J Krishi Vigyan 2023, 11 (2) : 274-280 DOI : 10.5958/2349-4433.2023.00051.X

Performance of Different Levels of NADEP Manure on Nutrient Contents and Quality of Different Organically Grown Crops

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ABSTRACT

A field experiment was conducted at the certified organic farm of Navsari Agricultural University, Navsari Gujarat, during rabi 2018-19 years to study the effect of different levels of NADEP manures on nutrient content and quality of different crops. NADEP is the method of organic composting uses a wide range of organic materials such as crop residues, weeds, forest litter and kitchen waste with an end product of a fertilizer that serves as a good alternative to farmyard manure. The experiment was conducted with five different crops (C_1: Maize, C_2: Indian bean, C_3: Cauliflower, C_4: Garlic, C_5: Carrot) and three levels of NADEP manures (M_1: 100 % RDN, M_2: 50 % RDN, M_3: 4/ha) in FRBD with three replications. Results indicated that the interaction effect of M_1C_4 recorded significantly maximum P (%) as well as M_1C_3 recorded significantly maximum K (%). Indian bean recorded significantly higher protein and N which was found at par with Garlic. Cauliflower recorded significantly higher nutrients like K, Mn, Zn and Cu whereas Carrot recorded significantly higher Fe and reducing sugar. Maize recorded higher total sugar and non-reducing sugar in economic parts of different crops. Economic produce of crops was found nutritionally rich under the treatment of 100 % RDN applied through NADEP compost. In the case of different crop residue parts, significantly higher content of P, Fe, Mn, and Cu was recorded in Cauliflower whereas significantly maximum Zn was recorded in Maize. Significantly maximum K and maximum N were recorded in the Indian bean which was observed at par with Cauliflower. The interaction effect was found non-significant for different crop residue parts.

Key Words: Manures, Nutrients Organic Farming, Protein Content, Sugar.

INTRODUCTION

The organic farming system proved best for soil fertility and sustainability as compared to conventional farming under rice-wheat cropping cultivation (Mithlesh *et al*, 2019). Organic agriculture sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. (Kubrevi *et al*, 2017). Organic agriculture sustains the health of soils, ecosystems and people (Gill M S, 2014). Thus, this conventional farming paved the way for organic or natural farming. Organic farming revolves around the four main principles *viz*., health, ecology, fairness and care. To comply with these four principles of organic farming, there is a need to revisit and reorient the different nutrient management practices in organic farming systems like as crop rotation, crop residues, bulky organic manures, green manures, *etc*. as well as optimum utilization of farm resources is needed for making organic crop production feasible on harsh ground realities. India produces 686 Mt of gross crop residue biomass on annual basis, of which 234 Mt (34 % of gross) are estimated as surplus (Hiloidhari *et al*, 2014). On this base, per hectare biomass availability is 4.3 t and 1.5 t, respectively and per hectare nutrient availability from this biomass is 113 kg and 39 kg NPK, respectively. This indicates the very low availability of nutrients for crop production in organic farming from available crop residues. Ponti *et al* (2012) compiled and

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Table 1. Effect of different treatments on protein, total sugar, reducing sugar and non reducing sugar content in economic parts of different crops

Treatment	Protein (%)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)
Different crops (C)				
C_1: Maize	5.85	11.36	2.79	8.57
C_2: Indian bean	23.13	3.80	1.72	2.08
C_3: Cauliflower	16.76	3.56	2.28	1.29
C_4: Garlic	22.67	4.87	1.39	3.47
C_5: Carrot	6.91	8.38	4.02	4.36
S. Em. ±	0.36	010.	0.06	0.08
C.D. @ 5 %	1.05	0.30	0.17	0.24
Levels of manures (M)				
M_1: 100 % RDN	15.66	6.49	2.47	4.02
M_2: 50 % RDN	14.88	6.37	2.43	3.94
M_3: 4 t/ha RDN	14.65	6.32	2.42	3.90
S. Em. ±	0.28	0.08	0.05	0.07
C.D. @ 5 %	0.813	NS	NS	NS
Interaction (C x M)				
S. Em. ±	0.63	0.18	0.10	0.15
C.D. @ 5 %	NS	NS	NS	NS
C.V. %	7.21	4.87	7.35	6.40

analyzed a meta-dataset of 362 published organic–conventional comparative crop yields. The result of this analysis showed a 20 % reduction in crop yield under organic farming as compared to conventional ones. Therefore, the nutrient content and quality of crops are important criteria for identifying crops and varieties suitable for organic farming, particularly under nutrient-stress conditions.

