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Efficient and Judicious Usage of Precious Natural Entities for Sustainable Yield Levels in Tomato Crop at Eastern Dry Zone of Karnataka

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Abstract: Site Specific Nutrient Application (SSNA) of Integrated nutrients (T_7) including Recommended Dose of Fertilizers of (250:250:250 kgs) of NPK along with 30 tonnes of Farm Yard Manure (FYM), 3.0 tonnes of Vermicomost, 2.0 kg of Phosphate Solubilising Bacteria (PSB), 5.0 kg Zinc Sulphate ($ZnSo_{4)}$ and 5.00 kg of Boron (Borax 5.00 kg/ha) per hectare as a basal dose with Crop Demand Based Irrigation (CDBI-30 irrigations) under black polythene mulching has recorded the highest mean fruit yield of (**112.50 t/ha**) whereas in the control i.e. farmers practice T_1- (625:625:625 kgs NPK +35 tonnes of Farm Yard Manure + 450 kgs of Pongamia Cake + Every Alternate Day Irrigation i.e. higher frequency of irrigations (60 irrigations) and Non Application of Vermicomost, Micronutrients and Bio Fertilizers per hectare) the mean fruit yield recorded in T_1 was **99.29 t/ha**. The significantly higher fruit yield recorded in T_7 was due to the presence and supply microbial activity and balanced nutrition. In addition, presence of vermicompost alienates soil toxicity and improves soil fertility and promotes soil health. Also, applied micro nutrients and bio fertilizers under mulching could definitely serve the crop demand and helps in the amelioration of the crop deficiencies. The vermicompost and bio fertilizers are mores responsible for soil conversion into porous nature, which in turn enhances the soil moisture retention capacity. That accelerates the supply of all the dissolved plant nutrients at different stages of crop growth. That could be contributed towards the synthesis of more photosynthates in the source and accumulation of these photosynthates in the sink. The fruit yield reduction in farmers practice could be due to the excess application of water under mulch and pongamia cake which contains the flovanoids and uranoflavanoids. During the course of release, these flavanoides and uranoflavanoids may hinder the microbial activity and excess moisture under mulch creates suffocation for roots activity. It will also create the high temperature (>18.0^o C) than the optimum, due to this the solubilising soil microbial population could get affected and timely release and supply of nutrients as per the plant requirement would get insufficient. Also, non application bio fertilizers and required micronutrients will leads to non retention of more fruiting bodies in the plant. Hence, practicing the Site Specific Nutrient Management of both organic & inorganic sources with minimum number of frequencies (30 irrigations) under mulch higher fruit yield in Tomato will be harvested.

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I. INTRODUCTION

Tomato (*Lycopersicon esculentum*) was originated from South American Andes and it was spread to Europe in sometime by 15th century where it was soon become popular and exported all around the world and it was used as a food by the Central and South Americans since pre historic times. Tomato is now world's largest known vegetable crop and known as protective food because of its special nutritive value and its wide spread production. Tomato is one of the most important vegetable crops cultivated for its fleshy fruits. In addition, it is also considered as important commercial and dietary vegetable crop. Botanically it belongs to *Solanacea* family and the scientific name of the tomato is *Lycopersicon esculentum*. Among the vegetables by occupying a prominent place it is being consumed in various forms these including raw as an ingredient in several dishes, sauces, salads and drinks. Its usage was increasing day by day because it is rich in Vitamin A, B.C, It is also rich in folic acid and two important antioxidant namely Lycopene & Beta certain which are having the capacity to fight against the stomach cancer

Tomato Production scenario at Global, National and Regional levels

Tomatoes are one of the world's most consumed vegetable crops. The world production of tomatoes has been consistently increasing over the last decades. It grew more than 54 % from 2000 to 2014 (FAO 2017). At the global level China is the largest producer of tomatoes followed by the United States and India. Other

major players in the tomato market are the European Union and Turkey. Together, these top five tomato producers supply around 70% of the global production. Mexico is the largest exporter of tomatoes in the world followed by Netherlands and Spain (The world Fact book 2017)

In India, the total sown area under Kharief tomato is 80.98 thousand ha in the different in the tomato growing states. Madhya Pradesh has sown highest area i.e.25.44 thousand ha followed by Maharashtra (16.98 thousand ha), Andhra Pradesh (14.87 thousand ha.), Tamil Nadu (10.26 thousand ha.) Rajasthan (8.57 thousand ha.) Haryana (7.7 thousand ha) and Karnataka (5.7 thousand ha).

In Chikkaballapura district the total are under vegetable crops is 13768 ha with the production of 2.53913 MT and the yield is 18.44 MT/ha. In Chintamani taluk the total area under tomato cultivation is 2474 ha with the productivity of 45 t/ha.

