HYDROPONICS- SUPERIOR IN BOTH QUALITATIVE AND QUANTITATIVE TERMS OVER TRADITIONAL FARMING

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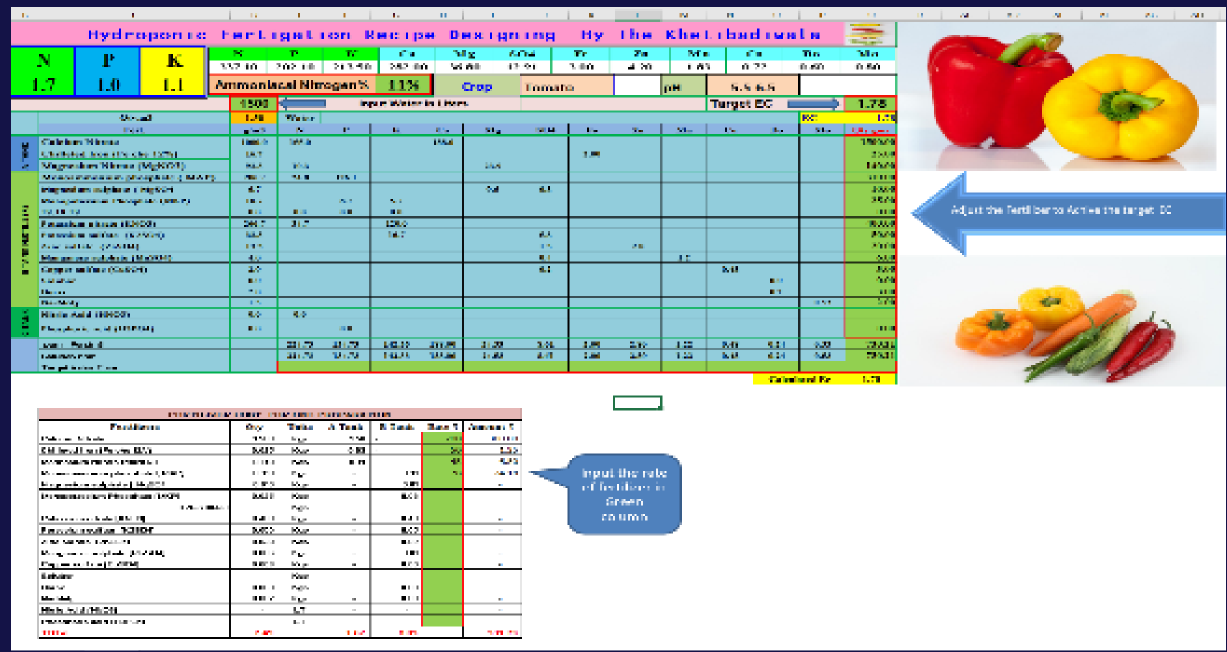
Indian agriculture is evolving into two segments; one is the traditional farming focusing on the production of grain and urban farming focusing mainly on growing green vegetables. Though the share of urban farming is quite small, the days are not far when this segment will create an impact in the farming sector. The entry of educated and professional farmers into urban farming is an indication of the bright future of urban hi-tech farming. Hydroponic farming is one of the possible options for meeting the need for urban green vegetables. Expansion of hydroponic farming will bring benefits like reducing pressure on land, ensuring efficient resource utilization and ensuring a supply of healthy and nutritive agricultural produce.

