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Final report

Evaluation of Nitrogen Fertilization for Tomato Grown Under Greenhouse Using Different Organic Manure Sources

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Executive Summary

Most of the farmers in the Jordan Valley do not use any soil or water analysis to design their fertigation planning. They usually depend on their own experience or fertigation programs developed by private companies suggesting an important efficiency lost.

A demo plot in NCARE research station of Deir Allah was conducted to study a new alternative of fertilization planning based on NO_3 soil and sap analysis. Nitrachek tester was used to determine fertilization application for tomato grown under green house according to weekly NO_3 sap analysis. In addition, soil NO_3 content was recorded in four Organic Matter (O.M.) treatments: chicken, sheep, mixed (chicken and sheep), and control without O.M. to study their contribution in NO_3 mineralization.

If the Nitrachek allowed a good monitoring of sap and soil content, the fertigation procedure using tomato sap analysis should be reviewed to fit to the particular condition of the Jordan Valley (long cycle of production, short day…). Compared to other fertigation methodology, using soil and sap test to design the fertigation application allow 69 % of fertilization saving. The final yields were lower than the expected yield obtained in Europe using the same fertilization technique (around 9t/0.5du). The production from the demo plot varied among the O.M. treatments but without statistical differences between them (ANOVA 0.05). The chicken gave the highest yield with 7.63 tones while the mixture sheep and the control gave respectively 6.75 6.12 and 5.27 tones/du. The over whole miss-management of the demo plot might affected negatively the results. Similar experimentation should be repeated next season to get more accurate data.

Introduction

Fertilization practices in the Jordan Valley mostly rely on inherent technical knowledge and private company extension services (report GTZ and IRWA). Usually neither soil nor water contents are taken into consideration by farmers in their fertilization planning resulting in over use of fertilizers. In addition, if the use of O.M. is a common practice, little information is available on its contribution in NO_3 mineralization.

IrWa technical team implemented one demo plot in Jordan Valley aiming to develop new planning for optimizing fertilization practices of farmer and to test the effect of different types of manure.

Using Nitrachek tester, nitrate level in tomato sap and in soil extraction was measured weekly. Fertigation was program according to NO_3 sap content and following APREL advises.

Plant analysis data

Nitratest is a non-laboratory and semi-quantitative nitrate sap tests that enable farmers to assess the actual nitrogen status of the crop and facilitate decisions on N rate/timing directly in the field. Those tests are linked to a decision grids indicating the fertilization depending on the N values (PILazo method). References are already available for certain crops (melons, eggplant, carrots…) but not for tomato. The

nitracheck tester provides direct field measurements for the nitrate in the soil, sap, and water so that the fertilization judgment can be done easily.

Nitrachek tester is an instrument for the optical evaluation of the colour scale of nitrate test strips. It is widely used to measure:

- Nitrogen in the soil (N-min.)
- Nitrate concentration of the plant / fruit
- Nitrate concentration of the water[1]
- and have an accuracy ±10%

Justification

This study was implemented to develop new alternative for fertilization planning on tomato grown under greenhouse using different types of manure.

General Objective

The main objective of the study is to establish sound fertigation planning taking into account the furniture of the soil and organic matter using Nitrachek tool.

Material and Methods

a. Location
The experiment was conducted from the end of October 2007 till the mid of May 2008 in NCARE - Deir Allah Research Station located in the Central Jordan Valley, at latitude of 32^{o} N, 35^{o}:30 East-longitude with an elevation of 224 meters below the sea level.

b. Soil analysis
Soil analysis was performed in NCARE laboratories before planting. The soil is calcareous with silty-clay texture setting the layout of the experiment and the results was:

Figure 1: Soil Analysis Before Planting[2]

	Tests			
	Organic Matter	P	K	NO_3
	1.7%	41 ppm	789 ppm	70 kg/ha
Comments	quite good organic	Excessive P level	Very high to Excessive	Well furnished[3]

[1] http://www.stepsystems.de/Start_en.html
[2] GTZ Fertilization Guidelines 2006
[3] Test Performed with NITRACHEK

Excessive P level might lead to Zn deficiency, and Potassium (789 ppm); Very high to Excessive soluble K might lead to Ca, Mg deficiency.

c. Experimentation layout.
The following treatments were performed in a Randomly Completely Design (RCD) with five replications:

- T1: Tomato plot treated with sheep manure
- T2: Tomato plot treated with Chicken manure
- T3: Tomato plot treated with (1:1) sheep: chicken manure
- T4: Tomato plot without manure (control treatment).

