International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 1377-1381

Received: 25-11-2019
Accepted: 27-12-2019

BS Gunjal
Department of Agronomy, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar, Maharashtra State, India

SP Shinde
Department of Agronomy, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar, Maharashtra State, India

SS Chitodkar
Department of Agronomy, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar, Maharashtra State, India

Corresponding Author:
BS Gunjal
Department of Agronomy, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar, Maharashtra State, India

Effect of integrated nutrient management on sweet corn–potato cropping system: Productivity, economic yield and soil nutrient balance

BS Gunjal, SP Shinde and SS Chitodkar

DOI: https://doi.org/10.22271/chemi.2020.v8.i1s.8447

Abstract
The study was conducted to estimate the productivity, economic yield and soil nutrient balance of integrated nutrient management in sweet corn-potato cropping sequence was conducted during *kharif* and *rabi* season of 2014-15 to 2015-16 at Instructional Research Farm, Central Campus, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri. The performance of sweet corn–potato cropping sequence was assessed in terms of residual fertility status at the end of two years crop sequence. The treatment T_1-100% GRDF to preceding crop sweet corn during *kharif* season registered maximum net gain of nitrogen, phosphorus and potassium (+49.19, +6.54 and +80.74 kg ha^{-1}) at the end of two years experimentation.

Keywords: Sweet corn, cropping system, nutrient balance, potato, soil fertility

Introduction

Integrated nutrient management (INM), a combined application of organic and inorganic sources of nutrients, maintains storage of plant nutrients in soil and improves nutrients-use efficiency that is essential for sustainable crop production. Organic matter acts as a source and a sink for plant nutrients as well as provides energy substrate for soil micro-organisms. Thus, it enhances activities of soil flora and fauna as well as intrinsic soil properties, soil nutrient capital, water-holding capacity and soil structure in turn makes soil less susceptible to leaching and erosion. Therefore, INM practices are essential to maintain/enhance the soil quality and sustainability of an agro-ecosystem (Carter *et al*. 2004) [8]. Kharif maize often face terminal drought resulted crop failure or very less productivity. It may be overcome by growing the maize for sweet corn instead of green cob. Besides farmyard manure (FYM), now-a-days vermicompost is gaining attention of both the researchers and the farmers due to its immense production potential using farm. Vermicomposting is a biotechnological and mesophilic (10–32 °C) process of composting. This process is faster and safe than the conventional composting as the material passes through the earthworm gut resulting earthworm castings is rich in microbial activity and have plant growth regulators. Vermicompost can be utilized in crop production as a component of INM and as a single source of all essential crop nutrients (Bejbaruha *et al*., 2009) [6]. All nutrients in vermicompost are in readily available form, thereby, enhancing nutrients uptake by plants (Banik and Sharma 2009) [5]. Still the information on this aspect is meager therefore a study thus designed to evaluate the different nutrient management practices on productivity, economic yield and soil nutrient balance of sweet corn–potato cropping system.

Materials and Methods

The field experiment was conducted for two consecutive years at the Post Graduate Institute Research Farm, M.P.K.V., Rahuri (M.S.) during the year 2014-15 and 2015 -16. It is observed that, the soil of experimental site was clayey in texture. The chemical composition according criteria laid by Muhr *et al*. (1965) [20] indicated that soil was low in available nitrogen (241.35 kg ha^{-1}), medium in available phosphorous (22.85 kg ha^{-1}) and very high in potassium (365.75 kg ha^{-1}). The experiment was laid out in a Randomized Block Design with three replications. The treatment consisted T_1 – 100% GRDF, T_2 - 75% RDN + 25% N through FYM, T_3 - 75%