The term "hydroponics" is derived from two Greek words, i.e., hydro means water and ponos means labour. It is a method of growing plants in water containing essential plant nutrients. The principal advantage is the saving of labour by automating watering and fertilising. The earliest reference to growing plants without soil is in 1627 in the book "A Natural History" by Francis Bacon. Inspired by his work, many scientists experimented with growing plants in water culture. Most notably, in 1699, when John Woodward published his water culture experiments with spearmint. He found that plants grew better in less pure water sources than in distilled water. The work of Julius von Sachs and Wilhelm Knop from 1859 to 1875 resulted in the development of the technique of soilless cultivation. They took advantage of the list of nine elements compiled in 1842, which were found to be essential for plant growth and development. Interestingly, the list grew to 16 elements (and currently 17), which are now termed essential. And this was made possible by employing the technique of hydroponics for plant physiological studies. William Frederick Gericke of the University of California in 1937 introduced the term hydroponics, proposed to him by W. A. Satchell for water culture. In 1938, a classic Bulletin on 'The Water Culture Method for Growing Plants without Soil' was published by Claude B. Hutchison, Denis Robert Hoagland, and Daniel Israel Arnon of the University of California. The research that followed improved the hydroponic techniques that were suitable for commercial production of crops.

The hydroponics technique involves caring for roots that grow in water and for shoots that grow above ground. Historically,

all studies have been devoted to root care. The water in which the roots grew was enriched with essential plant nutrients such as N, P, K, Ca, Mg, S, and micronutrients. Several nutrient solution formulations with varying ratios of essential mineral elements have been developed over the years by Hoagland and Arnon (1938), Hewitt (1966), Cooper (1979), and Steiner (1984). Crop nutrient management works as the heart of a hydroponic growing system. Efficient growers, in a hydroponic growing system, are those who efficiently manage the crop nutrition. Those who manage efficient crop nutrition always succeed in getting qualitative and quantitative superiority over other growers. Efficient crop-nutrient management helps in resolving around 80% of the challenges the grower faces in growing crops.

FERTILIZER MANAGEMENT USING RECIPE SHEET:



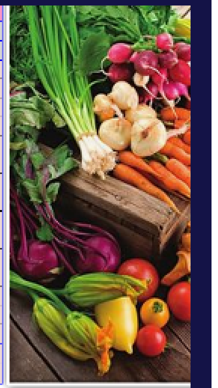
Fertilizer management is the key to ensuring the success of any hydroponic venture. To facilitate the grower, a user-friendly fertilizer recipe designing sheet has been developed. This sheet was developed based on our experience in hydroponic growing. The sheet is a formula-driven sheet and any grower can use it with little knowledge. The cells of the sheet having the formula are protected with a password, so the chances of disturbing the formula should be limited. The growers are allowed to make changes only in the cells where the value needs to be filled.

DESIGNING FERTILIZER RECIPE

Nutrient Supply working

Fertilizer Source	Supplied Nutrients												Quantity	
	N	P	K	Ca	Mg	SO4	Fe	Zn	Mn	Cu	Bo	Mo	Gm/Day	Gm/weeks
itrate	232.50			282.00									1500	10500
Iron (Fe che 12%)							3.00						25	175
n Nitrate (MgNO3)	15.40				35.84								140	980
onium phosphate (MAP)	37.20	189.10											310	2170
n sulphate (MgSO4)					0.96	1.20							10	70
sium Phosphate (MKP)		13.00	8.50										25	175
	0.00	0.00	0.00										0	0
nitrate (KNO3)	52.00		180.00										400	2800
sulfate (K2SO4)			25.00			8.75							50	350
e (ZnSO4)						2.00		4.20					20	140
sulphate (MnSO4)						0.60			1.83				6	42
fate (CuSO4)						0.36				0.72			3	21
											0.00		0	0
											0.60		3	21
												0.80	2	
(HNO3)	**337.10**	**202.10**	**213.50**	**282.00**	**36.80**	**12.91**	**3.00**	**4.20**	**1.83**	**0.72**	**0.60**	**0.80**		
acid (H3PO4)	2359.7	1414.7	1494.5	1974	257.6	90.37	21	29.4	12.81	5.04	4.2	5.6		

N	P	K	Ca	Mg	SO4	Fe	Zn	Mn	Cu	Bo	Mo
337.10	202.10	213.50	282.00	36.80	12.91	3.00	4.20	1.83	0.72	0.60	0.80



