Applicationof Fuzzy Logic for Evaluating the Influence of Panchagavya on Tomato Yield in Grow Bags

Fuzzy logic for Tomato yeild

[1]A.Sathya
[2]S.Jayalalitha
[1]School of Chemical and Biotechnology
[2]School of Electrical Electronic Engineering
SASTRA University, Thanjavur, India
sathyaalbert@gmail.com

R.Sabitha, R.Swetha T.Brintha
School of Chemical and Biotechnology
SASTRA University
Thanjavur, India

***Abstract*— Application of engineering algorithms for varied branches of applied sciences is reliable. This paper props up the concept of application of fuzzy logic in assessing the influence of 'Panchagavya'- an organic concoction in regulating the tomato yield. As an effort to evaluate the 'real aura' of 'Panchagavya' as a capable nutrient cum immune protective tonic for plants especially to Tomato, 'grow bag' study has been carried out both with seed treatment and foliar spray of Panchagavya on the organically raised tomato plants. The results of above study are used to derive 5 fuzzy logic membership functions by converting the crisp data into fuzzy data and to defuzzify for generating results for Tomato yield. The fuzzy results confirm that Young age, with optimum application of Panchagavya with high disease resistance, high plant height and more no of fruits set is perfect membership combination for optimum output of Tomato yield.**

Keywords—Fuzzy logic; Organic agriculture; Panchagavya; Organic concoction, Disease resistance, Tomato yield

I. INTRODUCTION

Of late, the awareness and bias towards organic food products is virally spreading all over the world. As more and more people demand for 'Pure & Real' organic products, the opportunistic producers and middlemen adulterate with 'False conventional' products to exploit the market's demands. As the 'Organoculture' is not rapid, hasty and immediate, the market supply can't be flooded with a great surge. Hence, additional area is added under organoculture by the motivated farmers with the adoption of diversified organic techniques. Many organic boosters, tonics, decocotions and enrichners are in circulation in the market outlets. But, out of all these, 'Panchagavya' has been the pioneer 'Bio tonic' noted for its effective immunity against pests & diseases in addition to nutrient enrichment to the substrate and plant. Many types of successful organic farming employ the application of 'Panchagavya' as a vital lifeline solution. Hence, it is imperative to verify its effectiveness with scientific study and evaluate its wider scope of application effects using fuzzy logic in Tomato productivity.

II. MATERIALS & METHODS

A. Selection of plant

As Tomato is a versatile consumable vegetable, it is a 'ever in demand' crop with diversified varieties in shape, taste, flavor and nutrient richness. Especially, the traditional varieties of tomato are more preferred for culinary and consumption purposes than the hybrids. For the present study, seeds of one of the native traditional landrace (Open pollinated variety) of Musiri, Trichy district in Cauvery delta region of South India has been used for experimentation..

B. The grow bag technique

The ease in handling, justifiable use of resources such as nutrient & water without loss, precise & uniform application of treatments, regular and clear observation on the parameters, are the deciding factors for using grow bag techniques for experimentation in this study.

C. Method of 'Panchagavya' preparation

'Panchagavya' - is a concoction of 5 bovine by products namely curd, milk, urine, dung and ghee.

a) Ingredients

Fresh cow dung – 2.5 Kg
Cow ghee – 500 gm
Cow urine – 1.5 litre
Cow milk – 1 litre
Cow curd -1 llitre
Tender coconut water – 1.5 litre
Ripened Banana- Six Nos
Jaggery- 250 gm (from palm wine)
Jaggery – 100 gm (From sugarcane)
Yeast -100 gm

b) Jaggery solution preparation:

Add 250 gm of Jaggery made from palm with 1.5 litre of water.

c) Yeast & Jaggery solution preparation:

978-1-5386-0814-2/17/$31.00 ©2017 IEEE

Add 100 gm of yeast & 100 gm of Jaggery (from sugarcane) and dissolve in 1.5 litre of warm water and keep it for 15 minutes.