RDN + 25% N through VC, T_4 – 100% RDN + 25% N through FYM T_5 -100% RDN + 25% N through VC, T_6 – 125% RDN + 25% N through FYM and T_7 – 125% RDN + 25% N through VC for kharif sweet corn as a main plot treatment, whereas for rabi potato two sub plot treatment levels of GRDF viz., F_1 - 75 per cent GRDF and F_2 - 100 per cent GRDF replicated two times in split plot design resulting in seven treatment combinations replicated thrice during kharif season and fourteen treatment combinations during rabi season in RBD-split plot design replicated thrice. The required quantity of different manures viz. FYM and vermicompost as per the treatments was applied in the field ten days before sowing of both the crops. The available N, P and K content were 1.02, 0.50 and 0.80% in vermicompost, 0.50, 0.20, and 0.44% in FYM. In doing so the respective contribution of P and K from vermicompost and FYM was also considered. The chemical properties of experimental site, FYM and vermicompost analyzed as per methods adopted given in Table No 1. The fertilizers used were urea for N, single superphosphate for P, and muriate of potash for K. The seed of sweet corn var. Suger-75) was dibbled on the ridge sides at a spacing of 20 cm at 4 cm depth and required plant population (83,000 plant ha^{-1}) was maintained by thinning of plants after one week of germination. Similarly, potato var. K. Jyoti seed tubers of 25–30 cm size were sown 5 cm deep on the south side of the ridges at a spacing of 20 cm between tubers in rainy and winter seasons respectively. The chemical analysis of plant was done for N, P and K concentration in grain and stover of sweet corn and tuber and haulms of potato as per the standard analysis methods (Tandon (1993) [31]. Uptake by plants was calculated by multiplying dry matter yield/ha with corresponding values of their concentration divided by 100 and were expressed as kg/ha. Protein concentration in cobs of sweet corn was calculated by multiplying the N concentration by a factor of 6.25.

Results and Discussion

Green cob and fodder yield

Perusal of the results of green cobs and fodder yield revealed that the treatment T_7 - 125% RDN + 25% N through VC recorded significantly the maximum green cob yield and green fodder yield higher over the rest of treatments, but it was at par with T_6 -125% RDN + 25% N through FYM in the pooled analysis. Kar *et al.*, (2006) [15] also reported that higher doses of nitrogen applied to maize increased its availability and uptake, resulting in production of more photosynthetic in terms of dry matter which ultimately increased yield of sweet corn. Similar results are also reported by Sahoo and Mahapatra, (2004) [25] and Arunkumar *et al.*, (2007) [3] in sweet corn. Further vermicompost application increased green cobs yield numerically over FYM application. These might be due to vermicompost which improved the soil fertility where all the appropriate nutrients are in readily available forms to the plants and have narrow C:N ratio (below 20:1) than FYM (Vasanthi and Kumarswamy, 2000). These results are in accordance with the findings by Shambhavi and Sharma, (2008). The higher yield observed with the application of vermicompost in comparison to FYM may be explained on the basis of higher nutrient content, faster decomposition and released nutrients in vermicompost besides enhancing the microbial population and higher root biomass (Kannan *et al.*, 2005) [14]. These findings are alike with those reported by Keerthi *et al.* (2013) [16] on INM in sweet corn, Zeinab *et al.* (2014) [32] and Syahmi *et al.* (2015) [30] in sweet corn.

Total tuber and haulms yield

The highest tuber and haulm yields were recorded on the residual fertility of FYM application treatment T_1-100% GRDF recorded significantly superior total tuber yield and haulms yield than rest of the treatments and was at par with treatment T_6-125% RDN + 25% N through FYM. Application of FYM to the preceding sweet corn crop recorded higher tuber yield and the magnitude of yield increase was over the application of NPK through VC. The increase in tuber yields under these treatments was the reflection of improved growth, yield parameters and nutrient uptake of the crop. The superiority of FYM was attributed to its slow decomposition (Singh *et al.*, 1996) [28], which caused immobilization of nitrogen and low availability of nitrogen for the sweet corn crop found to be reversed during the succeeding potato crop. With nutrition point of view, it was observed that increase in tuber yield due to integration of synthetic fertilizers and farmyard manure might regulated supply of nutrients to potato crop through readily available nutrients from synthetic fertilizers at initial stage and later stages through mineralization of organic manure into available form of nutrients for crop (Sarkar *et al.*, 2011, Kumar *et al.*, 2012) [26, 18]. Thus, higher potato yield might be due to higher residual soil fertility built-up by organic manure. The results are in conformity with the findings of reported by Congera *et al.* (2013) [10]; Najm *et al.* (2013) [21]; Narayan *et al.* (2013) [22]; Balemi (2014) [4] and Biruk *et al.* (2014) [7].

