.11
Soil texture	sandy clay loam
Sand%	70.48
Clay%	21.52
Slit%	8.0

Table 2.0 Chemical properties of soil after harvesting of onion

Treatments	pH	Organic matter %	CEC C mol	NO3- -N (ppm)	NH4+ - N (ppb)
T_1 No N fertilizer application	7.7abc	0.83d	24.2d	0.90c	325d
T2 Urea 50%N	7.8a	1.03d	24.8cd	1.11bc	442dc
T_3 Urea 100 %N	7.8ab	1.17bcd	25.8c	1.09bc	464dc
T4 Urea 150%N	7.9a	1.13cd	25.6c	1.12bc	564bc
T5 Urea 50%N+ *Sesbania rostrata 50%N*	7.5bcd	1.53abc	32a	1.28ab	748ab
T6 Urea 50%N and *Crotalaria juncea 50%N*	7.6abcd	1.67a	32.8a	1.33ab	739ab
T7 Urea50%N + *Sesbania rostrata 25%N*+ *Crotalaria juncea 25%N*	7.3d	1.70a	32.3a	1.43a	767a
T8 urea 25%N + *Sesbania rostrata 75%N*	7.5bcd	1.57ab	30.4b	1.37ab	671ab
T9 Urea 25%N+ *Crotalaria juncea 75%N*	7.4cd	1.63a	31.5ab	1.31ab	683ab

Note : Means with the same letters are not significantly

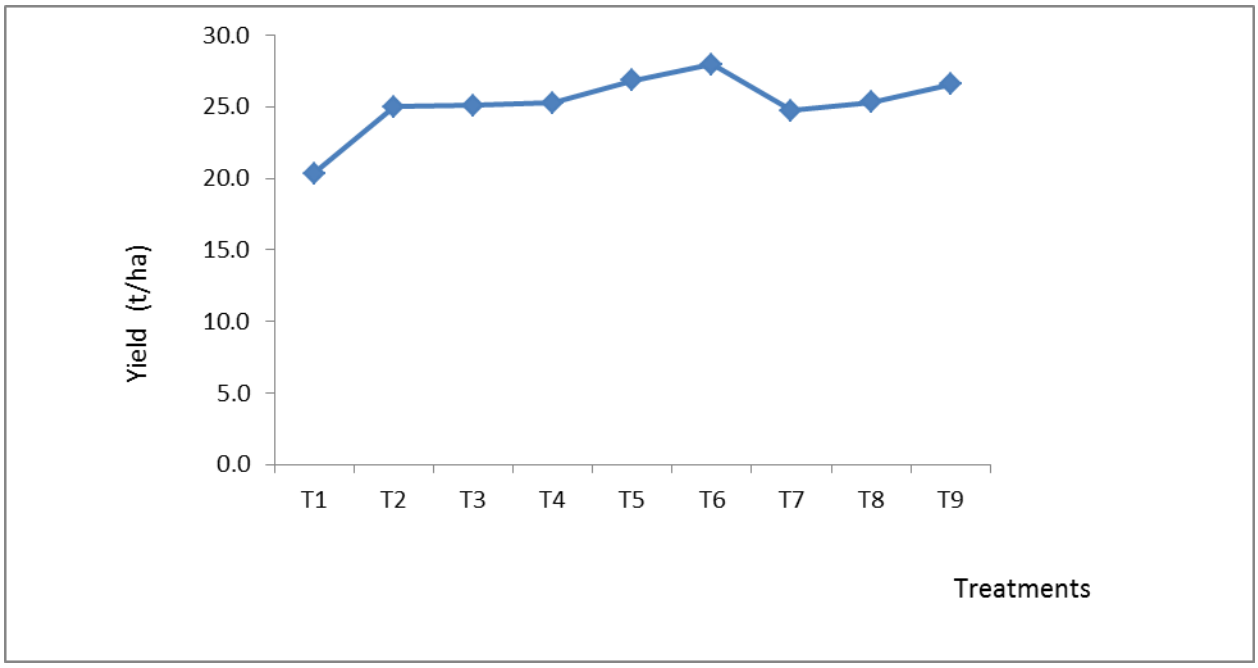

Figure 2.0 Onion Yield under green manure application

Table 3.0 Onion yield under different treatments

Treatments	Yield (t/ha)
T_1 No N fertilizer application	20.3c
T2 Urea 50%N	25.0b
T_3 Urea 100 %N	25.1b
T4 Urea 150%N	25.2ab
T5 Urea 50%N+ *Sesbania rostrata 50%N*	26.8ab
T6 Urea 50%N and *Crotalaria juncea 50%N*	27.9a
T7 Urea50%N + *Sesbania rostrata 25%N+ Crotalaria juncea 25%N*	24.7b
T8 urea 25%N + *Sesbania rostrata 75%N*	25.3ab
T9 Urea 25%N+ *Crotalaria juncea 75%N*	26.5ab

Note : Means with the same letters are not significantly different.

Table 4.0 Nitrate nitrogen in below root zone

Treatments	NO3- -N (ppm)
T_1 No N fertilizer application	0.82^{c}
T2 Urea 50%N	1.29^{ab}
T_3 Urea 100 %N	1.34^{ab}
T4 Urea 150%N	1.43^{a}
T5 Urea 50%N+ *Sesbania rostrata 50%N*	1.26^{b}
T6 Urea 50%N and *Crotalaria juncea 50%N*	1.26^{b}
T7 Urea50%N + *Sesbania rostrata 25%N+ Crotalaria juncea 25%N*	1.22^{b}
T8 urea 25%N + *Sesbania rostrata 75%N*	1.17^{b}
T9 Urea 25%N+ *Crotalaria juncea 75%N*	1.29^{ab}

Note : Means with the same letters are not significantly different.