Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(2): 2034-2038
Received: 22-01-2020
Accepted: 24-02-2020

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Influence of organic formulations and inorganic fertilizations on soil properties and macronutrient uptake by tomato

Tejswini R Kachave, AL Dhamak and Bhagyaresha R Gajbhiye

Abstract
Field experiments were planned and conducted during *kharif* 2017-18 and 2018-19 to evaluate the "Influence of organic formulations and inorganic fertilizations on soil properties and nutrient uptake by tomato", at the research farm, College of Agriculture, Golegaon, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiments were laid out in randomized block design with three replications. There were twelve treatments comprising of organic formulations and inorganic fertilizers. The finding emerged out indicated that conjoint use of RDF + Beejamruth + Jeevamruth + Panchagavya significantly enhanced in nutrient uptake in tomato. Among the different applications widely applying with RDF + Beejamruth + Jeevamruth + Panchagavya followed by RDF + Beejamruth + Panchagavya to nutrient uptake. It can be concluded from these experiment that the balanced use of organic formulations with inorganic fertilizations affect the nutrients uptake on tomato plants.

Keywords: Organic formulations, inorganic fertilizations, soil properties, nutrient uptake

Introduction
Tomato (*Solanum lycopersicum* L.) belongs to family *solanaceae*, is an annual vegetable crop grown throughout the world and ranks second in important after potato. The tomato is believed to have been originated in Central Africa and South America (Vavilov, 1951) [8]. It is herbaceous annual which is sexually propagated by seed. Tomato is one of the most widely, grown vegetable in India and has become popular within the last six decades. Application of scientific approaches to organic farming practices holds the possibility of maintaining and in some cases increasing the yield over long run, while sustaining bio-diversity, soil fertility, soil biological cycles and natural ecosystem processes and services that under in the agriculture. It offers us productive way out of increasing environmental degradation that has triggered by many intensive agricultural practices. Apart from this, it allows the farmers to overcome the risk of crop failures and increased cost of production. Organic farming encourages producing healthy food of high quality. In a view of this fact study in this direction of having organic sources of nutrition like Panchagavya, Beejamruth, Jeevamruth etc. need to be undertaken. Therefore, an experiment entitled "Influence of organic formulations and inorganic fertilizations on soil properties and nutrient uptake by tomato"

Materials and methods
The field experiments were carried out during *kharif* 2017-18 and 2018-19 using tomato (var. *Akash Ganga*) at experimental farm, College of Agriculture, Golegaon, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiments were laid out in randomized block design. There were twelve treatments comprising of organic formulations and inorganic fertilizers viz., T_1 RDF (100% NPK through fertilization), T_2 Panchagavya only, T_3 Jeevamruth only, T_4 Beejamruth only, T_5 Panchagavya + Beejamruth, T_6 Beejamruth + Jeevamruth, T_7 Panchagavya + Jeevamruth, T_8 RDF + Beejamruth + Panchagavya, T_9 RDF + Beejamruth + Jeevamruth, T_{10} RDF + Beejamruth + Jeevamruth + Panchagavya, T_{11} Beejamruth + Jeevamruth + Panchagavya, T_{12} 100% N through FYM. Soil is characterized by black colour dominated by montmorillonite clay with high coefficient of expansion and shrinkage leads to deep cracking. The soils are formed from basaltic material. According to 7th approximation, the soils are classified as Smectic Isohyperthermic Typic Haplusterts (Malewar, 1977) [6] and are included in Parbhani series. The topography of experimental plot was fairly level. Seedlings of Akash Ganga are transplanted after one month of days after sowing. Growth and yield contributions characters were recorded at different growth stages. From each plot, 5 random plants were selected to record biometric observations on growth and yield

attributes. Five plants uprooted from the observation unit for recording the dry matter studies and after removing the roots, plant samples were kept in well labeled brown paper bag. First the samples were dried in shade and after that kept in oven at 65 °C±2 °C, and then weight of dry matter was taken and expressed on per plant basis. All the data were subjected to analysis of variance.

Results and Discussion

Effect of organic formulations and inorganic fertilizations on physico-chemical properties of soil under tomato.