MATERIALS AND METHODS

The field experiment was conducted during rabi 2018-19 at the certified organic farm of Navsari Agricultural University, Navsari, Gujarat. The experiment was conducted with five different crops (C_1: Maize, C_2: Indian bean, C_3: Cauliflower, C_4: Garlic, C_5: Carrot) and three levels of NADEP manures (M_1: 100 % RDN, M_2: 50 % RDN, M_3: 4 t ha^{-1}) in FRBD with three replications. The soil of the experimental plot was medium in organic carbon, available N and P_2O_5 and high in available K_2O. The pH (1:2.5 soil: water) values were near neutral in reaction and there was no problem with salinity. The NADEP manure was applied N equivalent basis. The RDN for Maize, Indian bean, Cauliflower, Garlic and Carrot was 120, 20, 150, 100, and 100 kg/ha, respectively. Biofertilizers *viz*., *Azospirillum* and PSB for Maize and Rhizobium and PSB for Indian bean were treated with seeds @ 10 ml/kg seed. In the case of Cauliflower seedlings, roots were dipped in the *Azotobacter* suspension (2-5 ml *Azotobacter*/L of water) before transplanting. Maize (GM-6), Indian bean (Gujarat Indian Bean-2), Cauliflower (Snowball 16), Garlic (GAUG-2) and Carrot (Madhavan) were raised with the recommended package of practices. After harvest, the fresh weight of each economic part and total yield (grain yield of Maize, seed yield of Indian bean, bulb yield of Garlic and head yield of

Table 2. Effect of different treatments on macro and micronutrients content in economic parts of different crops.

Treatment	Macro nutrients (%)			Micronutrients (mg kg^{-1})			
	N	P	K	Fe	Mn	Zn	Cu
Different crops (C)							
C_1: Maize	0.94	0.28	0.33	22.10	51.69	0.34	0.21
C_2:Indian bean	3.70	0.19	0.10	29.56	6.29	6.52	3.17
C_3: Cauliflower	2.68	0.44	2.36	233.00	106.00	65.88	28.79
C_4: Garlic	3.63	0.60	1.32	115.22	30.39	47.01	26.03
C_5: Carrot	1.11	0.44	1.06	338.36	46.69	22.46	12.85
S. Em. ±	0.06	0.01	0.02	2.70	1.07	0.74	0.33
C.D. @ 5 %	0.17	0.03	0.06	7.82	3.10	2.13	0.97
Levels of manures (M)							
M_1: 100 % RDN	2.51	0.43	1.09	148.41	49.87	29.49	14.74
M_2: 50 % RDN	2.38	0.39	1.02	147.62	48.45	28.55	14.19
M_3: 4 t/ha RDN	2.34	0.35	0.99	146.91	46.31	27.28	13.70
S. Em.±	0.04	0.01	0.02	2.09	0.83	0.57	0.26
C.D. @ 5 %	0.130	0.020	0.048	NS	2.39	1.65	0.750
Interaction (C x M)							
S. Em. ±	0.10	0.02	0.04	4.68	1.85	1.27	0.58
C.D. @ 5 %	NS	0.05	0.11	NS	NS	NS	NS
C.V. %	7.21	7.02	6.20	5.49	6.65	7.76	7.06

Cauliflower and root yield of Carrot) were recorded and expressed as t/ha. The plant samples were collected at maturity, dried in the air and then in an oven at 65±5º C to constant weight (AOAC, 1990). Plant samples were analyzed for total N, P and K content by using a standard procedure (Jackson, 1967). Total Fe, Mn, Zn and Cu were determined by atomic absorption spectrophotometer (Elwell and Gridley, 1967). Among the quality parameters, crude protein content in economic plant parts was determined by multiplying nitrogen percent with 6.25 (Bhuiya and Chowdhary, 1974). Reducing sugars and total sugar were quantitatively estimated by the phenol-sulphuric acid method (Sadasivam and Manickam, 1992) and non-reducing sugar was obtained by subtracting reducing sugars from the amount of total sugars.

RESULTS AND DISCUSSION

Quality parameters

Protein content

The results regarding protein (%) are presented in Table 1. Protein content in economic plant parts (Maize grain, Indian bean seed, Cauliflower curd, Garlic clove and Carrot root) were derived by multiplying N content in the economic part with 6.25, therefore, the treatment effect was the same as that observed in N content in the economic part of different crops (Table 1). Higher protein content was recorded in Indian bean seed (23.13 %) followed by Garlic clove (22.67 %), Cauliflower curd (16.76 %), Maize grain (5.85 %) and Carrot root (6.91 %). As far as manure levels are concerned, application of 100 % RDN through NADEP (M_1) recorded higher protein content in crops (15.66 %) which

Table 3. Interaction effect of different treatments on P and K content in economic parts of different crops