d) Protocol

The Cow dung and the Ghee have been mixed well in the plastic container. During the entire experiment, the container has been kept in the shade. The two ingredients have been allowed to ferment for three days with intermittent stirring in the morning and in the evening. On the fourth day, the rest of the ingredients (Urine, Milk, Curd, Banana, Coconut water, Jaggery solution and Yeast & Jaggery solution) have been added to the fermented product. The content has been constantly stirred twice a day (morning and evening) & has been allowed to ferment for about 18 days . On the 19th day, the Panchagavya solution is ready and the mouth of the container has been closed with fine cloth to prevent from the fly laying eggs. On the 21st day the Panchagavya is ready and it is used for further experiment.

One litre of the Panchagavya solution is mixed with 10 L of water, and then used for application from 21st day onwards.

D.Panchagavya' treatment design'

Treatment1: Healthy plant without Panchagavya
Treatment2: Infected plant without Panchagavya
Treatment3: Infected plant, Panchagavya sprayed
Treatment4: Healthy plant with Panchagavya
Treatment5: Infected, Panchagavya sprayed before & after
Treatment6: Seed treated, Panchagavya sprayed
Treatment7: Seed treated, no Panchagavya sprayed
Treatment8: Seed treated, infected, Panchagavya sprayed
Treatment9: Seed treated, infected, no Panchagavya sprayed

3 replications with at least 5 plants have been maintained for each replication. Panchagavya treatment has been given as 'seed treatment' and as 'foliar spray' in 10 days interval both for healthy as well as infected plants as listed in the above treatment design. The plants in treatments 2, 3 and 5 have been infected with 'Tobmato Mosaic Virus' by rubbing the infected leaf extracts over the healthy leaves frequently until the disease development. $% foliar spray in Chick pea has been studied by [9]. The bioefficacy of Panchagavya has been reviewed by [10].

E. Parameter of evaluation

In general, for any special treatment, the stage of the plant, the frequency of treatment, nature of treatments, are the key factors. Hence, it is obvious that these parameters need to be carefully decided for observation of effectiveness of the treatment of Panchagavya for 'its acquired immunity / resistance' against pests and diseases, increments in plant height, increase in flower bloom for fruit set [7].

In the present stiudy, as there was 'monkey menace' in the study area, the observation on the ripened fruits was intruded but the rate of fruit set assisted in supplementing the observation for fruit set.

III. Application of Fuzzy logic

One of the major sectors for beneficial application of fuzzy logic is agriculture and the 'OA'- Organic agriculture is more booming at present, its application for organic agriculture is imperative. The core reason for the ease in use of (Fuzzy logic) FL in agriculture is owing to the unpredictable and indecisive precincts. It has been reported in 2010 by [1], according to the literature survey, 14% of FL related report out of 136 are about research findings in food. Beginning with precision mathematics of Aristotle, to Parminides proposal on 'Laws of Excluded Middle' to Heraclitus & Platos' foundation for fuzzy logic adding to the inputs of Hegel, Marx and Engels then gaining strength with Lukasiewicz, fuzzy logic now stands firm on the shoulders of fuzzification and defuzzification [4].

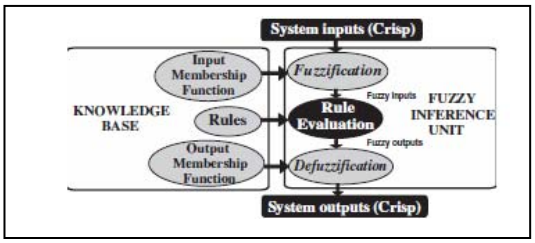


Fig. 1. FL (fuzzy inference system) –Block diagram [6]

Application of fuzzy for controlling soil pH has been reported by [8]. As plant science and food science are the main pillars of agriculture, FL fits to uplift these applied sciences including environmental influence on crop production. A forecast on Wheat productivity influenced by environment has been analysed using FL and has been reported by [2] and [3]. [5] has reported the application of fuzzy systems for quality determination in grading *'Mozafati'* dates. Use of FL in crop prediction and detection has also been reported [4].

