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RESEARCH PAPER

Organic farming studies in maize

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Abstract : Field experiments were conducted for two consecutive *Kharif* seasons of 2003 and 2004 at S.V. Agricultural college farm (ANGRAU), Tirupati , Southern plateau and Hills zone of India on red sandy soils with fourteen treatments comprising of six different sources of nitrogen *viz.*, farm yard manure, vermicompost, neem leaf, poultry manure, pig manure and fertilizer to supply recommended dose of nitrogen on equal nitrogen basis and one absolute control. All the seven treatments were tried with and without the foliar application of *Panchagavya*, thus, making the total treatments to fourteen. Various parameters of maize were influenced differently by varied manurial practices tried. However, during both the years of investigation, the trend was largely similar between the two years, with respect to all the parameters. All the growth and yield attributes, yield (grain as well as stover) harvest index, nitrogen uptake and the grain quality parameters (protein content, starch content and amino acid content) and gross returns as well as net returns of maize were at their best with recommended dose of fertilizer either with or without *Panchagavya* spray. However, among different organic manures all the above mentioned parameters were significantly higher with the application of farm yard manure or pig manure or vermicompost in combination with foliar application of *Panchagavya* than with any other organic manurial practices tried. Foliar application of *Panchagavya* could not exert any pronounced effect in combination with recommended dose of fertilizer, while combination of foliar application of *Panchagavya* would be fruitful only with certain organic manures only.

Key Words : Maize,Organic farming, *Panchagavya*,Yield, Nutrient uptake

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INTRODUCTION

Organic farming is not a new concept to Indian farmers, because they have practiced it since times immemorial. Organic farming system relies on crop rotation, crop residues, animal manures, legumes, green manures, off- farm wastes and biological pest control. Yields in organic farming are lower than chemical farming during initial years of practice and it takes a few years to stabilize the yields .However, in the long run, if properly followed ,yield with organic farming would be a greater than those obtained with chemical farming . The gravity of environmental degradation has drawn the attention of the scientists and planners towards finding out ecologically sound, viable and sustainable farm technologies, keeping in view of the needs of the future generations. Most of the Indian soils contain less than 0.5 per cent organic carbon. Unless it is raised to 0.9 – 1 per cent level, productivity of the soil can not be optimized. In view of the resurgence of interest in alternative agriculture in recent years, organic farming has been considered to be sound and viable option in most of the countries. In light of the above, investigations were taken up for two consecutive years, with the objectives of studying the response of maize to different organic manures, to investigate the influence of *Panchagavya* on the productivity and quality of maize, to trace out the effect of organic manures applied to maize and also to work out the dynamics of soil fertility to suggest the best organic manurial practice for maize, based on productivity, economic viability and sustenance of soil fertility.

MATERIALS AND METHODS

Field experiments were conducted for two consecutive *Kharif* seasons of 2003and 2004 at S.V. Agricultural College