Sweet corn equivalent yield (q ha^{-1})

The sweet corn equivalent yield was significantly influenced by the various fertilizer levels to preceding sweet corn crop. The treatment T_1-100% GRDF registered maximum sweet corn equivalent yield over rest of treatments and was at par with treatment T_6-125% RDN + 25% N through FYM. This is mainly due to higher market price of sweet corn and potato as these crops were grown and harvested as vegetables. The sweet corn-potato system produced significantly maximum sweet corn equivalent yield mainly due to inclusion of high value crops like potato. These results are in close conformity with the findings of several other researchers from different Agro-climatic conditions (Singh *et al.*, 2011 and Dubey *et al.*, 2014) [27, 11]. The productivity of cropping system in term of sweet corn-equivalent yield (system productivity) was significantly higher in treatment T_1 - 100% GRDF (309.71, 329.99 and 319.85 q ha^{-1}) (Table 1). Mahavishnan *et al.* (2005) [19] and Gaur *et al.* (1984) [12] also reported that when FYM was applied at less than 30% N, about 60–70% P and 75% K become available to the immediate follow-up crop. Thus, higher potato yield might be due to higher residual soil fertility built-up by organic manure. The results are in conformity with the findings of Banik and Sharma (2009) [5] and Bejbaruha *et al.* (2009) [6].

Nutrient balance sheet

The nutrient balance after harvest of sweet corn and potato crop considered in sweet corn -potato crop sequence was assessed during the study period to check the gain or deficit observed due to use of organic and inorganic fertilizers. The nutrients *viz.*, nitrogen, phosphorus and potassium balance sheet as affected by different treatments tried is presented in Table 2 after harvest of sequential crops.

Effect of preceded crop

The performance of sweet corn–potato cropping sequence was assessed in terms of residual fertility status at the end of two years crop sequence. The treatment T_1 -100% GRDF to preceding crop sweet corn during *kharif* season registered minimum net loss of nitrogen (-38.50 kg ha^{-1}) and maximum gain of phosphorus and potassium (+0.88 and +33.69 kg ha^{-1}) than rest of other treatments and followed by treatment T_6 - 125% RDN + 25% N through FYM minimum net loss of nitrogen (-43.00 kg ha^{-1}) and maximum gain of phosphorus and potassium (+0.43 and +33.20 kg ha^{-1}). The effects of INM on nutrient dynamics were recorded, and it was concluded that combining FYM with inorganic fertilizers could maintain available N and P at either equal to or greater than the initial soil nutrient levels, thus maintaining soil fertility even under continuous cultivation Chaudhary, *et al.* (2009) [9]. The maximum loss of nitrogen and phosphorus (-49.63 and -2.27 kg ha^{-1}) minimum gain of potassium (+27.76 kg ha^{-1}) was observed under treatment T_3- 75% RDN + 25% N through VC at the end of two years experimentation.

Table 1: Chemical properties experimental site

S. No.	Particular	composition	Method adopted	References
(A)	**Chemical Composition**			
1	Organic carbon (g kg^{-1})	0.51	Walkley and Black's rapid titration method	Piper (1966)
2	Available N (kg ha^{-1})	241.35	Alkaline $KMNO_4$ method	Subbiah and Asija (1956)
3	Available P_2O_5 (kg ha^{-1})	22.85	0.5 N $NaHCO_3$ Ascorbic acid	Olsen and Dean 1965)
4	Available K_2O (kg ha^{-1})	365.75	Flame photometer	Jackson (1973
(B)	**Chemical properties of vermicompost**			
1	Total N (%)	1.02	Macro-kjeldhals method	A.O.A.C. (2005)
2	Total P_2O_5 (%)	0.50	Vanadomolybdate yellow colour method in nitric acid	Jackson (1973)
3	Total K_20 (%)	0.80	Flame photometer method	Knudsen *et al.* (1982)
(C)	**Chemical properties of FYM**			
1	Total N (%)	0.50	Macro-kjeldhals method	A.O.A.C. (1992)
2	Total P_2O_5 (%)	0.20	Vanadomolybdate yellow colour method in nitric acid	Jackson (1973)
3	Total K_20 (%)	0.44	Flame photometer method	Knudsen *et al.* (1982)