Soil pH

The data pertaining to soil pH is presented in Table 1. Soil pH is basic property which generally does not alter easily in Vertisol and associated black soil due to more buffering capacity. The initial soil pH was 8.03 and 8.04 during 2017 and 2018, respectively. Persual data on the pH observed that the soil reaction was not influenced significantly due to application of organic formulations. However, there was numerical decrease in pH due to application of organic formulations. Maximum reduction of pH was observed in treatment of 100% N through FYM and RDF + Beejamruth + Jeevamruth + Panchagavya as compared to RDF in flowering, harvesting and pooled mean in both the years of experimentation. Higher pH value was recorded in treatment T_1 (RDF – 100% NPK through fertilization). Soil pH was recorded high in treatment receiving only chemical fertilizer. However, it was slightly lowered down under the treatment of FYM and integration indicating the need of addition of organics for maintaining pH of soil. These results are in conformity with the findings of Devi *et al.* (2013) [3], Gore and Sreenivasa (2011) [4] and Kanwar and Sharma (2014) [5].

Electrical conductivity of soil

The results on electrical conductivity as influenced by organic formulations and inorganic fertilizations are pertained in Table 2. Electrical conductivity indicates total soluble salts in the soil solution. The initial electrical conductivity was 0.49 dSm^{-1} and 0.51 dSm^{-1} during 2017 and 2018, respectively. There was slight variation in the electrical conductivity due to application of organic formulations along with chemical fertilizers. Electrical conductivity was increased with increasing age of crop. The electrical conductivity of soil ranged from 0.39 to 0.51, 0.38 to 0.50 and 0.39 to 0.51 dSm^{-1} during both the years and pooled mean during flowering stage of tomato. At harvesting stage, it was varied from 0.42 to 0.54, 0.40 to 0.52 and 0.41 to 0.52 dSm^{-1} during both the years and pooled mean. The electrical conductivity was found statistically non significant at all the sampling stage. Slightly higher electrical conductivity was observed with RDF (0.51, 0.46 and 0.49 dSm^{-1}) at flowering stage of tomato during both the years and pooled mean. However, it was slightly higher with RDF (0.54, 0.49 and 0.52 dsm^{-1}) at harvest stage of tomato during both the years and pooled mean and lowest was found in (0.39, 0.38 and 0.39 dsm^{-1}) at flowering stage and (0.41, 0.40 and 0.41 dsm^{-1}) at harvesting stage during 2017, 2018 and pooled mean, respectively. The electrical conductivity was found statistically non significant at all the sampling stages of tomato during both the years and pooled mean.

Organic carbon content

The data on organic carbon content of soil at flowering and harvesting stage of tomato as influenced by organic formulations and inorganic fertilizations are narrated in Table 3. Organic carbon content in soil clearly indicated that there was buildup of organic carbon over initial values of tomato crop due to application of organic formulations with recommended dose of fertilizers. The trend of soil organic content was decreased with increasing age of crop. The highest build up of organic carbon in soil was recorded in T_{12} (100% N through FYM) treatment having values 4.99, 5.60 and 5.30 g kg^{-1} at harvest during 2017, 2018 and in pooled analysis, where as lowest value was noted in T_4 (4.31, 4.34 and 4.33 g kg^{-1}) receiving only Beejamruth application. It was increased with the magnitude of 16.04, 29.03 and 22.68 per cent over RDF and were found to be at par with treatment T_{10} at harvest stage during 2017, 2018 and in pooled analysis. The content of organic carbon in soil also depends on the range of precipitation within experimental area. Hot and dry climate is directly related with the treatment variation which is responsible for hastening the rate of oxidation of organic matter. Our results are corresponds to the findings of Arbad *et al.* (2014) [2] who reported that the soil organic carbon content increased only where plots treated with FYM as compared to plots treated with inorganic fertilizer.