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farm (ANGRAU), Tirupati , Southern plateau and Hills zone of India on red sandy soils with fourteen treatments comprising of six different sources of nitrogen *viz.*, farm yard manure, vermicompost, neem leaf, poultry manure, pig manure and fertilizer to supply recommended dose of nitrogen on equal nitrogen basis and one treatment of no manuring through any source. All the seven treatments were tried with and without the foliar application of *Panchagavya*, thus, making the total treatments to fourteen .The experiment was laid out in a randomized block design, replicated thrice and the experiment was carried in the same field during both the years of study with un distrubbed lay out . The test cultivar of maize, DHM-103 is used. *Panchagavya* is a mixture of cow dung (1kg), cow urine (750 ml), cow milk (500 ml), cow curd (500ml) and cow ghee (250ml). In addition, sugarcane juice (750ml), tender coconut water (750ml), pure honey (250ml) and ripe bananas (250g) were also added to accelerate the fermentation process. Plant height of maize was recorded from tagged plants at 15 days intervals up to tasseling, by measuring from the base of the plant to the growing tip of top most leaf and the mean plant height was calculated and expressed in cm. Leaf area of maize was computed at 15 days intervals till harvest. The leaf area was calculated, by measuring the length and maximum width of third leaf from the top and multiplied with the factor 0.75. Leaf area index was calculated by dividing the total leaf area with corresponding land area as per the formula. Five plants form the destructive sampling area were cut to the base, sun dried and then oven dried at 60°C till to a constant weight and expressed as kg ha^{-1}.Length of the cob from blunt end to the shank tip of ten randomly selected cobs was measured and the average for each treatment was expressed as cob length in cm. The cob girth of ten randomly selected cobs was measured at the point of maximum girth using a thread and measured with a scale. The mean girth of the cob was computed and expressed in cm. Randomly selected ten cobs were dried thoroughly under sun and their average weight was recorded and expressed in g. Total number of grain rows from ten randomly selected cobs was counted, averaged and expressed as number of seed rows cob^{-1}. Total number of grains row^{-1} from ten randomly selected cobs was counted and the mean value was presented as number of seeds row^{-1}.Ten cobs from each treatment were randomly selected and shelled. From those, five samples of 100 grains each were drawn and weighed and the mean of the five samples was presented as 100 grain weight expressed in g. rain from net plot was sun dried to moisture level of 11 per cent, cleaned thoroughly, weighed and expressed as kg ha^{-1}. Stover obtained from net plot was thoroughly sun dried to constant weight and expressed as kg ha^{-1}.The relationship of economic yield to the total biological yield was expressed as harvest index (HI). The important quality parameters of maize grain were analyzed in the laboratory as per the standard methods indicated below and biological properties of *Panchagavya* stock solution are given in Table A.

Quality parameter	Method
Protein content (%)	Lowry's method
Starch content (%)	Anthrone method
Lysine content (%)	Colorimetric method
Tryptophan content(%)	Colorimetric method

Table A : Biochemical properties of *Panchagavya* stock solution

Property	Composition value	Methodology
Total N (mg kg^{-1})	380	Microkjeldhal – Humphries (1956)
Total P (mg kg^{-1})	258	Triple acid digestion (calorimetry) Jackson (1973)
Total K ((mg kg^{-1})	430	Triple acid digestion (Flame Photometry) Jackson (1973)
Total organic carbon (%)	0.85	Wet digestion Walkley & Black (1934)
Total sugar (µg ml^{-1})	215	Nelson Somogyi's hydrolysis – Somogyi (1952)
Reducing sugars (µg ml^{-1})	88	
Glucose (mg/dl)	7.5	Glucose oxidase – Malick and Singh (1980)
Sodium (mg kg^{-1})	105	Triple acid digestion (Flame Photometry) Jackson (1973)
Calcium (mg kg^{-1})	28	
Yeast (CFU/ml)	38 X 10^4	Saborauds agar medium
Actinomycetes (CFU/Mml)	4 X 10^2	Ken Knight's medium Ken Knight and Muncie (1939)
Lactic acid bacteria (CFU/ml)	26X10^6	MRS agar
Zn (mg kg^{-1})	0.28	DTPA extractant (AAS) Lindsay and Norvell (1978)
Fe (mg kg^{-1})	0.87	
Mn (mg kg^{-1})	0.20	
Cu (mg kg^{-1})	0.17	

RESULTS AND DISCUSSION

During both the years, the tallest plants with largest leaf area and highest dry matter accrual with the longest cobs with largest girth and highest weight, highest grain weight (Table 1), highest yield (grain as well as stover), highest harvest index of maize and the quality parameters of grain (protein content, starch content amino acid content) were produced with recommended dose of fertilizer along with *Panchagavya* spray (Table 2). Which were however, comparable with recommended dose of fertilizer and significantly taller than organic manures regardless of the source with and without application of *Panchagavya*. It is obvious that with the recommended dose of fertilizer, any crop would perform at its best, because of adequate and balanced nutrient supply to the crop at the right time of requirement. Accordingly, the maize crop under comfortable nutrition could produce the growth parameters of the highest stature, which could accrue huge quantity of biomass and partitioned a large fraction of assimilates to the sink thus, resulting in better yield structure as displayed by all the yield attributes of the largest stature, which could result in the highest economic yield as well as the by-product. Quality parameters of maize grain were found to be the highest with the above mentioned manurial practice. Balanced nutrition and higher nitrogen uptake would have resulted in higher amino acid, protein and starch content in the maize grain. Similar findings were reported earlier by Parthian and premasekhar (2002). Among organic manures , significantly higher growth, yield attributes, yield and quality parameters were recorded with farm yard manure+ *Panchagavya* spray followed by pig manure+ *Panchagavya* spray and vermicompost + *Panchagavya* spray which in turn maintained parity among them. The latter treatments maintained statistical superiority over poultry manure, and neem leaf manure either with or without *Panchagavya* spray which were comparable among them and significantly higher than with no manuring with or without *Panchagavya* spray.

