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Impact of Factory Effluent and Inorganic Fertilizers on Availability of Nutrients in Lateritic Soil of Konkan

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A B S T R A C T

Field experiment was conducted during *Rabi* season 2013-2014 at Central Experiment Station, Pangari Block, Wakawali, Dr. B.S.K.K.V. Dapoli, Dist. Ratnagiri. The objective of experiment was effect of factory effluent on available of nutrients in soil. The experiment was laid out in Randomize block design with three replication and nine treatments. The experimental soil was acidic but after application effluent it goes to the alkaline having pH above 7. After application of effluent with inorganic fertilizers the availability of nutrients in soil was increased at great extent which is very necessary for plant growth and yield as compare to only recommended dose of fertilizer.

Introduction

Apart from the nutritive importance, palak is store house for many phyto-nutrients that have health promotional and disease prevention properties. Iron is one of the important trace element required by body for red blood cell production and as a co-factor for oxidation-reduction enzyme, cytochrome oxidase during the cellular metabolism. Fresh leaves are rich source of several vital anti-oxidant vitamins like vitamin A and vitamin C. Vitamin A is required for maintaining healthy mucus membranes and skin and is essential for normal eye-sight. This green leafy vegetable also contains good amount of many B-complex vitamins such as vitamin-B6 (pyridoxine), thiamin (vitamin B-1), riboflavin, folate and niacin. Folate help prevent neural tube defect in the offspring.

Under the present trend of exploitive agriculture in India, inherent soil fertility can no longer be maintained on the sustainable basis. It is said that nutrient supplying capacity of soil declines steadily under continuous and intensive cropping system. The use of optimum levels of N, P and K failed to maintain yield levels probably due to increasing secondary and micronutrient deficiencies and also unfavorable alterations in the physical and chemical properties of soil. Apart from the fertility and productivity issues, use of chemical fertilizers is also becoming more and more difficult for the farmers due to their high costs and scarcity during peak season. Though, the lateritic soils are the best suited for spinach cultivation, extremely suffers by low yield especially due to acidic soil, deficiency of major nutrients (N and P) and lack of affordability of farm inputs.

The use of effluent either in liquid or solid form in agriculture has been practiced in India, since the inception of the industry. In certain areas, the scarcity of water has forced the farmers to use the effluent as a substitute for irrigation water over the years. The indiscriminate disposal in the open area and near natural water bodies causes high water table and contaminate surface and ground waters making them unsuitable for use. Since the conventional methods of waste treatment are uneconomical and especially the difficulty in handling and transporting of large quantities, alternative methods like application of effluents to agricultural land is receiving increasing attention. The increasing cost of fertilizers and most essential nutrients also demand the attention as spent wash contains high amount of nutrients like nitrogen, phosphorus, potassium, calcium and sulphur. This is an important problem of the industries and challenge for the scientists how to use this resource as a source of nutrients and irrigation in crop production.

Materials and Method

The present field experiment was conducted at Research Farm of Pangari Block, Central Experiment Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during *Rabi*, season 2013-14. The selection of site was done on the basis of suitability of land for the cultivation of Spinach. Effluent (composite sample of digester over flow) from the Saf Yeast Company Private Limited, Gane-Khadpoli, Chiplun District-Ratnagiri was collected and applied to the crop. Based on the irrigation requirement of the crop per plot quantity of effluent was calculated and applied directly to the plot before sowing and after first cutting of spinach as per the treatments. The research was conducted during *Rabi*, 2013-14 with all green variety of spinach where nine treatments are replicated thrice in randomize block design in lateritic soil of Konkan. The treatments were T_1 (recommended dose of fertilizers), T_2 (application of effluent before sowing), T_3 (T_2 + 100% RDF), T_4 (T_2 + 50% RDF), T_5 (T_2 + 25% RDF), T_6 (application of effluent before sowing and after 1st cutting), T_7 (T_6 + 100% RDF), T_8 (T_6 + 50% RDF), T_9 (T_6 + 25% RDF). The available nutrient content was analyzed on the basis of methods of analysis of soils, plants, water and fertilizers tondon (1993).