Table 1: Effect integrated nutrient on yield of sweet corn, yield of potato and equivalent yield sweet corn equivalent yield (BCEY) of the system.

Treatment		Green cob yield (q ha^{-1})		Green fodder yield (q ha^{-1})		Tuber yield (q ha^{-1})		Haulm yield (q ha^{-1})		Sweet corn equivalent yield (q ha^{-1})	
		2014-15	**2015-16**	**2014-15**	**2015-16**	**2014-15**	**2015-16**	**2014-15**	**2015-16**	**2014-15**	**2015-16**
Fertilizer levels to sweet corn											
T_1 :	100% GRDF	265.25	271.99	527.85	540.80	280.21	286.96	12.31	13.52	309.71	329.99
T_2 :	75% RDN + 25% N through FYM	249.75	256.25	509.49	520.66	260.35	272.35	10.46	10.54	287.76	313.20
T_3 :	75% RDN + 25% N through VC	255.35	262.09	518.36	531.26	255.71	266.72	10.31	10.46	282.63	306.73
T_4 :	100% RDN + 25% N through FYM	258.45	264.84	522.07	534.76	265.53	276.51	10.90	11.12	293.48	317.99
T_5 :	100% RDN + 25% N through VC	260.74	267.04	524.09	536.58	261.65	274.71	10.66	10.97	289.19	315.92
T_6 :	125% RDN + 25% N through FYM	271.94	277.49	538.44	546.82	275.36	282.11	11.17	12.26	304.35	325.43
T_7 :	125% RDN + 25% N through VC	275.55	281.55	542.83	554.19	271.55	278.95	11.06	11.17	300.13	320.79
	S. Em. ±	2.69	2.75	3.26	3.51	2.47	2.53	0.41	0.47	2.75	2.96
	C. D. at 5%	7.98	8.25	9.80	10.55	7.41	7.59	1.22	1.41	8.26	8.89
Fertilizer levels to potato											
F_1 :	75% GRDF					264.66	274.75	10.69	10.95	292.52	315.96
F_2 :	100% GRDF					270.21	279.60	10.98	11.64	298.65	321.54
	S. Em. ±					2.44	1.04	0.13	0.11	1.03	0.88
	C. D. at 5%					NS	NS	NS	NS	NS	NS
	Interaction					NS	NS	NS	NS	NS	NS
	General mean					267.44	277.18	10.83	11.29	295.59	318.75

Table 2: Soil nutrient balance sheet as influenced by different treatments after two years of sweet corn- potato sequence

Treatment		Initial nutrient status			Nutrient added			Nutrient uptake			Apparent nutrient status			Actual nutrient status			Gain (+)/ loss (-)		
		A			B			C			D			X=(A+B)-C			Y=D-A		
		N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Fertilizer Levels to sweet corn																			
T_1 :	100% GRDF	800.02	85.63	1317.13	854	290	558	799.92	101.55	532.08	761.52	86.51	1350.82	854.10	274.08	1343.05	-38.50	0.88	33.69
T_2 :	75% RDN + 25%N through FYM	760.16	82.22	1269.35	754	280	518	636.92	81.64	385.31	711.92	80.38	1299.87	877.27	280.58	1402.04	-48.27	-1.84	30.52
T_3 :	75% RDN + 25% N through VC	748.51	81.72	1265.91	754	284	524	651.07	79.98	380.32	698.88	79.45	1293.67	851.44	285.74	1409.59	-49.63	-2.27	27.76
T_4 :	100% RDN + 25%N through FYM	770.76	83.36	1276.99	814	280	518	721.58	91.13	443.26	726.51	82.35	1308.98	863.18	272.23	1351.73	-44.25	-1.01	31.99
T_5 :	100%	766.05	83.06	1273.38	814	284	524	711.02	87.80	419.70	719.18	81.89	1304.05	869.03	269.26	1377.68	-46.87	-1.17	30.67