The highest nitrogen uptake of maize was registered with recommended dose of fertilizer, while and highest phosphorus uptake was recoded with poultry manure and the highest potassium uptake was recorded with vermicompost (Table 3). Under recommended level of nitrogen supply, N would be taken up by the crop uninterruptedly, since it was applied in suitable number of splits to match the physiological needs of the crop, resulting greater absorption compared to the organic source of N applied totally as basal. The highest P uptake by maize crop as recorded with poultry manure and the highest K uptake was associated with vermicompost. This was due to higher levels of P and K in the corresponding organic manure, which happened to be due to the application of al manures and fertilizer on equal N basis. The results of the present study are in accordance with those of Bhiday (1994), Lam *et al*.

Table 1: Growth and yield attributes of maize as influenced by varied manurial practices and *Panchagavya* spray

	Treatments	Plant height at tasseling(cm)		Leaf area index at 75DAS		Dry matter production (kg ha^{-1})		Cob length(cm)		Cob girth(cm)		Cob weight(g)		Hundred grain weight(g)	
		2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
T_1	No manure	64.0	64.8	1.98	1.98	3752	3864	8.0	8.5	5.8	6.0	52.0	54.6	18.2	19.6
T_2	*Panchagavya spray*	72.2	72.6	2.22	2.20	4325	4482	9.4	10.2	6.7	6.9	67.4	69.2	19.5	20.8
T_3	Recommended dose of fertilizer	108.5	109.6	3.12	3.22	11846	12216	17.2	17.6	10.6	11.5	128.6	130.5	26.2	27.2
T_4	Recommended dose of fertilizer + *Panchagavya*	110.3	110.5	3.14	3.24	11960	12382	17.8	18.1	10.8	11.7	129.8	132.2	26.4	27.5
T_5	Farm yard manure	93.8	95.4	2.70	2.72	10081	10064	13.8	14.0	8.8	9.5	100.8	100.9	23.8	24.8
T_6	Farm yard manure + *Panchagavya*	102.6	103.2	2.94	2.98	11125	11286	16.0	16.0	9.8	10.6	115.2	117.2	25.2	26.2
T_7	Vermicompost	92.5	93.5	2.65	2.69	9801	9945	13.0	13.8	8.6	9.2	98.0	98.2	23.2	24.2
T_8	Vermicompost + *Panchagavya*	99.4	101.8	2.90	2.95	10825	11096	15.4	15.6	9.5	10.4	113.8	114.2	25.0	25.8
T_9	Neem leaf	84.8	84.8	2.40	2.44	8792	8702	11.0	11.8	7.4	7.8	80.8	82.8	20.8	22.2
T_{10}	Neem leaf + *Panchagavya*	85.2	85.4	2.42	2.44	8865	8784	11.0	12.0	7.6	8.0	81.6	83.4	21.0	22.5
T_{11}	Poultry manure	86.0	86.2	2.44	2.45	8963	8865	11.2	12.0	7.8	8.0	83.2	84.2	21.2	22.6
T_{12}	Poultry manure + *Panchagavya*	86.4	86.8	2.48	2.46	9079	8942	11.6	12.2	7.8	8.3	84.6	84.8	21.4	23.0
T_{13}	Pig manure	93.6	94.6	2.67	2.71	9964	10012	13.4	13.8	8.6	9.4	98.2	99.2	23.6	24.5
T_{14}	Pig manure + *Panchagavya*	100.8	102.8	2.92	2.96	10981	11182	15.8	15.8	9.6	10.4	114.6	115.8	25.0	26.0
	S.E.±	1.90	2.18	0.056	0.074	198.9	208.5	0.46	0.53	0.21	0.28	4.51	4.65	0.28	0.32
	C.D. (P = 0.05)	5.4	6.2	0.16	0.21	565	592	1.3	1.5	0.6	0.8	12.8	13.2	0.8	0.9