Crop	P Content (%)				K Content (%)			
	Manures (M)							
	M_1: 100 % RDN	M_2: 50 % RDN	M_3: 4 t ha^{-1} RDN	Mean	M_1: 100 % RDN	M_2: 50 % RDN	M_3: 4 t ha^{-1} RDN	Mean
C_1: Maize	0.31	0.27	0.25	0.28	0.36	0.34	0.31	0.33
C_2: Indian bean	0.20	0.20	0.18	0.19	0.10	0.10	0.09	0.10
C_3: Cauliflower	0.51	0.44	0.37	0.44	2.53	2.30	2.25	2.36
C_4: Garlic	0.65	0.59	0.56	0.60	1.37	1.30	1.29	1.32
C_5: Carrot	0.47	0.43	0.41	0.44	1.08	1.06	1.03	1.06
Mean	0.43	0.39	0.35		1.09	1.02	0.99	
	C	M	C × M		C	M	C × M	
S. Em. ±	0.01	0.01	0.02		0.02	0.02	0.04	
C.D. @ 5 %	0.03	0.020	0.05		0.06	0.048	0.11	
C.V. %	7.02				6.20			

was found at par with the application of 50 % RDN through NADEP (14.88 %) and M_3 (NADEP @ 4t/ha) recorded minimum (14.65 %) protein content (%). Treatments involving levels of manure and its interaction with crops (C x M) failed to exert any significant effect on protein content. The results conform with the finding of Degwale (2016).

Sugar content

Total sugar content: The data about total sugar content was found significant in different crops. The higher total sugar content was observed in Maize seed followed by Carrot root, Garlic clove, Indian bean seed and Cauliflower curd (Table 1). Furthermore, Treatments involving levels of manure (M) and its interaction with crops (C x M) failed to exert any significant effect on the total sugar content of different crops.

Reducing sugar content: Reducing sugar content in economic parts of different crops was recorded higher in Carrot (4.02 %) followed by Maize (2.79 %). Whereas, the lower reducing sugar content recorded in Garlic (1.39 %) is depicted in table 1. The individual effects of manures as well as the interaction effect of levels of manure with crops (C x M) on reducing sugar content were found non-significant.

Non-reducing sugar content: The result regarding non-reducing sugar in economic plant parts are presented in table 1. Non-reducing sugar content in economic parts of different crops varied from 1.29 to 8.57 %. Significantly higher non-reducing sugar content (8.57 %) was recorded in Maize seed (C_1) whereas lower non-reducing sugar (1.29 %) was recorded in Cauliflower curd (C_3). The individual effect of manures as well as the interaction effect of C x M was found non-significant regarding non-reducing sugar content.

Nutrients content in economic parts of different crops

Macronutrient content

Economic parts of the crops varied in their N content (Table 2). The higher N content was recorded in Indian bean seeds (3.70 %), while the minimum N content was recorded in Maize grain (0.94 %). Manure treatment had a significant effect on N content in the economic parts of different crops. Significantly higher N content in the economic part of crops was recorded under treatment M_1 (100 %

Table 4. Effect of different treatments on macro and micronutrients content in residue parts of different crops.

Treatment	Macro nutrients (%)			Micronutrients (mg kg^{-1})			
	N	P	K	Fe	Mn	Zn	Cu
Different crops (C)							
C_1: Maize	0.48	0.19	0.97	19.82	36.41	124.56	0.18
C_2: Indian bean	2.43	0.22	2.25	150.07	17.91	29.56	5.73
C_3: Cauliflower	2.36	0.44	1.83	237.00	79.55	57.49	25.32
C_4: Garlic	2.23	0.31	1.56	71.27	11.00	18.39	4.99
C_5: Carrot	1.82	0.32	0.28	126.67	21.01	28.86	19.14
S. Em. ±	0.05	0.01	0.03	2.63	0.78	1.17	0.34
C.D. @ 5 %	0.14	0.02	0.09	7.63	2.26	3.39	0.97
Levels of manures (M)							
M_1: 100 % RDN	1.94	0.31	1.42	124.36	35.21	54.16	11.45
M_2: 50 % RDN	1.85	0.30	1.38	121.06	32.73	50.91	11.11
M_3: 4 t/ha RDN	1.80	0.28	1.33	117.48	31.59	50.25	10.66
S. Em. ±	0.04	0.00	0.02	2.04	0.61	0.91	0.26
C.D. @ 5 %	0.110	0.014	0.069	NS	1.753	2.622	NS
Interaction (C x M)							
S. Em. ±	0.09	0.01	0.05	4.56	1.35	2.02	0.58
C.D. @ 5 %	NS	NS	NS	NS	NS	NS	NS
C.V. %	7.91	6.31	6.71	6.53	7.06	6.77	9.11

RDN through NADEP) which was followed by M_2 (50 % RDN trough NADEP). The interaction of different crops and manure was found non-significant in N content.