Prime objectives of the study:

The study was carried out by achieving the following prime objectives, they are

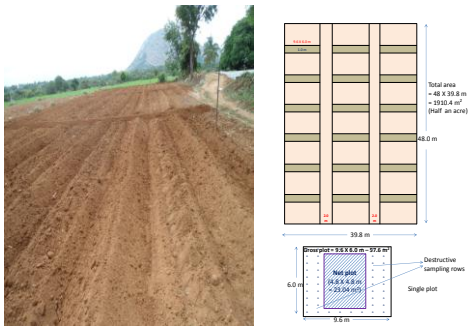
1. To study the actual cultural practices being followed in Tomato cultivation in the study area
2. To experiment the proven technical aspects and comparing the local control practices
3. To demonstrate the recommended package of practices are still more feasible for sustainable higher yields in tomato crop.

II. MATERIAL AND METHODS:

The present study was carried out in the district of Chikkaballapura largest producers of Tomato in Karnataka and ranks first both in area and production (Srinivas et.al. 2014) before conducting the field trail, the pilot field based survey was conducted in that survey out of 147 respondents 79.59 percent respondents responded "Good idea" for the tomato cultivation as a new technology which is partly (RDF) based on the package of practices of tomato cultivation of UAS (B) and also in the combination of both organics, bio inoculants and micronutrients. Initially, the soil samples were collected based on the quadrangle method and the representative soil sample was sent to the Krishi Vignana Kendra Kuruburu Chikkaballapura district and the soil test report indicated that low in organic carbon, Nitrogen, phosphorus, Zinc and Iron and also sulphur. All the required inputs are procured and the material used the field experimentation .

After the collection soil samples the experimental plot was ploughed three times. The above enlisted inputs were procured. Field experiment layout was designed and as per the design the following treatments were imposed.

Experimental layout in three replications



T1: CONTROL ((625:625:625 kgs NPK +35t of FYM+ 450 kgs of PC + EADI + NAVC+NABF &MN)
T2: Farm Yard Manure (FYM) + Recommended Dose of Fertilizer (RDF) + Mulching
T3: Farm Yard Manure (FYM) + Recommended Dose of Fertilizer (RDF) +Vermi-Compost (VC) + Mulching
T4: Farm Yard Manure (FYM) + Recommended Dose of Fertilizer (RDF) +Vermi-Compost (VC) +Micro Nutrient (MN) + Mulching
T5: Farm Yard Manure (FYM) + Mulching
T6: Recommended Dose of Fertilizer (RDF) + Mulching
T7: Farm Yard Manure (FYM) + Recommended Dose of Fertilizer (RDF) +Vermi- Compost (VC) +Micro Nutrient (MN) + Trichoderma (TD) + Mulching.

Imposition of treatments: As per the approval of the Doctoral committee the set of treatments were imposed, the treatment one (T1) control serves as the check, i.e., all the tomato cultivation practices followed in that particular locality has been followed.

Transplanting: Transplanting seedlings were taken up on 6th July2015. At the rate of 5555 plants per acre were planted and it has been taken up in three replications and hence totally 16.665 plants were planted in the experimental plot.

Fig: 1. Transplanting of tomato seedlings:

III. EXPERIMENTAL RESULTS:

The experimental results were presented in the following headings; ***Plant height: (cm)*** The crop (Tomato) growth and development was recorded at the intervals of 30, 60, 90 and 120 days DATP (Days after Transplanting).At 30 DATP It was noticed that the mean plant height was highest (20.66 cm) in the 7th treatment and it was followed by T2 i.e. (20.21 cm) but at 60DATP the height plant height (49.28 cm) was recorded in the control i.e. farmers practice followed by third treatment (48.56 cm). Similarly at 90 DATP the highest plant height was recorded in the seventh treatment (170.05 cm) followed by second and fourth treatments, however they are on par with each other. At this stage it was found that there was significant difference was noticed between the treatments that the plant growth in farmers practice was nearly 42.27 cm is less than the best treatment i.e. treatment seven. Finally, the highest plant height (175.5 cm) was recorded in the seventh treatment at 120 DATP.

Number of leaves: (No): The number leaves at 30, 60 90 and 120 DATP was recorded the highest number of leaves was recorded in the fourth treatment (6.33) followed by second and sixth treatment at 30 DATP. But whereas at 60 DATP the highest plant height was recorded in the seventh treatment (27.22) followed by third treatment (23.41). Similarly, at 90 DATP the highest plant height (39.13 cm)

Stem girth (cm): The stem girth was recorded during different growth stages of the tomato crop. The mean highest tomato plant girth was recorded in the seventh treatment at 60 DATP. It was 1.65 cm more than the control. Similarly at 90 DATP the mean highest plant height was recorded (7.27 cm), it was 2.28 cm higher than the control.