Calcium carbonate content

The data on effect of organic formulations and inorganic fertilizations on calcium carbonate content in soil at flowering and harvest stage of tomato are pertained in Table 4. The initial calcium carbonate content in soil was 134.00 and 131.00 g kg^{-1} during 2017 and 2018, respectively. The calcium carbonate content in soil was 113.30 and 133.40 g kg^{-1}, 113.30 to 133.30 g kg^{-1} and 115.90 to 134.60 during 2017, 2018 and pooled analysis respectively at harvesting stage of tomato. The calcium carbonate content was not influenced significantly due to application of organic formulations and inorganic fertilization. However, there was numerical decrease or increase in calcium carbonate content. The slight reduction in soil calcium carbonate was observed as compared to initial values at various sampling stages but treatment differences were non significant. The slight reduction in soil $CaCO_3$ treatment receiving FYM and combined use of organic formulations might be due to acidification effect of micro organisms in soil.

The calcareous nature along with dominance of montmorillonite clay influenced greatly the availability of nutrient for plant. The calcium carbonate could not change significantly due to one or two crop season, as black soil is highly buffered. Similar findings were also reported by Arbad *et al.* (2014) [2] and Kanwar and Sharma (2014) [5].

Effect of organic formulations and inorganic fertilization on nutrient uptake in tomato after harvest of crop.

Nitrogen uptake

As regard to N uptake in tomato plant influenced by different organic formulations and inorganic fertilization are pertained in Table 5. The uptake of nitrogen by tomato plant after harvest varied from 15.87 to 47.83, 21.84 to 67.07 and 18.86 to 57.45 kg ha^{-1} during 2017, 2018 and pooled analysis.

Maximum nitrogen uptake was recorded with treatment T_{10} (47.83, 67.07 and 57.45 kg ha^{-1}) receiving RDF + Beejamruth + Jeevamruth + Panchagvya followed by T_8 (41.73, 54.97 and 48.35 kg ha^{-1}) receiving RDF + Beejamruth + Panchagvya during both the years of experimentation and pooled data, respectively. Minimum nitrogen uptake was observed with treatment T_4 (15.87, 21.84 and 18.86 kg ha^{-1}) receiving alone application of Beejamruth. Among organic formulations, the application of alone Panchagavya was found to be

significantly superior over Beejamruth or Jeevamruth with respect to the nitrogen uptake during both the years of study and pooled analysis. Enhanced uptake of plant nutrient by application with organic formulations brought significant chance in various plant growth parameters such as plant uptake might be attributed to more biological nitrogen fixation by plant growth promoting rhizobacteria and N assimilation. Similar findings are reported by earlier workers Anandan *et al*. (2016) [1], Sanjutha *et al.* (2008) [7] and Palve *et al.* (2011)

Phosphorous uptake

The data clearly demonstrate a remarkable P uptake with the application of organic formulations along with fertilizers as compared to single application of organic formulations and RDF. The data narrated in Table 6 revealed that different organic formulations had significant influence on phosphorous uptake in tomato plant. Significantly highest P uptake was recorded with treatment T_{10} (8.01, 10.70 and 9.36 kg ha^{-1}) during both the years of experimentation and pooled data, respectively. Minimum value of phosphorous uptake was obtained with treatment T_4 (2.37, 3.74 and 3.06 kg ha^{-1}) during 2017, 2018 and pooled analysis, respectively. Among organic formulations, the application of alone Panchagavya was found to be significantly superior over Beejamruth or Jeevamruth with respect to phosphorous uptake during both the years of study and pooled mean. Increase in the nutrient concentration in the plant owed to bioavailability of nutrients in the root zone. Microbial release of nutrient enhanced the nutrient concentration in soil and hence more uptake by plant. Phytohormones present in organic formulation enhanced the root mass and length thus enhanced the nutrient concentration in tomato plant. These findings are also in line with the results obtained by Anandan *et al.* (2016) [1].