	RDN + 25% N through VC																		
T_6 :	125% RDN + 25% N through FYM	779.81	84.99	1300.43	874	280	518	808.33	101.50	525.54	736.81	85.42	1333.63	847.48	263.49	1292.89	-43.00	0.43	33.20
T_7 :	125% RDN + 25% N through VC	775.68	84.39	1279.88	874	284	524	812.84	99.80	489.90	730.56	84.23	1311.95	836.84	268.59	1313.98	-43.32	-0.16	32.07
Fertilizer levels to potato																			
F_1 :	75% GRDF	769.94	83.56	1281.77	745.71	261.14	468.29	730.51	90.96	449.11	723.06	81.93	1311.36	785.15	253.74	1300.95	-46.89	-1.92	29.59
F_2 :	100% GRDF	773.85	83.75	1283.61	893.71	305.14	584.29	736.36	92.17	455.01	726.75	82.45	1315.06	931.20	296.72	1412.89	-46.10	-1.30	31.45
	General mean	771.90	83.65	1282.69	819.71	283.14	526.29	733.44	91.57	452.06	724.90	82.19	1313.21	858.17	275.23	1356.92	-46.49	-1.46	30.52

References

1. AOAC. Official Methods of analysis. 16th Edn. Association of Official Analytical Chemists. Washington D.C, 1992.
2. AOAC. Official Methods of Analysis, Association of Official Agricultural Chemists, Washington, D.C, 2005.
3. Arunkumar MA, Galiand SK, Hebsur NS. Effect of different level of NPK on growth quality and yield parameters of sweet corn. Karnataka J Agric. Sci. 2007; 20(1):41 43.
4. Balemi T. Effect of integrated use of cattle manure and inorganic fertilizers on tuber yield of potato in Ethiopia. J Soil Sci. and Plant Nutrit. 2014; 12(2):253-261.
5. Banik P, Sharma RC. Effect of organic and inorganic sources of nutrients on the winter crops-rice based cropping systems in sub-humid tropics of India. Archive of Agrono and Soil Sci. 2009; 55:285-94.
6. Bejbaruha R, Sharma RC, Banik P. Direct and residual effect of organic and inorganic source of nutrients on rice based cropping systems in sub-humid tropics of India. J Sustainable Agril. 2009; 33:674-89.
7. Biruk MZ, Nigussie DR, Bekele A, Yibekal A, Tamado T. Influence of combined application of inorganic N and P fertilizers and cattle manure on quality and shelf-life of potato (*Solanum tuberosum* L.) tubers. J Post harv. Technl. 2014; 02(03):152-168.
8. Carter MR. Soil quality for sustainable land management, organic matter and aggregation interactions that maintain soil functions. J Agron. 2002; 94:38-47.
9. Chaudhary S, Dheri GS, Brar BS. Long-term effects of NPK fertilizers and organic manures on carbon stabilization and management index under rice-wheat cropping system. Soil Tillage Res. 2017; 166:59-66. [Google Scholar] [CrossRef]
10. Congera A, Nanappa MA, Indiresh KM, Kumara BS. Effect of integrated nutrient management on tuber dry matter accumulation and uptake of nutrients by potato (*Solanum tuberosum* L.). Crop Res. 2013; 46(1-3):174-177.
11. Dubey R, Sharma RS, Dubey DP. Effect of organic, inorganic and integrate nutrient management on crop productivity, water productivity and soil properties under various rice-based cropping systems in Madhya Pradesh, India. Int. J Curr. Microb. App. Sci. 2014; 3(2):381-389.
12. Gaur AC, Neelakantan S, Dargan SK. Organic Manures. Ind. Council of Agricultural Research, New Delhi, 1984.
13. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd, New Delhi, 1973.
14. Kannan P, Saravanan A, Krishnakumar S, Natarajan SK. Biological properties of soil as influenced by different organic manures. Res. J Agric. and Biol. Sci. 2005; 1(2):181-183.