In a hydroponic growing system, EC and pH are at the heart of crop nutrition. Nutrient solution pH is the most crucial aspect in ensuring absorption of nutrients by the plant roots. Any deviation in pH value will have a negative impact on the rate of nutrient absorption. Those growers who know efficient management of nutrition in hydroponics are capable of growing good crops. Every crop type or stage of crop requires a different nutrient concentration and ratio. While designing the fertilizer recipe, the grower needs to know the stage of the crop and the nutritional requirements of the crop stage. In long-duration crops, the grower needs to design the fertilizer recipe as per the crop growth stage. However, for short-duration leafy vegetables, the grower can use a single fertilizer recipe for the complete crop duration. While designing the fertilizer recipe, the grower needs to consider the climatic conditions and the project location too.

The fertilizer recipe needs to be project, crop and crop stage specific. There is no scope of copy and paste method of fertilizer recipe designing in hydroponic growing system. In hydroponic growing system, the most critical challenge is to design fertilizer recipe. Considering that, a simple formula driven excel sheet is developed as a tool to design your own fertilizer recipe. The fertiliser recipe designing tool is a user-friendly tool and can be used with limited knowledge. The user needs to provide information like water quantity, targeted EC and targeted crop, etc. This information could be used as input in the fertiliser recipe designing sheet. After filling in this information, the user needs to adjust the fertiliser quantity to achieve the targeted EC and nutrient ratio. The user needs to generate information around the targeted EC or PPM from the secondary platforms. He could use this information while standardizing the fertiliser recipe in their pilot project. As the sheet is formula-driven and password-protected, the user has the freedom to adjust the fertiliser quantity to reach the targeted fertiliser recipe.

RIGHT SOURCES OF NITROGEN FERTILIZER:

Calcium Nitrate: Total Nitrogen 15.5% (Ammoniacal 1.1% & 14.4% Nitrate)
18:18:18: Total Nitrogen 18% (Ammoniacal 8.2% & 9.8% Nitrate)
Potassium Nitrate: Total Nitrogen 13% (100% as Nitrate)
Mono-Ammonium Phosphate: Total Nitrogen 12% (100% as Ammoniacal form)

STEPS OF DESIGNING FERTILIZERS RECIPE

The user needs to follow some steps to use this fertilizer recipe designing tool. These steps are:
Step - I: Generate the information on targeted crops around the recommended EC, pH and ppm
Step - II: Study about the water quality used for the irrigation
Step - III: Finalize the quantity of water used per day
Step - IV: Finalize the targeted EC
Step V: Start the fertilizer quantity calibration to achieve the targeted EC
Step VI: Study the nutrient ratio as per the crop requirement
Step VII: Test the recipe and calibrate (if required)
Step VIII: Finalize the recipe for commercial use
By following these steps, the growers will be able to develop an ideal fertilizer recipe for their crop and project.

FACTS ON THE USE OF NITROGEN FERTILIZERS

Understanding the existing facts about nitrogenous fertilizer is required before using them in a Hydroponic growing system. Before finalizing the sources of nitrogen fertilizer, the grower needs to understand following facts:

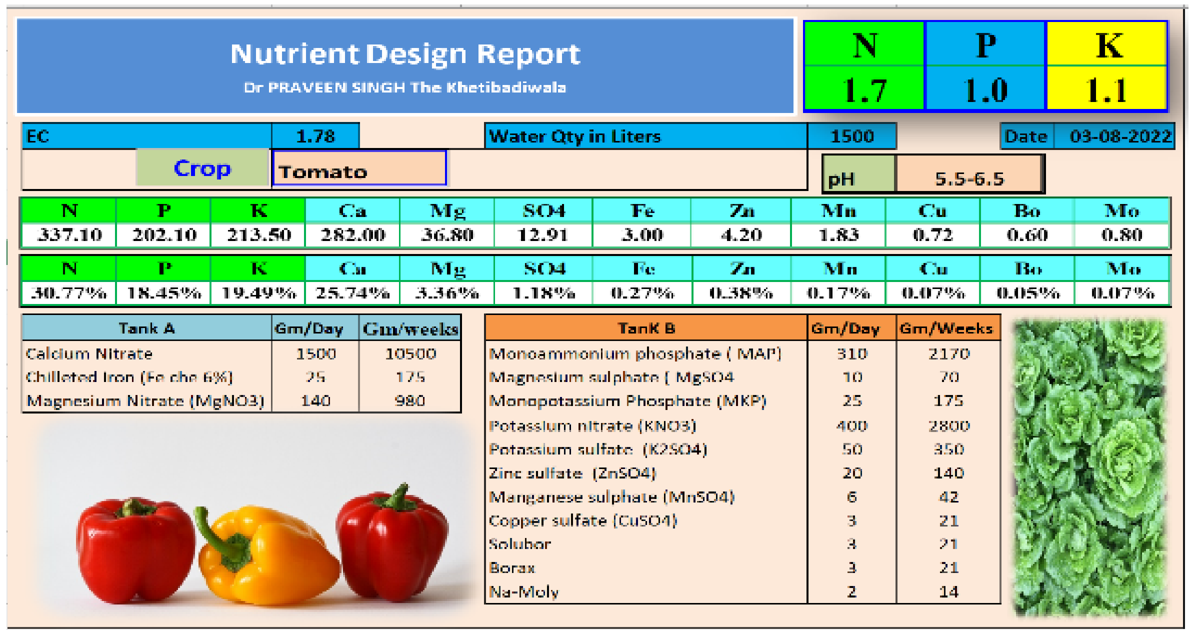
It is not advisable to use urea and DAP in a hydroponic growing system because the nitrogen source in this fertiliser is an amide. Hence, the grower needs to identify the right source of nitrogenous fertiliser before initiating the process of designing fertiliser recipes.

19:19:19 fertiliser grade is one of the most commonly used water-soluble fertilisers in hi-tech farming. But this grade is not recommended for hydroponics systems because in this fertiliser too, the source of nitrogen is a combination of urea and nitrate. And urea is not a suitable fertiliser for hydroponic growing systems. The criteria for selecting the right source of nitrogenous fertiliser are:

1. Use the optimal ratio of nitrate and ammoniacal sources of fertilizer, which should be in the range of 90:10 in favour of nitrate fertilizer
2. Never use urea-based fertilizer
3. Only use nitrogen fertiliser that is water-soluble.

FERTILIZER RECIPE CALIBRATION

Plant nutrient deficiency is one of the most used tools to calibrate the fertilizer recipe. So, it is required to understand the plant nutrient deficiency symptoms.



Nutrient Design Report

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N	P	K
1.7	1.0	1.1

EC	1.78	Water Qty in Liters	1500	Date	03-08-2022
Crop	Tomato	pH	5.5-6.5		

N	P	K	Ca	Mg	SO4	Fe	Zn	Mn	Cu	Bo	Mo
337.10	202.10	213.50	282.00	36.80	12.91	3.00	4.20	1.83	0.72	0.60	0.80

N	P	K	Ca	Mg	SO4	Fe	Zn	Mn	Cu	Bo	Mo
30.77%	18.45%	19.49%	25.74%	3.36%	1.18%	0.27%	0.38%	0.17%	0.07%	0.05%	0.07%

Tank A	Gm/Day	Gm/weeks
Calcium Nitrate	1500	10500
Chilleted Iron (Fe che 6%)	25	175
Magnesium Nitrate (MgNO3)	140	980

TanK B	Gm/Day	Gm/Weeks
Monoammonium phosphate (MAP)	310	2170
Magnesium sulphate (MgSO4	10	70
Monopotassium Phosphate (MKP)	25	175
Potassium nitrate (KNO3)	400	2800
Potassium sulfate (K2SO4)	50	350
Zinc sulfate (ZnSO4)	20	140
Manganese sulphate (MnSO4)	6	42
Copper sulfate (CuSO4)	3	21
Solubor	3	21
Borax	3	21
Na-Moly	2	14