Eight hundred tomato transplants (CV. Galia) were planted in one greenhouse during end of October (25th Oct. 2007); distributed into five planting rows at distance of 1 m between rows and 0.40 m between plants. Each treatment had its own drip irrigation line (space between emitter 40 cm, with discharge rate 4.0 L/hr).

d. Fertilization planning
The fertilization was done according to the nitrachek sap readings. The following threshold was applied based on APREL recommendation, and the source of Nitrogen was taken from compound fertilizers and varied depending on crop stage

Figure 2 : Nitrate Threshold According to the Tomato Growth Stage

Stage of Growth in Weeks	1 – 4	5 – 10	10 – end of the season
Threshold (ppm)	4500	4500 – 2500	2500 – 500
Fertilizer Used	30 – 10 – 10	16 – 8 – 32	12 – 12 – 44
Amount of Fertilizer (kg)	3	5	4

e. Data collection
The harvest was done twice a week for seven weeks. Tomatoes were harvested from twelve plants selected randomly in each (i.e. forty eight plants per treatment) before being classified into Class A fruits and Class B (figure 3).

Figure3: Qualitative Classification of Produced Tomato

	Class A	Class B
Shape	Round, free from cracks, spots and infections	Round, free from major cracks and spots
Size	Above 45 mm in diameter	Below 40 mm in diameter
Color	Uniform in color and 3/4 of the fruit is red	Uniform in color and 3/4 of the fruit is red

The soil and sap analysis were performed weekly using NITRACHEK tool.

f. Problems encountered

Despite that IrWa project employed one labor full time the following problems were faced:

- The very poor irrigation management resulted in water stress during fruiting period that affect severely fruit size and quality.
- No proper filtration system were used until February resulting in dripper clogging and clear lost of irrigation water efficiency.
- Pest and disease miss management was one of the main agronomical constrains; (Powdery Mildew, Early and Late plight, and White Fly) affected the production.
- Un-controlled and late pruning affected the plant development.

Also, the following results should be taken with care [4] and the experimentation should be repeated next year to get more accurate data.

[4] All these problems were summated to NCARE DG who committed to repeat the experimentation next season.

Results and Discussion

a. Fertilization

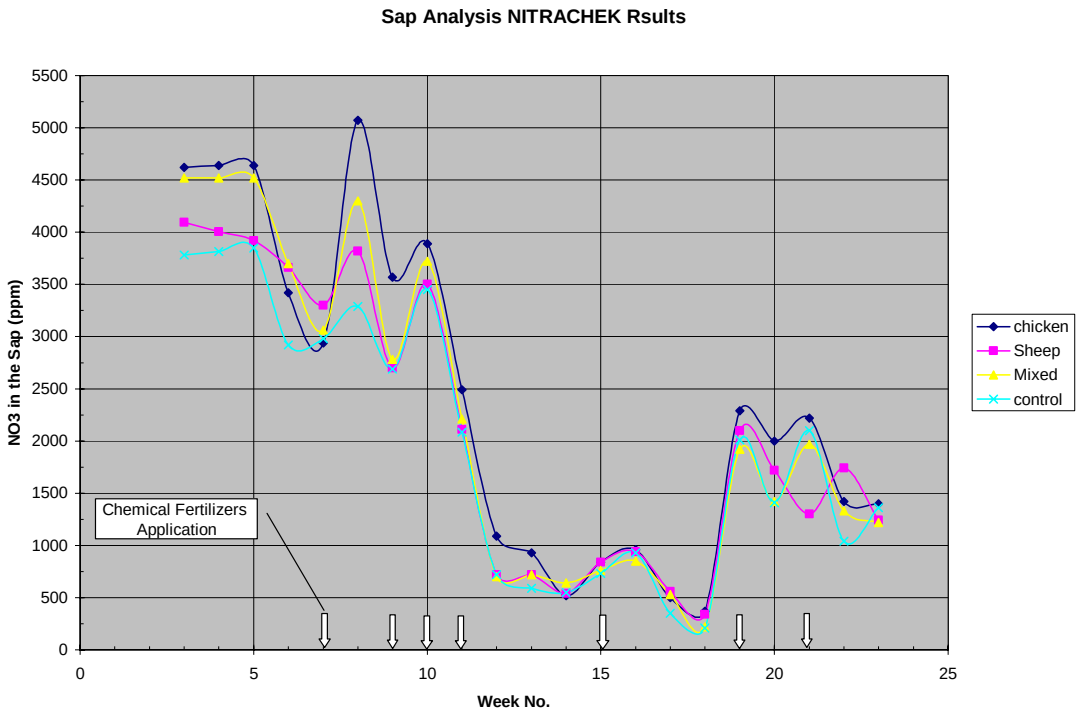

Figure 4: Sap Analysis with the Time of Fertilizer Application

The fluctuation in the sap NO3 content depends on plant uptake. From the first to the fifth week the soil NO3 content was enough to sustain plant uptake (enough level of NO3 in the sap). After the seventh week an application of 30 – 10 – 10 was required. Starting from the tenth week the cold weather reduced drastically the plant uptake. Although chemical fertilization was applied (the 10^{th} and 11^{th} weeks) no changes in NO3 sap content were noticed. On the contrary, the application done the 15^{th} week – during an amelioration of the climatic condition – increased plant NO3 content. Also the 2 previous applications might have been deleted or postponed to be effective.