A. Input method and variables

Fuzzy inference system has been formulated with 5 input variables and 1 output variable. The interface with following specifications has been used for each input. Each input variable has been assigned with three membership functions. Triangular membership function (trimf) has been used for 5 input variable and one output variable. The fuzzification of membership functions for both input and output variables is presented in table I-VI. The rules framed for defuzzification is presented in table VII.

Type= 'mamdani'
Version=2.0

Input variables used are:

- Age of the plant (No of days)
- Frequency of treatment (No)
- Disease –Incidence (%)

- Shoot height (cm)
- No. of fruits/Fruit numbers (no.)

Output variable – Productivity (kg/plant)

```
[Input1]
Name='Age'
Range=[0 90]
NumMFs=3
MF1='Seedling':'trimf',[0 15 30]
MF2='Intermediate':'trimf',[30 45 60]
MF3='Mature':'trimf',[60 75 90]

[Input2]
Name='Frequency-of-treatment'
Range=[0 9]
NumMFs=3
MF1='Few':'trimf',[0 1.5 3]
MF2='Optimum':'trimf',[3 5 7]
MF3='Effective':'trimf',[6 7.5 9]

[Input3]
Name='Disease-incidence'
Range=[0 90]
NumMFs=3
MF1='Reduction':'trimf',[0 5 10]
MF2='Controlled':'trimf',[10 20 30]
MF3='Uncontrolled':'trimf',[25 60 95]

[Input4]
Name='Shoot-Height'
Range=[0 70]
NumMFs=3
MF1='Short':'trimf',[0 17.5 35]
MF2='Medium':'trimf',[20 40 60]
MF3='Tall':'trimf',[50 60 70]

[Input5]
Name='Fruits-Numbers-Per-Plant'
Range=[0 25]
NumMFs=3
MF1='Low':'trimf',[0 5 10]
MF2='Medium':'trimf',[5 12 20]
MF3='High':'trimf',[15 20 25]

[Output1]
Name='output1'
Range=[0 12]
NumMFs=3
MF1='Low-Productivity':'trimf',[0 2.5 5]
MF2='Conservative-Productivity':'trimf',[4 7 10]
MF3='Optimum-High_Productivity':'trimf',[8 10 12]
```

TABLE I. INPUT PARAMETER DETAILS FOR AGE

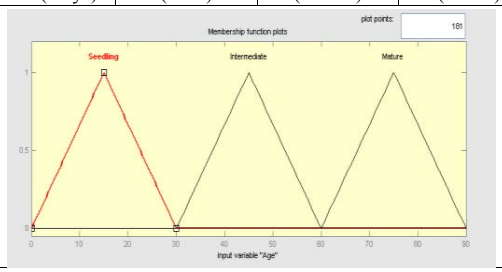
S.No	*Name of the parameter*	*MF1*	*MF2*	*MF3*
1.	Age of the plant (Days)	Seedling (0-30)	Intermediate (30-60\)	Mature (60-90)
				

TABLE II. INPUT PPARAMETER DETAILS FOR FREQUENCY OF TREATMENT

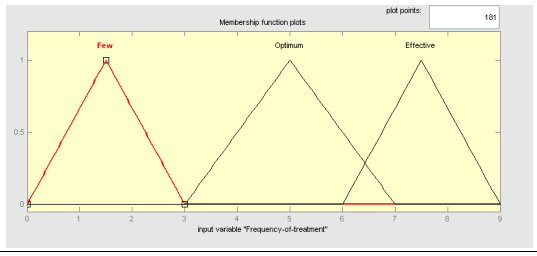
S.No	*Name of the parameter*	*MF1*	*MF2*	*MF3*
1.	Frequency of treatment (no. of times)	Few (0-3)	Optimum (3-7)	Effective (6-9)
				