Table 2: Yield, harvest index and quality parameters of maize as influenced by varied manurial practices and *Panchagavya* spray

Treatments		Grain yield (kg ha^{-1})		Stover yield (kg ha^{-1})		Harvest index		Protein content (%)		Starch content (%)		Lysine (%)		Tryptophan (%)	
		2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
T_1	No manure	966	1002	2245	2428	25.74	25.92	6.4	6.6	53.2	53.8	0.192	0.196	0.046	0.048
T_2	*Panchagavya spray*	1147	1203	2708	2872	26.52	26.84	7.1	7.3	55.4	55.6	0.200	0.204	0.052	0.054
T_3	Recommended dose of fertilizer	3715	3894	7464	7845	31.36	31.88	10.3	11.0	63.2	64.0	0.271	0.278	0.071	0.075
T_4	Recommended dose of fertilizer + *Panchagavya*	3791	3957	7725	7912	31.45	31.96	10.5	11.1	63.2	64.2	0.271	0.278	0.071	0.075
T_5	Farm yard manure	3016	3051	6428	6586	29.92	30.32	8.8	9.5	59.4	60.0	0.264	0.268	0.064	0.066
T_6	Farm yard manure + *Panchagavya*	3402	3514	7068	7369	30.58	31.14	9.6	10.3	61.5	62.0	0.268	0.274	0.068	0.071
T_7	Vermicompost	2903	2982	6284	6432	29.62	29.98	8.8	9.2	59.2	59.6	0.264	0.268	0.063	0.065
T_8	Vermicompost + *panchagavya*	3273	3412	6965	7154	30.24	30.75	9.5	10.2	61.0	61.8	0.268	0.274	0.068	0.070
T_9	Neem leaf	2493	2499	5602	5698	28.36	28.72	7.8	8.2	57.2	57.4	0.258	0.260	0.058	0.059
T_{10}	Neem leaf + *panchagavya*	2530	2535	5762	5746	28.54	28.86	7.8	8.4	57.2	57.6	0.258	0.260	0.058	0.059
T_{11}	Poultry manure	2571	2578	5786	5824	28.68	29.08	7.9	8.5	57.4	57.8	0.260	0.262	0.058	0.060
T_{12}	Poultry manure + *panchagavya*	2629	2615	5845	5978	28.96	29.24	8.0	8.5	57.4	57.8	0.260	0.262	0.059	0.060
T_{13}	Pig manure	2967	3018	6312	6492	29.78	30.14	8.8	9.3	59.4	59.8	0.264	0.268	0.064	0.065
T_{14}	Pig manure + *panchagavya*	3340	3457	6972	7274	30.42	30.92	9.6	10.3	61.2	62.0	0.268	0.274	0.068	0.071
	S.E.±	75.7	79.6	138.0	143.7	0.109	0.134	0.18	0.21	0.53	0.60	0.0007	0.0011	0.0007	0.0007
	C.D (P = 0.05)	215	226	392	408	0.31	0.38	0.5	0.6	1.5	1.7	0.002	0.003	0.002	0.002

Table 3 : Nitrogen, phosphorus and potassium uptake (kg ha^{-1}) of maize at harvest and post soil available nutrient status as influenced by varied manurial practices and *Panchagavya* spray