Potassium uptake

The perusal of data pertained in Table 7. The effect of organic formulations along with fertilizers on uptake of potassium revealed that there was significant variation occurred between different organic formulations along with fertilizers, single organic formulation application and RDF only. Among the different treatments potassium uptake was found significantly highest with treatment T_{10} (17.59, 21.92 and 19.76 kg ha^{-1}) during both the years of experimentation i.e 2017, 2018 and pooled analysis, respectively. Whereas, minimum value was noted with the treatment T_4 (5.25, 7.34 and 6.29 kg ha^{-1}) during 2017, 2018 and pooled analysis, respectively. The increased uptake was also due to added supply of nutrient and well developed root system under balanced nutrient application resulting in better absorption of water and nutrient. Gore and Sreenivasa (2011) [4] also reported that nutrient uptake of K was highest with 100% RDF + Beejamruth + Jeevamruth + Panchagavya.

Conclusion

After both the experiments a general improvement in the effect of application of organic formulations on soil pH, electrical conductivity and calcium carbonate content at flowering and harvest stage of tomato was non-significant. The highest buildup of organic carbon in soil was recorded in T_{12} (100% N through FYM) treatment followed by T_{10} (RDF + Beejamruth + Jeevamruth + Panchagavya) treatment at flowering and harvest stage of tomato during both the years. Whereas lowest value of organic carbon was noted with treatment T_4 receiving only Beejamruth application.

Table 1: Effect of organic formulations and inorganic fertilizations on pH of soil at flowering and harvesting stage of tomato

Treatment	(pH)					
	2017-18		2018-19		Pooled	
	Flowering	Harvesting	Flowering	Harvesting	Flowering	Harvesting
T_1: RDF (100% NPK through fertilizer)	8.01	8.02	8.03	8.04	8.02	8.04
T_2: Panchagavya only	7.94	7.95	7.91	7.93	7.92	7.92
T_3: Jeevamruth only	7.92	7.97	7.96	7.93	7.94	7.95
T_4: Beejamruth only	7.96	7.97	7.90	7.91	7.93	7.94
T_5: Panchagavya + Beejamruth	7.91	7.94	7.89	7.91	7.90	7.92
T_6: Beejamruth + Jeevamruth	7.97	8.02	7.92	7.95	7.95	7.99
T_7: Panchagavya + Jeevamruth	7.94	7.99	7.93	7.96	7.94	7.98
T_8: RDF + Beejamruth + Panchagavya	7.98	8.01	7.95	7.98	7.97	8.00
T_9: RDF + Beejamruth + Jeevamruth	7.96	7.98	7.93	7.96	7.95	7.97
T_{10}: RDF + Beejamruth + Jeevamruth + Panchagavya	7.84	7.89	7.83	7.83	7.84	7.86
T_{11}: Beejamruth + Jeevamruth + Panchagavya	7.81	7.87	7.82	7.82	7.82	7.84
T_{12}: 100% N through FYM	7.79	7.82	7.79	7.78	7.79	7.79
SEm ±	0.24	0.22	0.22	0.33	0.15	0.20
CD at 5%	NS	NS	NS	NS	NS	NS
Grand mean	7.93	7.97	7.92	7.93	8.00	7.95

Table 2: Effect of organic formulations and inorganic fertilizations on EC of soil at flowering and harvesting stage of tomato

Treatment	EC (dSm^{-1})					
	2017-18		2018-19		Pooled	
	Flowering	Harvesting	Flowering	Harvesting	Flowering	Harvesting
T_1: RDF (100% NPK through fertilizer)	0.51	0.54	0.46	0.49	0.49	0.52
T_2: Panchagavya only	0.43	0.44	0.40	0.44	0.42	0.44
T_3: Jeevamruth only	0.45	0.45	0.41	0.46	0.43	0.46
T_4: Beejamruth only	0.43	0.44	0.39	0.44	0.41	0.44
T_5: Panchagavya + Beejamruth	0.42	0.44	0.40	0.45	0.41	0.44
T_6: Beejamruth + Jeevamruth	0.42	0.42	0.38	0.43	0.40	0.43
T_7: Panchagavya + Jeevamruth	0.47	0.49	0.46	0.50	0.47	0.50
T_8: RDF + Beejamruth + Panchagavya	0.48	0.48	0.47	0.52	0.48	0.50