Results and Discussion

Soil reaction

There was significant increase in soil pH due to application of effluent before sowing and after first cutting over RDF (i.e. no effluent treatment) (Table 1).This might be due to alkaline nature of effluent having (pH 8.05). From 1st to 3rd cutting the treatment T_7 (application of effluent before sowing and after first cutting + 100 % RDF) recorded significantly the highest soil pH 6.57, 7.18 and 7.10 at 1st, 2nd and 3rd cutting, respectively as compared to RDF alone and only application of effluent. The result are agreement with those reported by Sweeney and Graetz (1991) who observed that the addition of distillery effluent, regardless of rate, raised the soil pH, owing to the increase in soil K, Ca, Mg levels.

Soil EC

The electrical conductivity appears to increase with application of effluent before sowing and after 1st cutting from treatments T_6 to T_9 at 2nd and 3rd cutting, while it was decreased in case of treatments T_1 to T_5 at 2nd and 3rd cutting

(Table 1). This decrease may, probably due to downward movement of water and uptake of salts by the plants (Dargan *et al.*, 1967).

Organic carbon (g kg^{-1})

The organic carbon content in the soil continually increased from 1^{st} cutting to 3^{rd} cutting in all treatments except treatment T_1 (Table 1).

Distillery effluent is a plant extract; it contains the high organic load.

So the application of this distillery effluent significantly increased organic carbon content of the post-harvest soil (Mattiazo and Adagloria 1985; Rajukkanu *et al.*, 1996; Kayalvizhi *et al.*, 2001).

Effect of factory effluent and inorganic fertilizers on available of N, P and Kin soil

Available nitrogen (kg ha^{-1})

The data presented in (Table 24 and Fig. 10) indicating that available N in soil showed that its content varied from 370.04 to 430.01 kg ha^{-1} at 1^{st} cutting, 369.00 to 452.62 kg ha^{-1} at 2^{nd} cutting and 262.14 to 466.21 kg ha^{-1} at 3^{rd} cutting of spinach (Table 2).

It is observed from the data that the application of effluent and inorganic fertilizers significantly influenced the available nitrogen. Rajukkannu *et al.*, (1996) reported that the higher available N in the post-harvest soil in the effluent treated plots might be due to mineralization of organic matter in soil supplied through distillery effluent.

The increase in N content over periods of observation may partly be due to the decomposition of effluent and split application of N. Further, the available N content of soil in all treatments decreased to a certain extent at 3^{rd} cutting. This may be attributed to the fact that lateritic soils are percolative in nature and there are probable N losses due to leaching and denitrification under field conditions.

Available Phosphorous (kg ha^{-1})

The data regarding available phosphorus in soil as influenced by various treatments and time interval (Table 24 and Fig. 11), indicated that its content varied from 13.42 to 41.38 kg ha^{-1} at 1^{st} cutting 10.66 to 49 kg ha^{-1} at 2^{nd} cutting and 6.16 to 51.87 kg ha^{-1} at 3^{rd} cutting (Table 2). A perusal of the data indicated that there was increase in P content in soil with application of effluent and different levels of recommended fertilizers. Increase in P status could be attributed to the high P content of the effluent. Similar findings were reported by Ale Rita *et al.*, (2008) and Devarajan and Oblisami (1995a and 1995b). Rajukkannu *et al.*, (1996) clarified that the acidity and HCO_3 of distillery spent wash had solubilized the native insoluble soil P and thus helped to increase the available P.

Available potassium (kg ha^{-1})

The available K_2O content of the soil ranged from 251.61 to 4157.44 kg ha^{-1} at 1^{st} cutting, 232.98 to 5356.52 kg ha^{-1} at 2^{nd} cutting and 219.52 to 7624.96 kg ha^{-1} at 3^{rd} cutting, respectively (Table 2). The application of effluent significantly affected the availability of K_2O in soil.

These results corroborates with the finding of Pathak *et al.*, (1998) who also reported the increase in soil K due to application of distillery effluent. Increase in K status could be attributed to the high K content of the effluent. The data noticed that the available K_2O was decreased at 2^{nd} cutting but it was gradually increased at 3^{rd} cutting in all treatment except treatment T_1.