TABLE III. INPUT PPARAMETER DETAILS FOR DISEASE INCIDENCE

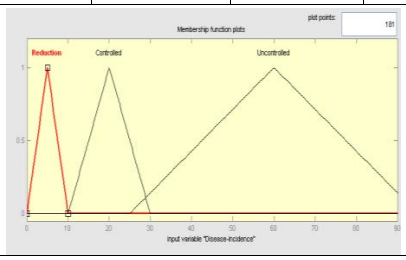
S.No	*Name of the parameter*	*MF1*	*MF2*	*MF3*
1.	Disease incidence (%)	Reduction (0-10)	Controlled (10-30)	Uncontrolled (25-95)
				

TABLE IV. INPUT PARAMETER DETAILS FOR SHOOT HEIGHT

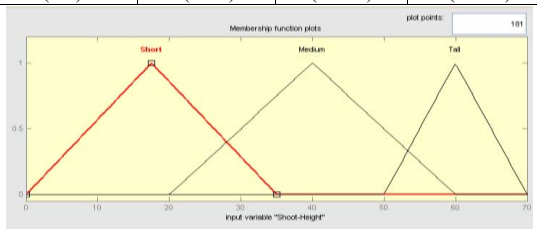
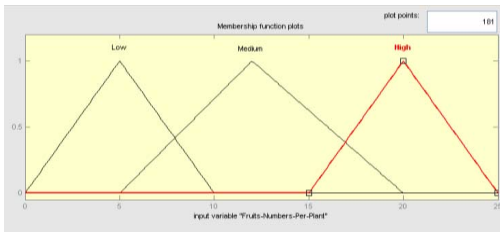
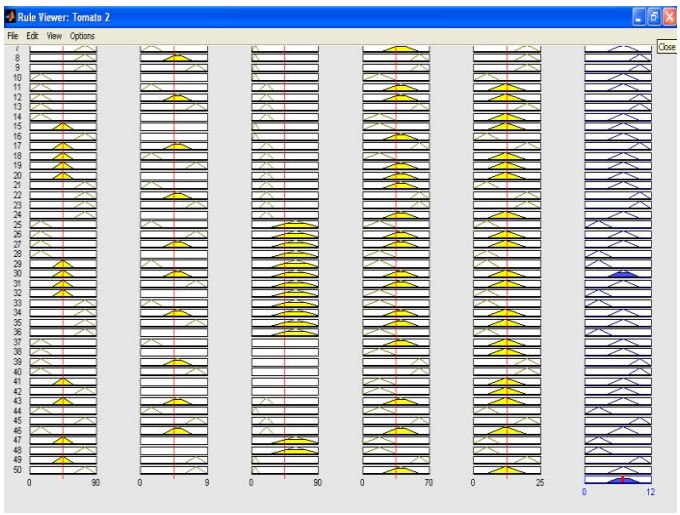
S.No	*Name of the parameter*	*MF1*	*MF2*	*MF3*
1.	Shoot height (cm)	Short (0-35)	Medium (20-60)	Tall (50-70)
				

TABLE V. INPUT PARAMETER DETAILS FOR FRUITS/PLANT

S.No	*Name of the parameter*	*MF1*	*MF2*	*MF3*
1.	Fruits /plant (no)	Low (0-10)	Medium (5-20)	High (15-25)
				

(MF- Membership Function)

TABLE VI. RULES FOR DEFUZZIFICATION WITH END RESULT



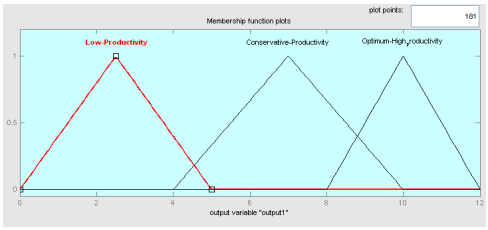
About 243 rules need to be framed for defuzzification. The following are selected rules used in the analysis.