Treatments		N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})		Organic carbon (%)		Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})	
		2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Initial		-	-	-	-	-	-	0.23	0.32	135.6	142.2	17.63	26.75	176.5	202.5
T_1	No manure	62.4	61.4	10.80	11.30	71.0	71.8	0.18	0.16	108.2	90.4	12.72	8.23	167.2	142.6
T_2	*Panchagavya spray*	71.2	72.8	10.86	11.54	72.4	73.4	0.18	0.16	107.5	90.1	12.70	8.18	167.0	140.8
T_3	Recommended dose of fertilizer	172.4	175.6	19.40	20.08	107.4	96.3	0.21	0.18	128.4	136.8	25.15	41.40	228.2	280.5
T_4	RDF + *Panchagavya*	173.5	176.9	19.46	20.24	109.2	97.9	0.21	0.18	127.2	134.9	24.52	40.44	225.8	276.4
T_5	Farm yard manure	153.2	156.2	19.56	20.42	127.5	146.5	0.35	0.42	141.2	178.2	18.54	22.88	234.2	292.4
T_6	Farm yard manure + *Panchagavya*	163.8	166.8	19.62	20.48	128.6	147.8	0.35	0.42	140.5	175.6	18.28	22.43	230.8	288.2
T_7	Vermicompost	151.2	154.8	20.92	21.85	145.8	165.8	0.36	0.45	150.4	190.9	20.60	27.92	254.8	318.4
T_8	Vermicompost + *Panchagavya*	161.8	164.8	20.95	22.06	147.1	167.0	0.36	0.45	148.8	189.8	20.26	27.64	251.5	315.8
T_9	Neem leaf	139.5	143.6	21.06	22.18	126.2	144.9	0.38	0.46	158.6	215.9	22.82	33.63	236.4	298.2
T_{10}	Neem leaf + *Panchagavya*	140.6	144.5	21.14	22.20	126.8	145.8	0.38	0.46	158.2	214.8	22.45	33.04	234.5	295.8
T_{11}	Poultry manure	141.2	145.2	23.86	25.60	124.8	143.2	0.28	0.34	155.2	202.6	28.26	48.06	229.5	286.5
T_{12}	Poultry manure + *Panchagavya*	142.6	146.0	24.00	25.70	125.5	143.8	0.28	0.34	154.6	201.7	27.84	47.04	228.4	282.8
T_{13}	Pig manure	152.5	155.6	22.48	24.00	136.8	156.5	0.30	0.35	142.5	181.2	24.45	39.16	248.6	312.4
T_{14}	Pig manure + *Panchagavya*	162.6	165.4	22.54	24.10	137.5	157.4	0.30	0.35	141.8	180.6	23.88	38.21	245.4	309.5
	S.E.±	2.96	2.99	0.451	0.465	2.78	2.89	0.028	0.02	4.49	4.78	0.878	1.019	7.46	7.18
	C.D. (P = 0.05)	8.4	8.5	1.28	1.32	7.9	8.2	0.08	0.06	12.8	13.6	2.5	2.9	21.2	20.4

(1997) and Dosani *et al.* (1999).

Fertilizer application could just maintain the status of soil organic carbon in the cropping system, with neither improving nor declining at the end of the annual cropping cycle. While it was found gradually built up compared to the pre-experimental level with the application of organic manures. Among the organic sources tried, neem leaf manure, vermicompost and farmyard manure added more organic carbon to the soil compared to pig manure and poultry manure. Slow decomposition of neem leaf , vermi compost and farmyard manure over other manures may probably the reason for the differences in soil organic carbon .Neverthless, organics did build up the organic content as well as nutrients there by indicating the sustenance of soil productivity. Ramesh and Rao (2009) also reported that soil health could be sustained with organic nutrition due to diversification of soil biota.