The following table show the fertilizers applied along the season with their quantities:

Figure 5: Chemical Fertilizers Applied Along the Season

No.	Date	Fertilizer Type/Name	Total quantity applied / GH	N	P	K
1	5/11	H_3PO_4	150 mL	0.00	0.09	0.00
2	5/12	H_3PO_4	150 mL	0.00	0.09	0.00
		30 - 10 -10	3	0.90	0.30	0.30
3	17/12	16 – 8 - 32	5 kg	0.80	0.40	1.60
4	2/1	16 – 8 - 32	5 kg	0.80	0.40	1.60
5	28/1	16 – 8 - 32	5 kg	0.80	0.40	1.60
6	4/2	Ammounim Nitrate	5 L	1.68	0.00	0.00
7	19/2	16 – 8 - 32	3 kg	0.48	0.24	0.96
8	26/2	12 – 12 - 44	3kg	0.36	0.36	1.32
9	4/3	12 – 12 - 44	1 kg	0.12	0.12	0.44
		Gaint	175 mL	0.00	0.08	0.10
10	27/3	12 – 12 - 44	4 kg	0.48	0.48	1.76
			Total (kg)	6.46	2.96	9.68

Additional sprayings were performed for micro elements using: Micronate, Iron (Chelating compounds), Calcium (Ca) and Magnesium (Mg) (Cal-Mag).

The total nitrogen, phosphor and potassium applied was around 6.5 kg, 3 kg and 10 kg respectively. According to rule of thumb developed by of the GTZ[5], each tone of product requires: 10kg of ammoniac, 2kg of urea phosphate and 4 kg of potassium nitrate. When interpolated with the yield reached from the demo plot (7 T), the use of nitrachek allowed a reduction of 69% for N, 54% for P and 11% for K.

[5] Manual for Fertigation Training, Themes and Principles of Different Posters

b. Impact of fertilization and O.M on soil content

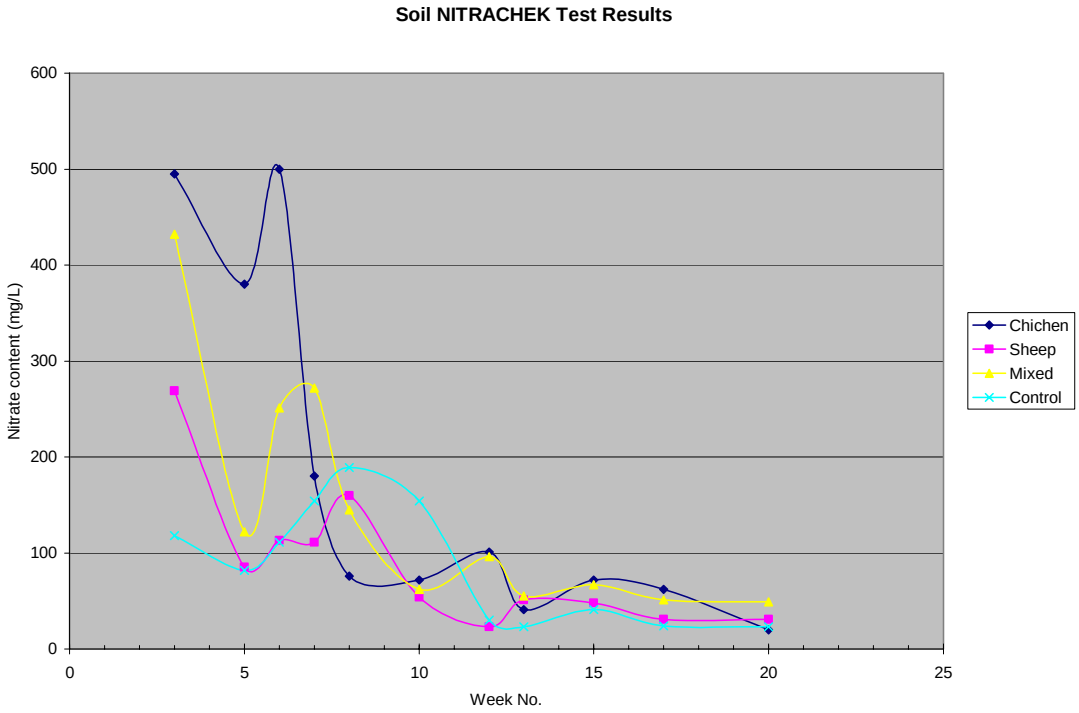

Figure 6: Soil NITRACHEK Results

In the beginning stage (0 to 5 weeks) the NO_3 mineralization from the chicken manure was the highest followed by mixed and sheep treatments. In the case of chicken and mixed OM we can think that most of the NO_3 from the mineralization is not used as the plant is at the beginning of its growing stage (important leaching).