Number of branches (No): The number of total branches during growth and development of tomato crop was recorded at 60 and 90 DATP. The highest number of branches was noticed in the seventh treatment (7.9) followed by fourth treatment (6.83). Similarly at 90 DATP the number of branches is 27.02 in the seventh treatment and it was followed by the fourth treatment i.e.24.12. However, it was observed that the number of branches at 90 DATP in the farmers practice was only 14.37. Numbers of branches low compared to the best treatment are 12.65

The trend in the vegetative growth and development was observed that there was a significant difference among the treatments and this is leading to the better development of reproductive growth and development in the crop.

Table: 1. The vegetative growth parameters recorded at different intervals (30, 60, 80 and 120 DATP) during the crop growth and development phases.

	Plant height (cm)				No. of leaves (No)				Stem girth (cm)				No. of branches (No)			
Treatment	30	60	90	120	30	60	90	120	30	60	90	120	30	60	90	120
T1	19.0	49.2	122.7	127.5	4.6	20.2	26.0	29.3	1.05	2.1	4.9	6.2	2.1	6.0	14.3	15.8
T2	20.2	44.4	147.3	149.5	5.6	28.4	29.2	32.8	0.99	2.0	6.3	6.6	2.2	5.1	16.0	18.6
T3	18.5	48.5	132.0	137.3	5.3	20.9	27.5	29.6	1.04	2.2	5.4	6.4	2.6	5.5	20.7	21.9
T4	19.8	46.3	162.4	172.6	6.3	19.6	35.0	36.0	1.21	2.9	6.0	6.7	2.8	6.8	24.1	26.0
T5	19.6	43.9	146.3	115.2	4.3	22.4	28.2	30.0	1.21	2.0	5.6	6.6	2.0	4.8	16.7	17.9
T6	19.7	44.1	108.0	112.3	5.3	24.2	24.0	27.9	1.49	1.8	4.6	7.1	2.5	3.9	13.1	14.3
T7	20.6	44.1	170.0	175.5	5.1	27.2	39.1	32.9	1.94	3.8	7.2	8.7	3.37	7.9	27.0	28.1
Mean	**19.6**	**45.7**	**141.4**	**141.4**	**5.2**	**22.6**	**29.8**	**31.2**	**1.28**	**2.4**	**5.8**	**6.9**	**2.55**	**5.7**	**19.0**	**20.4**
Sem+	0.99	35.1	8.0	3.28	0.69	1.63	1.90	24.0	1.01	0.19	0.3	5.37	1.97	0.39	1.27	16.0
C.D @5%)	NS	NS	24.0	10.11	NS	NS	5.8	NS	NS	0.58	1.0	NS	NS	1.2	3.9	NS
CV (%)	8.79	133.7	9.8	4.0	23.0	12.7	11.0	133.0	137.4	13.41	9.5	133.3	134.1	12.0	11.6	135.9

It was observed since beginning of the crop initial stage there is an indication with increase in the growth and development of all the vegetative parameters like plant height, number of leaves stem girth and also number of branches. As (Jain et.al.2000) found the drip irrigation has created an interest because of decreased water requirement and possible increase in production. The series of proper growth of vegetative indices in the crop will be definitely contributed towards the higher production of final produce in the crop.

The growth and development of reproductive indices includes the number of flower buds, number of fruits and weight of fruits was found that there is an increasing trend in the growth and development, and also the number of fruits weighed per kilogram in the farmers practice and best treatment was also compared. The details are provided in the table 2.

Growth and development of reproductive indices includes the weight of fruits per pant in each harvesting and the total yield in all the treatments are provided in the table 2

Table: 2. The fruit yield harvested per plant and per unit area (Hectare) was recorded in both control (farmers practice) and improved package of practice and the same was presented in the following table.

Treatments	Fruit yield Per plant (kg)	Fruit yield per Ha (t/Ha)
T1	7	92.29
T2	6	80.82
T3	7	94.59
T4	7	99.19
T5	7	90.00
T6	6	77.25
T7	8	112.50
Mean	**6.70**	**92.38**
Sem+	0.081	**1.376**
C.D (0.05%)	0.251	4.24
CV(%)	2.10	**2.58**