T_9: RDF + Beejamruth + Jeevamruth	0.49	0.51	0.45	0.47	0.47	0.49
T_{10}: RDF + Beejamruth + Jeevamruth+ Panchagavya	0.51	0.52	0.50	0.52	0.51	0.52
T_{11}: Beejamruth + Jeevamruth + Panchagavya	0.47	0.47	0.41	0.43	0.44	0.45
T_{12}: 100% N through FYM	0.39	0.42	0.38	0.40	0.39	0.41
SEm ±	0.04	0.07	0.04	0.06	0.03	0.04
CD at 5%	NS	NS	NS	NS	NS	NS
Grand mean	0.46	0.47	0.43	0.46	0.44	0.47

Table 3: Effect of organic formulations and inorganic fertilizations on organic carbon in soil at flowering and harvesting stage of tomato

Treatment	Organic carbon (g kg^{-1})					
	2017-18		2018-19		Pooled	
	Flowering	Harvesting	Flowering	Harvesting	2017-18	2018-19
T_1: RDF (100% NPK through fertilizer)	4.26	4.30	4.36	4.34	4.31	4.32
T_2: Panchagavya only	4.30	4.35	4.40	4.39	4.35	4.37
T_3: Jeevamruth only	4.29	4.32	4.42	4.38	4.36	4.35
T_4: Beejamruth only	4.27	4.31	4.37	4.34	4.32	4.33
T_5: Panchagavya + Beejamruth	4.38	4.41	4.43	4.42	4.41	4.42
T_6: Beejamruth + Jeevamruth	4.08	4.13	4.45	4.44	4.27	4.29
T_7: Panchagavya + Jeevamruth	4.36	4.42	4.43	4.41	4.40	4.42
T_8: RDF + Beejamruth + Panchagavya	4.42	4.48	4.59	4.56	4.51	4.52
T_9: RDF + Beejamruth + Jeevamruth	4.40	4.45	4.56	4.54	4.48	4.49
T_{10}: RDF + Beejamruth + Jeevamruth + Panchagavya	4.80	4.90	4.99	4.96	4.90	4.93
T_{11}: Beejamruth + Jeevamruth + Panchagavya	4.39	4.43	4.51	4.48	4.45	4.46
T_{12}: 100% N through FYM	4.97	4.99	5.63	5.60	5.30	5.30
SEm ±	0.11	0.14	0.17	0.17	0.10	0.09
CD at 5%	0.32	0.41	0.49	0.52	0.28	0.25
Grand mean	4.41	4.46	4.60	4.57	4.50	4.51

Table 4: Effect of organic formulations and inorganic fertilizations on $CaCO_3$ content in soil at flowering and harvesting stage of tomato

Treatment	$CaCO_3$ (g kg^{-1})					
	2017-18		2018-19		Pooled	
	Flowering	Harvesting	Flowering	Harvesting	Flowering	Harvesting
T_1: RDF (100% NPK through fertilizer)	132.10	137.50	146.10	144.20	134.80	139.1
T_2: Panchagavya only	137.70	136.70	137.60	136.7	137.2	137.7
T_3: Jeevamruth only	137.60	137.00	138.20	137.0	137.3	137.9
T_4: Beejamruth only	126.80	125.60	126.4	125.6	126.2	126.6
T_5: Panchagavya + Beejamruth	133.20	133.20	135.5	133.1	133.2	134.4
T_6: Beejamruth + Jeevamruth	120.30	120.10	121.2	120.1	120.2	120.8
T_7: Panchagavya + Jeevamruth	135.10	133.40	134.2	133.4	134.2	134.7
T_8: RDF + Beejamruth + Panchagavya	133.80	128.30	129.1	128.3	131.1	131.5
T_9: RDF + Beejamruth + Jeevamruth	127.80	126.80	127.8	126.8	127.3	127.8
T_{10}: RDF + Beejamruth + Jeevamruth + Panchagavya	127.90	121.70	122.70	121.70	124.80	125.30
T_{11}: Beejamruth + Jeevamruth + Panchagavya	117.50	113.30	114.30	113.30	115.40	115.90
T_{12}: 100% N through FYM	117.70	115.50	116.80	115.50	116.60	117.30
SEm ±	0.52	0.56	0.65	0.62	0.39	0.41
CD at 5%	NS	NS	NS	NS	NS	NS
Grand mean	128.9	127.4	129.2	128.0	127.4	129.1