Rule 1: If Age is **'Intermediate'** *and* Frequency of treatment is **'Effective'** *and* Disease incidence is **'Reduction'** and shoot height is **'Tall'** *and* Fruit number per plant is **'High'** *then* the Productivity is **'Optimum-High'**

Rule 2: If Age is **'Intermediate'** *and* Frequency of treatment is **'None'** *and* Disease incidence is **'Uncontrolled'** and shoot height is **'Short'** *and* Fruit number per plant is **'Low'** *then* the Productivity is **'Low'**

Rule 3: If Age is **'Intermediate'** *and* Frequency of treatment is **'Optimum'** *and* Disease incidence is **'Controlled'** and shoot height is **'Medium'** *and* Fruit number per plant is **'Medium'** *then* the Productivity is **'Conservative'**

TABLE VII. OUTPUT PARAMETER DETAILS FOR PRODUCTIVITY

S.No	*Name of the parameter*	*MF1*	*MF2*	*MF3*
1.	Fruits /plant (kg)	Low productivity (0-5)	Conservative productivity (4-10)	Optimum-High productivity (8-12)
				

IV. RESULTS

The results of defuzzification has confirmed to the linguistic variables (knowledge based) and experimental results.

(e.g.) If the plant height is tall and with high fruit numbers per plant then the tomato productivity as per the experimental results is in the range of 8-12 t/acre for which the 3D surface viewer of MATLAB shows 7t/acre which classifies it into 'Conservative productivity' as the influence of disease incidence might be under 'controlled' category (Fig. 2).

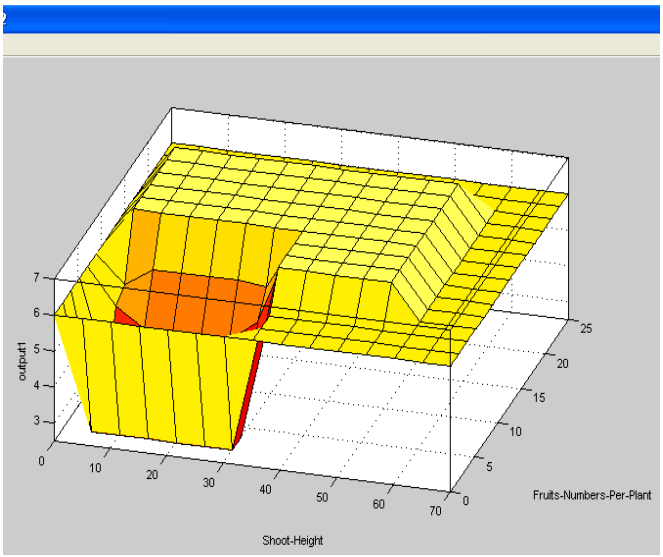


Fig.2.*3D Simulation for Input variables Shoot height and Fruit numbers with the Output variable Productivity (t-tonnes)*

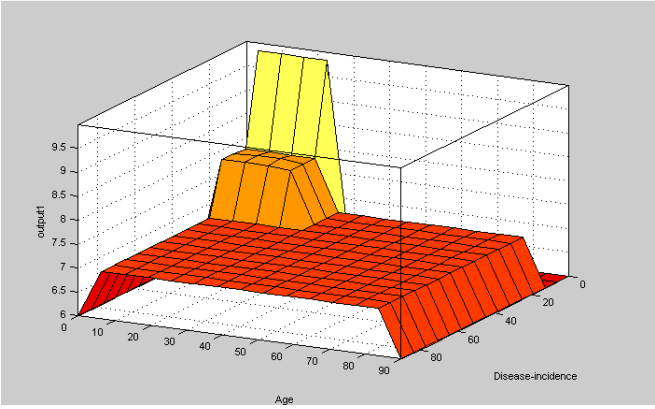


Fig.3.*3D Simulation for Input variables Age and disease incidence with the Output variable Productivity (t-tonnes)*

The above Fig.3 clearly projects that when the disease incidence is low from seedling stage due to Panchagavya application, then the productivity is Optimum- high (< 9t/acre)