The higher P content (0.60 %) was found in Garlic cloves (Table 3) while the minimum P content was found in Indian bean seed (0.19 %). The effect of manure doses on P content (0.43 %) in the economic part of crops was recorded as significantly higher in treatment M_1. While minimum P content (0.35 %) in the economic part of crops was recorded in M_3. As far as the interaction of C x M is concerned, higher P content (0.65 %) in the economic part of the crop was recorded in the interaction of C_4M_1 (Garlic crop with 100 % RDN through NADEP).

The result on K content in economic parts is given in Table 3. Cauliflower curd (C_3) recorded higher K content (2.36 %) and Indian bean seed recorded the lowest K content (0.10 %). The effect of manure level was found significantly on K content in the economic part of crops, and higher K content (1.09 %) was recorded in treatment M_1 (100 % RDN through NADEP). Similarly, the interaction effect of (C x M) was found significantly higher for K content (2.53 %) in the economic part of crops recorded in treatment combination C_3M_1.

Micronutrient content

The content of micronutrients *viz*., Fe, Mn, Zn and Cu were determined separately from economic plant parts and the results are presented in table 2. Carrot root recorded significantly higher Fe content (338.36 mg kg^{-1}) while, Cauliflower curd recorded higher Mn content (106 mg kg^{-1}), Zn content (65.88 mg kg^{-1}) and Cu content (28.79 75 mg kg^{-1}). Amongst the different manure levels, significantly higher Mn, Zn and Cu content were recorded in level 100 % RDN through NADEP compost (M_1).

Nutrient content in residues parts of different crops

Macronutrient content

The higher N content (Table 4) was recorded in Indian bean residues *i.e.* 2.43 per cent which remained at par with Cauliflower residue *i.e.* 2.36 per cent. The lowest N content was recorded in Maize residues *i.e.* 0.48 per cent. The application of 100 per cent RDN through NADEP manure (M_1) recorded significantly higher N content in the residue of crops which were recorded at par with M_2 whereas the lowest N content was recorded in M_3. The result of P content in residues of crops the higher and lower P content *i.e.* 0.44 per cent and 0.19 per cent was recorded in Cauliflower and Maize residues, respectively. Significantly higher P content in crop residues was recorded in treatment M_1. Here, treatment M_2 remained at par with treatment M_1. The result of K content in residues of different crops varied in their K content and the range of K content in residues of crops was 0.28 to 2.25 per cent. Here, maximum K content was found in Indian bean residues and lower K content was found in Carrot residues. Higher K content (1.42 %) in the residue of crops was recorded under treatment M_1 (100 % RDN through NADEP) however, it remained at par with M_2 (1.38 %) (50 % RDN through NADEP).

Micronutrient content

The content of micronutrients *viz*., Fe, Mn, Zn and Cu were determined separately from crop residue parts and the results are presented in (Table 4). Significantly higher Fe content (237.0 mg kg^{-1}), Mn content (79.55 mg kg^{-1}) and Cu content (25.32 mg kg^{-1}) was recorded in Cauliflower residues. While the maximum Zn content was recorded in Maize residues (124.56 mg kg^{-1}). Crops (Maize, indianbean, Cauliflower, Garlic and Carrot) are genetically varied in their nutrient content and quality parameters. Therefore, variation in nutrient content in different parts of crops might be observed. Amongst the different manure levels, significantly higher Mn and Zn content was recorded in level 100 % RDN through NADEP compost (M_1). It may be due to treatment receiving higher NADEP compost improves nutritional status in the root zone of the plants and subsequently higher nutrient absorption, translocation and accumulation of nutrients by the plant (Patel, 2012).

CONCLUSION

Plants grown with a higher amount of NADEP compost recorded maximum N, P, K and from the economic part and maximum Mn and Zn from the residue parts of crops. However, maximum Mn, Zn and Cu were recorded from a higher amount (100 %) of NADEP compost which was recorded at par with 50 % RDN of NADEP from the economic parts. Similarly, from residue parts, maximum N, P and K were recorded from a higher amount (100 %) of NADEP compost which was recorded at par with 50 % RDN of NADEP. Produce of the crops that received a higher amount of NADEP compost were nutritionally rich as compared to produce that received lower levels of NADEP compost.

ACKNOWLEDGMENT

The authors are grateful to the Dean of N.M. College and College of Horticulture & Forestry and Directorate of Research, NAU, Navsari for providing requirements in conducting the laboratory and farm work.

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Received on 3/9/2022 *Accepted on 15/3/2023*