Table 5: Effect of organic formulations and inorganic fertilizations on N uptake in tomato plant after harvest of crop

Treatment	N uptake (kg ha^{-1})		
	2017-18	2018-19	Pooled
	At harvest	At harvest	At harvest
T_1: RDF (100% NPK through fertilizer)	32.57	40.30	36.43
T_2: Panchagavya only	19.32	26.39	22.85
T_3: Jeevamruth only	17.32	23.84	20.58
T_4: Beejamruth only	15.87	21.84	18.86
T_5: Panchagavya + Beejamruth	26.31	33.11	29.71
T_6: Beejamruth + Jeevamruth	22.18	28.22	25.20
T_7: Panchagavya + Jeevamruth	23.28	30.75	27.02
T_8: RDF + Beejamruth + Panchagavya	41.73	54.97	48.35
T_9: RDF + Beejamruth + Jeevamruth	37.51	48.13	42.82
T_{10}: RDF + Beejamruth + Jeevamruth + Panchagavya	47.83	67.07	57.45
T_{11}: Beejamruth + Jeevamruth + Panchagavya	26.55	50.12	38.33
T_{12}: 100% N through FYM	24.64	33.85	29.25
SEm ±	1.03	1.94	2.84
CD at 5%	3.01	5.69	8.84
Grand mean	27.93	38.22	33.07

Table 6: Effect of organic formulations and inorganic fertilizations on P uptake in tomato plant after harvest of crop

Treatment	P uptake (kg ha^{-1})		
	2017-18	2018-19	Pooled
	At harvest	At harvest	At harvest
T_1: RDF (100% NPK through fertilizer)	5.66	7.45	6.55
T_2: Panchagavya only	3.26	4.81	4.04
T_3: Jeevamruth only	2.90	4.32	3.61
T_4: Beejamruth only	2.37	3.74	3.06
T_5: Panchagavya + Beejamruth	4.39	6.51	5.45
T_6: Beejamruth + Jeevamruth	3.85	5.13	4.49
T_7: Panchagavya + Jeevamruth	4.16	5.82	4.99
T_8: RDF + Beejamruth + Panchagavya	6.83	8.74	7.79
T_9: RDF + Beejamruth + Jeevamruth	6.27	7.85	7.06
T_{10}: RDF + Beejamruth + Jeevamruth + Panchagavya	8.01	10.70	9.36
T_{11}: Beejamruth + Jeevamruth + Panchagavya	4.75	8.67	6.71
T_{12}: 100% N through FYM	5.32	6.88	6.10
SEm ±	0.26	0.26	0.37
CD at 5%	0.76	0.76	1.16
Grand mean	4.81	6.72	5.77

Table 7: Effect of organic formulations and inorganic fertilizations on K uptake in tomato plant after harvest of crop

Treatment	K uptake (kg ha^{-1})		
	2017-18	2018-19	Pooled
	At harvest	At harvest	At harvest
T_1: RDF (100% NPK through fertilizer)	10.98	13.75	12.37
T_2: Panchagavya only	6.39	8.63	7.51
T_3: Jeevamruth only	5.78	7.84	6.81
T_4: Beejamruth only	5.25	7.34	6.29
T_5: Panchagavya + Beejamruth	8.29	10.97	9.63
T_6: Beejamruth + Jeevamruth	7.29	9.23	8.26
T_7: Panchagavya + Jeevamruth	7.83	10.38	9.10
T_8: RDF + Beejamruth + Panchagavya	15.94	18.86	17.40
T_9: RDF + Beejamruth + Jeevamruth	14.70	16.96	15.83
T_{10}: RDF + Beejamruth + Jeevamruth + Panchagavya	17.59	21.92	19.76
T_{11}: Beejamruth + Jeevamruth + Panchagavya	9.49	16.38	12.93
T_{12}: 100% N through FYM	9.04	11.71	10.38
SEm ±	0.37	0.54	0.70
CD at 5%	1.08	1.58	2.17
Grand mean	9.88	12.83	11.36

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