Table.1 Effect of factory effluent and inorganic fertilizers on pH, EC and organic carbon in soil at various cuttings of spinach

Tr. No.	Treatments	pH			EC (ds m^{-1})			OC (g kg^{-1})		
		1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting
T_1	RDF (100:50:50 kg ha^{-1})	5.65	5.54	5.38	0.210	0.167	0.147	8.70	7.20	6.90
T_2	Application of effluent before sowing	6.34	6.88	6.59	0.361	0.342	0.322	10.17	11.80	12.10
T_3	T_2 + 100% RDF	6.55	6.74	6.41	0.381	0.366	0.344	13.63	14.20	15.10
T_4	T_2 + 50% RDF	6.45	6.85	6.78	0.354	0.350	0.339	12.07	12.40	12.60
T_5	T_2 + 25% RDF	6.41	6.82	6.78	0.343	0.330	0.319	9.97	11.00	11.40
T_6	Application of effluent before sowing and after 1st cutting	6.48	7.09	7.02	0.336	3.283	4.022	10.50	15.80	15.80
T_7	T_6 + 100% RDF	6.57	7.18	7.10	0.377	2.806	3.049	13.33	17.50	17.70
T_8	T_6 + 50% RDF	6.50	7.05	7.03	0.336	2.567	2.891	11.47	14.10	14.50
T_9	T_6 + 25% RDF	6.27	6.92	6.85	0.333	1.954	2.749	10.57	12.80	13.10
S.E.±		0.09	0.11	0.13	0.014	0.393	0.408	0.37	1.35	0.62
C.D. (P=0.05)		0.26	0.34	0.38	0.043	1.179	1.223	1.11	4.06	1.86

Table.2 Effect of factory effluent and inorganic fertilizers on available N, P and K in soil at various cuttings of spinach

Tr. No.	Treatments	N (kg ha^{-1})			P_2O_5 (kg ha^{-1})			K_2O (kg ha^{-1})		
		1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting
T_1	RDF (100:50:50 kg ha^{-1})	370.04	369.00	262.14	13.42	10.66	6.16	251.61	232.98	219.52
T_2	Application of effluent before sowing	391.67	431.72	375.99	23.05	29.85	28.62	3713.92	2186.24	2284.80
T_3	T_2 + 100% RDF	420.53	445.31	433.18	26.83	42.96	32.85	4157.44	2477.44	3346.56
T_4	T_2 + 50% RDF	406.63	426.82	421.19	32.06	33.32	29.69	3758.72	2325.12	3171.84
T_5	T_2 + 25% RDF	376.98	424.54	413.67	29.91	37.59	28.93	3660.16	2266.88	2867.20
T_6	Application of effluent before sowing and after 1st cutting	390.88	429.63	443.22	35.80	43.67	49.13	3409.28	4471.04	7423.36
T_7	T_6 + 100% RDF	430.01	452.62	466.21	41.38	49.00	51.87	4130.56	5356.52	7624.96
T_8	T_6 + 50% RDF	412.67	442.17	453.14	19.58	42.00	49.47	3991.68	5344.64	6773.71
T_9	T_6 + 25% RDF	375.54	429.63	442.20	26.69	40.43	44.73	3530.24	5187.84	6008.78
	S.E.±	3.13	14.82	9.02	4.119	4.271	4.848	281.86	451.00	448.51
	C.D. (P=0.05)	9.38	44.43	27.05	12.35	12.81	14.53	845.02	1352.10	1344.63

Table.3 Effect of factory effluent and inorganic fertilizers on exchangeable Ca and Mg and water soluble chloride in soil at various cuttings of spinach