15. Kar PP, Barik KC, Mahapatra PK, Garnayak LM, Rath BS, Bastia DK *et al*. Effect of planting geometry and nitrogen on yield, economics and nitrogen uptake of sweet corn (*Zea mays*). Indian J Agron. 2006; 51(1):43-45.
16. Keerthi S, Upendra Rao A, Ramana AV, Tejeswara Rao K. Effect of Integrated nutrient management practices on cob yield, protein content, NPK uptake by sweet corn and post harvest N, P_20_5 and K_20. Intern. J Appl. Biol. Res. 2013; 3(4):553-555.
17. Knudsen D, Peterson GA, Pratt PF. Lithium, sodium and potassium. In A.L. Page *et al.* (Ed.) methods of soil analysis, part II. 2nd edn. Agronomy Monogr. Madison. 1982, 225-246.
18. Kumar M, Baishya LK, Ghosh DC, Gupta VK. Yield and quality of potato (*Solanum tuberosum*) tubers as influenced by nutrients sources under rained conditions of Meghalaya. Indian J Agron. 2012; 56(3):260-266.
19. Mahavishnan K, Prasad M, Rekha KB. Integrated nutrient management in cotton-sunflower cropping system in the sandy loam soils of north India. J Tropic. Agri L. 2005; 43:29-32.
20. Muhr GR, Datta NP, Leley VK, Donahue RL. Soil testing in India. Second Ed. USAID, New Delhi, 1965.
21. Najm AA, Haj Seyed Hadi, Darzi MR, Fazeli MTF. Influence of nitrogen fertilizer and cattle manure on the vegetative growth and tuber production of potato. Int. J Agri. Crop Sci. 2013; 5(2):147-154.
22. Narayan Sumati, Kanth Raihana H, Narayan Raj Khan, Farooq A, Singh Parmeet, Rehman Shabir U. Effect of integrated nutrient management practices on yield of potato. Potato J. 2013; 40(1):84-86.
23. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA Circular No. 939, 1954.
24. Piper CS. Soil and plant analysis. Indian Ed. Hans Publisher, Mumbai, 1966, 186.
25. Sahoo SC, Mahapatra PK. Response of sweet corn (*Zea mays*) to nitrogen levels and plant population. Indian J Agric. Sci. 2004; 74(6):337-338.

26. Sarkar A, Sarkar S, Zaman A. Growth and yield of potato as influenced by combination of organic manures and inorganic fertilizers. Potato J. 2011; 38(1):78-80.
27. Singh NJ, Singh HA, Devi KN, Chontham ND, Singh BN, Sharma PT *et al*. Integrated nutrient management in potato based cropping pattern in south Bihar alluvial plains. Potato J. 2011; 38(2):162-169.
28. Singh SP, Vinay Singh, Singh RV, Lakhan R. Effect of phosphorus and farmyard manure application on yield, content and uptake of nitrogen, phosphorus and sulphate by potato (*Solanum tuberosum* L.). Indian J Agron. 1996; 41(4):630-632.
29. Subbiah BV Asija GL. A rapid procedure for estimation of available nitrogen in soil. Current Science. 1956; 25:259-60.
30. Syahmi Salleh, Nik MM, Nor Azwady. Effects of sewage sludge vermicompost and mineral fertilizer application on the above ground biomass and yield of (*Zea mays*). Malaysia Appl. Biol. 2015; 44(1):37-44.
31. Tandon HLS. Methods for Analysis of Soils, Plant, Water and Fertilizers. Development and Consultation Organization, New Delhi, India, 1993.
32. Zeinab AB, Zahedi Hossein, Sharghi Younes, Nik SS. Comparative assessment of conventional and organic nutrient management on yield and yield components of three corn cultivars. Intern. J Biosci. 2014; 4(12):281-287.