Available nitrogen status was higher with neem leaf manure followed by poultry manure and vermi compost than with pig manure and farmyard manure. Fertilizer application almost maintained the status of available nitrogen , while it was declined with absolute control. The mineralization of organic manures and release pattern of nitrogen into the soil solution differs at large and accordingly and available nitrogen replenished the soil solution. Built up soil available phosphorus and available potassium status in the was found compared to the pre-experimental level, with the application of organic manures as well as fertilizer. The buildup of soil available phosphorus status with varied manurial practices was in the descending order of poultry manure, pig manure ,fertilizer, neem leaf manure, vermicompost and farmyard manure, while the buildup of soil available potassium status with varied manurial practices was in the descending order of vermicompost, pig manure, neem leaf manure, farmyard manure, poultry manure and fertilizer. The P and K content of different organic sources tried differed to a large extent and the final balances of P and K were in commensurate to their respective contents of P and K in different organic sources. Higher available nutrient status with organic farming practices might be due to slow decomposition of organic components, the losses of N from these fractions may be minimized, in addition to synergistic effect on P and K transformation, the available nutrient status tend to improve slightly compared to the initial nutrient level. All the four soil fertility parameters were found depleted at the end of two year cropping cycles due to non-manuring to any of the crops in the cropping system *i.e.* absolute control. The results are in line with that of Stockdale *et al.*, 2001), who reported that soil fertility could be sustained with organic nutrition due to tightening the nutrient cycles.

Since the main aim of the study is on the scope organic farming, performance of crops with different organic manures has to be examined. Thus, keeping the best performance of maize crop with recommended dose of fertilizer apart, comparison was made among different organics tried. Among the organic manures tried on maize crop, farm yard manure, pig manure and vermicompost, which resulted in equal performance, were found better than poultry manure and neem leaf manure. The former three organic sources could produce growth parameters and yield attributes of higher stature, resulting in higher yield, nitrogen uptake, quality parameters of grain and gross returns than with the two latter sources. Among different organics, the highest net returns were realized with farmyard manure, while they were the lowest with neem leaf manure. Major nutrient balance would be different with different organic sources applied on equal nitrogen basis, since concentration of nutrients varied with them. The preference of crops differ with the source of organics applied, depending upon its nutritional requirement. Further, the mineralization pattern and release of nutrients into the soil solution differs. Since, each crop would likely to have its own preference, in the present study, maize has performed better with farm yard manure or pig manure or vermicompost than with poultry manure or neem leaf manure.

Built the present investigation revealed that if organic farming is desired, one can go for the choice of organic sources to maize, depending upon the abundant availability locally and cheaper cost among the sources, which would result in expected performance of a given crop. The outcome of the present investigation is in consonance with those of Bhiday (1994) and Gorodonii *et al.* (1994). Growth parameters, yield attributes, yield, nitrogen uptake, grain quality parameters, harvest index and gross as well as net returns of maize were found to be the highest with recommended dose of fertilizer along with spray of *Panchagavya*, but all of them were statistically comparable with recommended dose of fertilizer alone, indicating the fact that foliar application of *Panchagavya* could not exert any pronounced effect in combination with recommended dose of fertilizer, probably because of adequate and balanced nutrient supply to meet the crop's requirement, resulting in exploiting the maximum possible performance of maize crop under the domain of experimentation. The difference in grain yield of maize with recommended dose of fertilizer along with spray of *Panchagavya* and recommended dose of fertilizer alone was mere 1.6 per cent (mean of two years). Beyond a certain level, each crop under a given set of environmental conditions will have a biological ceiling to elevate its performance, in spite of supplementation with any beneficial additives. This fact in crop production can be substantiated with the analogy of non-responsiveness of *Rhizobium* inoculation to leguminous crops raised on soils of adequate available nitrogen status. Thus, the response of maize to foliar application of *Panchagavya* over and above the recommended dose of fertilizer was not perceptible.

The effect of foliar application of *Panchagavya* along with farmyard manure,pig manure and vermicompost was found considerable on all the above mentioned parameters of maize

compared to their individual application of the respective manures alone, while with poultry manure and neem leaf, the additional beneficial effect was not perceptible, as in the case of fertilizer. The grain yield difference of maize with farmyard manure, pig manure, vermicompost, poultry manure and neem leaf in combination with foliar application of *Panchagavya* over their individual application alone was to the tune of 13.8, 13.0, 12.9, 1.8 and 1.4 per cent, respectively (mean of two years). Crude protein content of maize grain was found improved to a tune of 2.0 to 11.0 per cent with the use of *Panchagavya* in combination with different manures applied. The above results indicate that for maize crop, combination of foliar application of *Panchagavya* would be fruitful only with certain organic manures and fruitless with others. Similar results were reported by Somasundaram (2003) from Tamil Nadu.

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