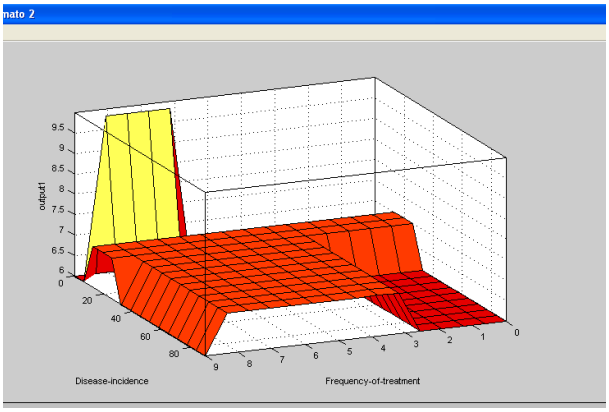


Fig.4.*3D Simulation for Input variables Frequency of treatment and Disease incidence with the Output variable Productivity(t-tonnes)*

The results corroborate well with the positive influence of 'Panchagavya' on Productivity of Tomato. Application of Panchagavya in regular intervals of once in 10 days drastically reduces the disease incidence, increasing the productivity to 9-12 t/acre (Optimum-High).

V. CONCLUSION

The fuzzy logic is applied for evaluating the influence of Panchagavya on Tomato yield. The results have been evaluated and presented, so that the result of fizzy inference system is reliable in making fitting rules for the recorded experimental results. Thus, it is well established that both the field level study and fuzzy logic votes positively for the increase in productivity of Tomato. Moreover, inclusion of other parameters such as nutrient level in the substrate, light intensity, temperature and humidity could picture out & reinforce the exact prediction by making additional fitting rule for preciser tomato yield using Panchagavya as 'Bio tonic' for high bio-efficacy in Tomato yield.

References

[1] Yanbo Huang, Yubin Lan, Steven J. Thomson, Alex Fang, Wesley C. Hoffmann and Ronald E. Lacey, "Development of soft computing and applications in agricultural and biological engineering", *Computers and Electronics in Agriculture*,71:107-127,2010.

[2] N.Javaheri, M.Gomeshi and S.M.Kashefipour, "Use of the fuzzy method for determination of sediment balance and its role on the morphological changes in meandering rivers", *Asian Journal of Scientific Research*, 4: 32-40, 2008.

[3] Narendra Kumar, Sachin Ahuja, Vipin Kumar and Amit Kumar, "Fuzzy time series forecasting of wheat production", *International* Journal on *computer science and Engineering*,2(3) :635-640,2010.

[4] Kartik Ingole , Kavita Katole , Ashwin Shinde and Minal Domke.,"Crop prediction and detection using fuzzy logic in MATLAB", *International Journal of Advances in Engineering and Technology*,6(2):2006-12, 2013

[5] Alavi,N."Quality determination of Mozafati dates using Mamdani Fuzzy inference system", *Journal of the Saudi society of agricultural sciences*,12:137-142, 2013.

[6] R. Mirabbasi, S.M. Mazloumzadeh, M.B. and Rahnama, "Evaluation of irrigation water quality using fuzzy logic", *Research Journal of Environmental Science,* pp 40–352, 2008.
http://dx.doi.org/10.3923/rjes.2008.340.352.

[7] Salem M.alAmri," Improved growth productivity and quality of Tomato 9Solanum lycopersiocum.L.) plants through application of shikkimic acid",*Saudi J.Biol Sci.,*20(4):339-345, *2013*

[8] M.A. Abu, E.M.M. Nasir and C.R. Bala, 'Simulation of the Soil pH Control System Using Fuzzy Logic Method", International Conference on Emerging Trends in Computer and Image Processing (ICETCIP'2014) Dec. 15-16, 2014, Pattaya (Thailand).

[9] Pratik Panchal, PH Patel, AG Patel and Ajit Desai, "Effect of Panchagavya on growth, yield and economics of chickpea (Cicer arietinum)", *International Journal of Chemical Studies,* 5(2): 265-267, 2017.

[10] Sudhanshu Verma, Abhishek Singh, Swati Swayamprabha Pradhan, R.K. Singh and J.P. Singh, "Bio-efficacy of Organic Formulations on Crop Production-A Review", *Int.J.Curr.Microbiol.App.Sci.,* 6(5): 648-665, 2017.