During the mid stage the contribution from the different OM is decreasing (maybe due to the decrease of temperature). In the end stage all the treatments showed nearly the same trend of mineralization and NO_3 levels.

c. Yield analysis

Despite that the chicken treatment gave the highest production no significant differences was found between the treatments (figures 7 and 8)

Figure 7: Production from Treatments (kg/plant)

	Control	Chicken	Sheep	Mixed
Class A	1.77	3.17	2.42	2.74
Class B	1.53	1.59	1.4	1.48
Total	3.29	4.77	3.82	4.22

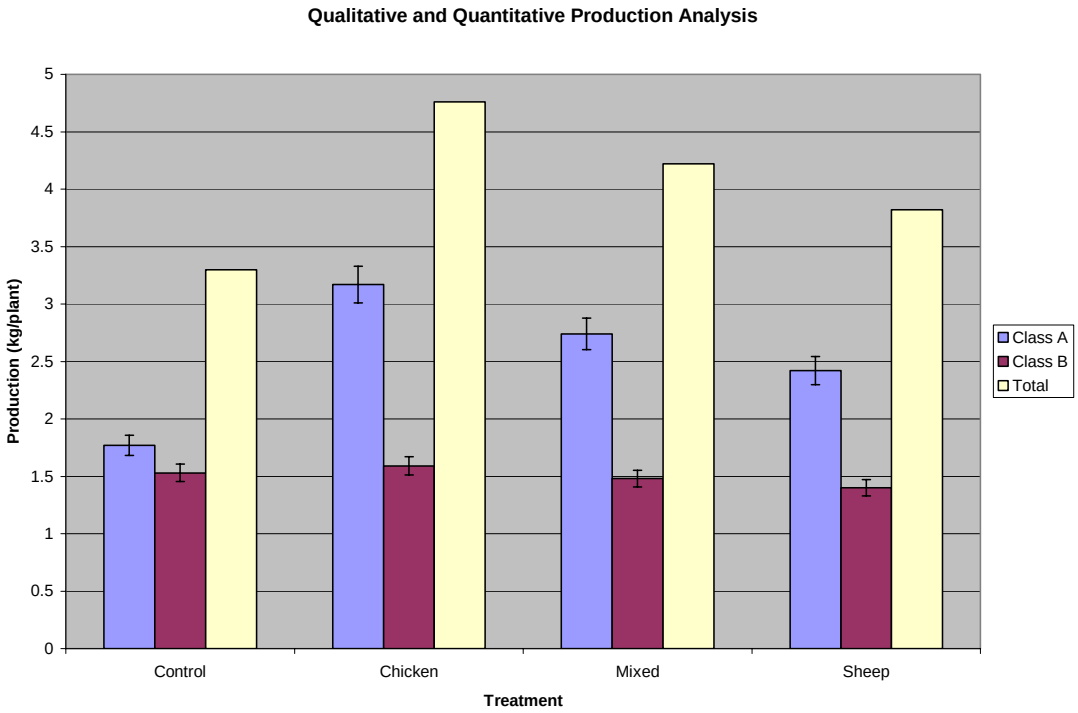

Figure 8: Production Analysis for the Different Treatments (no statistical significant differences were found applying an ANOVA 0.05%).

The production from the demo plot was calculated based on a planting density of 800 transplants per greenhouse (i.e. 1600 transplants per du) while the common density in the Jordan Valley is 2400 transplants per du (Figure 9).

Figure 9: Actual and Expected Production Based on the Growing Density

Treatment	Production (tons/du) 1600 plant/ du	Production (tones/du) 2400 plant/du
Control	5.27	7.89
Chicken	7.63	11.44
Sheep	6.11	9.17
Mixed	6.74	10.12

Conclusions and Recommendations:

- Nitrachek can help farmer in fertilization planning and can reduce the amount of fertilizers used along the season. Even so, other experimentations should be performed to check the validity of this tool in Jordan's environment.
- The organic manure has a positive impact on both the quality and quantity of the product.
- The chicken manure has very high mineralization rate in the beginning of the season but it is more than the plant needs, we can think that the excess NO3 will be leached, so the used of mixed manure chicken and others can provide better results
- Potassium and Phosphor were found in very high concentrations in the soil. Next implementation of the experiment should depend on the soil tests and use single fertilizers instead of the compound ones used in this season.
- As cold weather affect the plant uptake fertilization is not efficient when there is important drop in temperature. So that a further study on the plant uptake during the cold temperature is required.