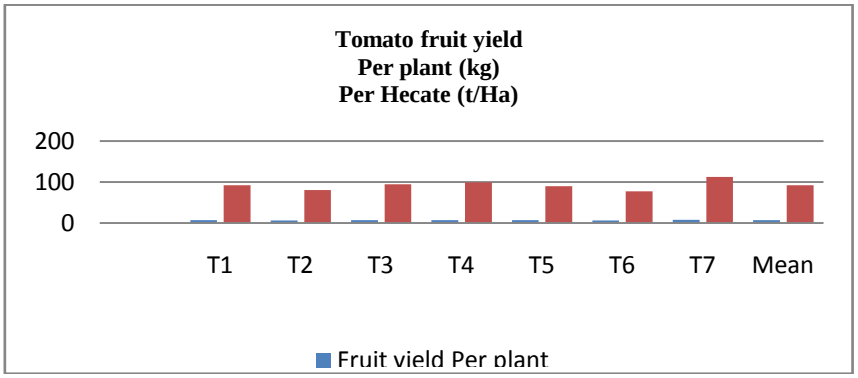


Fig: Tomato fruit yield per plant and per hectare

IV. Discussion and Summary

The increase in plant height, number of leaves, stem girth and number of branches at the vegetative stage is nearly 72.64, 89.0, 71.2 and 56.22 percent higher in treatment T7 than the farmers practice T1. The enhanced growth in the treatment t7 may be due the presence of optimum water regime and availability of ionic form of plant nutrients from the soil subsurface region. As, Hagan et.al. (2008), rightly pointed out that the production of most annual crops mostly sustained only through irrigation, which in-tern play a vital role in ensuring the continuity of production and good quality produce in terms of final yield. The cool-dry season, where irrigation facilities exist is the prepared environment for tomato production. However, irrigation is not without its drawbacks. Mismanagement of irrigation has adverse effects on both the soil and crop. Excessive irrigation delays maturity, harvesting and enhances the vegetative growth and reduces the soluble solids content in tomato, while its insufficiency reduces the yield and quality. In soils, excessive irrigation results in the lack of aeration, surface runoff, deep percolation, build up of water table with consequent decrease in root zone depth, water logging and possibly salinity. As we recorded there was high vegetative growth in the initial stage i.e. 60 DATP in farmers practice than the best treatment, it is mainly attributed to number irrigation frequencies and excessive irrigation.

The main yield attributing factors which are responsible for the total increase in crop are retention of more number of flower buds in each plant. The percent increase in the retention of flower buds in the best treatment compared to the farmers practice is 78.92 per cent, the decrease in the retention of flower buds in the farmers practice may be due to non application of micronutrients and also bioinoculents (Biofertlizers).AsTisdale et.al. (1985) asserted that micronutrient plays a specific role in improving growth yield and quality of fruit crops, even though these elements are needed in small quantity their application is very necessary to meet the demand at the particular stage of the crop. Zinc element is essentially required for growth, development and also involved in diverse range of enzymatic system in the fruit crops. The functional role of zinc includes the auxin metabolism influence on activating enzyme synthesis and stability of the ribosomal activity, When there is excess irrigation and non application of particular micronutrient these necessary plant physiological functions will not hence the rate of metabolic activities and food synthesis process will get disturbed and so as the translocation of produced carbohydrates (photosynthates) will reduce and it in turn reduces the total yield. As Biswas et.al (2015) pointed and stressed that the yield components and yield were significantly greater at all levels of irrigation in mulched treatments as compared to unmulched treatments. Mulches had a significant positive effect on plant height and the effect was more pronounced in lower water regime treatments than higher water regime treatment. Fruit size and fruit weight were found the maximum in drip irrigation with mulches, simillary, in our experiment less number of irrigations (20) with essential nutrients both organic inorganic and micronutrients has resulted in the production of higher fruit yield in tomato. Simmi Goel and Novjout Kaour (2012) asserted that application vermicompost in tomato has resulted in the maximum growth of the plants and the fruits produced have better colour and size than the non applied treatment. The application vermicompost was also resulted in the correction of soil pH and it was clear that vermicompost has positive effects on the growth, yield and quality of tomato plant.

Summary:

In the production of tomato especially in the regions like eastern dry zone of Karnataka water source and its availability during the cropping season is the topmost production limiting factor which plays a major key role in the final crop yield production. It also decides the production levels throughout the growing period. It was found that with timely planting in optimum spacing and maintenance of uniform plant population along with the initial irrigation and nutrition management has resulted in the uniform vegetative growth and development. Optimum levels of application and supply of balanced nutrition during reproductive stage has resulted in the retention and setting of more flowers and fruiting bodies. It in-tern caused the combined effect by the enhanced extraction of available nutrients applied during pre-final stage of the crop has emerged as the higher fruit yields than the control. The number of total irrigations and all the cultural practices carried out are minimum than the local control without causing heavy burden on the natural resources more essentially the water (Crop Demand Based Irrigation) was practiced.

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