Tr. No.	Treatments	Ca [cmol (p $^{+}$) kg^{-1}]			Mg [cmol (p $^{+}$) kg^{-1}]			Cl (meq L^{-1})		
		1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting
T_1	RDF (100:50:50 kg ha^{-1})	3.38	3.26	3.20	2.03	1.63	1.54	1.80	1.59	1.26
T_2	Application of effluent before sowing	4.43	5.27	4.50	4.27	4.67	3.22	5.50	5.18	3.17
T_3	T_2 + 100% RDF	5.00	5.37	5.00	5.03	5.63	4.63	6.17	5.90	4.17
T_4	T_2 + 50% RDF	4.80	4.83	4.80	4.43	5.00	4.43	4.50	4.30	4.17
T_5	T_2 + 25% RDF	4.13	5.03	4.57	4.43	5.00	4.03	2.62	2.24	2.13
T_6	Application of effluent before sowing and after 1st cutting	4.70	6.17	6.53	4.35	4.90	5.63	4.73	20.50	8.00
T_7	T_6 + 100% RDF	4.87	6.57	6.80	6.03	6.83	7.47	5.48	20.67	9.83
T_8	T_6 + 50% RDF	4.27	5.80	6.47	5.10	6.33	6.13	3.50	19.67	8.50
T_9	T_6 + 25% RDF	4.17	5.23	6.30	5.03	6.03	6.73	2.00	19.00	8.50
	S.E.±	0.26	0.56	0.51	0.47	0.43	0.18	0.21	0.35	0.72
	C.D. (P=0.05)	0.78	1.67	1.52	1.42	1.27	0.54	0.63	1.05	2.16

Effect of factory effluent and inorganic fertilizers on exchangeable Ca, Mg and Cl in soil

Exchangeable Ca (kg^{-1})

The soil calcium at various cuttings ranged from 3.38 to 5.00 cmol (p+) kg^{-1} at 1st cutting, 3.26 to 6.57 cmol (p+) kg^{-1} at 2nd cutting and 3.20 to 6.80 cmol (p+) kg^{-1} at 3rd cutting (Table 3). The effluent application significantly increased the exchangeable Ca content of soil at all cuttings. This might be due to Ca content of the effluent (Devrajan *et al.,* 1996; Baskar *et al.,* 2001; Kayalvizhi *et al.,* 2001 and Baskar *et al.,* 2003). Devarajan and Oblisami (1995b) also reported that the available Ca was significantly increased with graded doses of effluent from 5.2 per cent to 54.58 per cent.

Exchangeable Mg (kg^{-1})

The exchangeable magnesium content of soil ranged from 2.03 to 6.03 cmol (p+) kg^{-1} at 1st cutting, 1.63 to 6.83 cmol (p+) kg^{-1} at 2nd cutting and 1.54 to 7.47 cmol (p+) kg^{-1} at 3rd cutting (Table 3). The data further indicated that exchangeable magnesium content of the soil increased due to two time application of effluent over RDF from treatment T_6 to T_9 at 2nd and 3rd cutting. This might be due to Mg content of the effluent (Baskar *et al.,* 2003). This is in accordance with Devarajan and Oblisami (1995b) and Patil (2012) who reported that the exchangeable magnesium of the soils was significantly increased with graded effluent irrigations. In this context, Bose *et al.,* (1980) clarified that the increase in the content of Mg might be the reason for the little increase in the pH of post-harvest soil upon effluent application. Tisdale *et al.,* (1995) explained that organic matter increases CEC, which reduces potential leaching losses of effluent such as K^+, Ca^{2+} and Mg^{2+} and its availability.

Water soluble Chloride (meq L^{-1})

The data of water soluble chloride in soil showed that it's content varied from 1.80 to 6.17 meq L^{-1} at 1st cutting, 1.59 to 20.67 meq L^{-1} at 2nd cutting and 1.26 to 9.83 meq L^{-1} at 3rd cutting (Table 3). It is revealed that from the data the two time application of effluent significantly affected the water soluble chloride. There was significant and gradual increase in water soluble chloride content of soil with one or two time effluent application. This increase in chloride content might be due to more chloride content in the effluent.

Application of effluent with inorganic fertilizers resulted in a significant increase in soil pH, EC, organic carbon, available N, P, K, Ca, Mg and water soluble chloride contents in the soils and indicating build-up of soil fertility.

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