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Effect of INM on soil fertility, nutrient uptake and yield in rice-European dill (*Anethum graveolens* L.) cropping system

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ABSTRACT
Experiment conducted during kharif and rabi seasons of 2002-03 with eight treatments replicated thrice in both rice and European dill crop had significantly higher organic carbon content and available N, P, K in FYM+GM+CR+Azolla+RF, FYM+RF, GM+RF and GM+CR+RF treatments. The total N, P and K uptake by rice and European dill crop was also significantly higher in the above mentioned treatments. The yield of rice and European dill were also higher in the treatments having FYM, green manure, biofertilizer and crop residue combined with inorganic fertilizers. Therefore, application of FYM + GM + CR + *Azolla* + RF treatment followed by GM +CR + RF or FYM + RF or GM + RF treatments are recommended for higher yield of rice-European dill cropping system.

Key words : INM, Rice, European dill, NPK.

INTRODUCTION

In India, during the past 3 decades, intensive agriculture involving exhaustive high yielding varieties of rice and wheat has led to heavy withdrawl of nutrients from the soil. Further more, imbalanced use of chemical fertilizers by farmers has deteriorated soil health leading to diminishing soil productivity and multiple nutrient deficiencies and disorders (Bhardwaj, 1995).

Use of chemical fertilizers alone has adversely affected the sustainability by limiting the availability of nutrients and deterioration in soil physical condition. Under these constraints integrating bio-organics with chemical fertilizers is one option of alternative strategy which has beneficial effects on crop growth, yield and maintenance of soil fertility (Pattanayak *et al.*, 2001). Further the use of organic sources like biofertilizer, FYM and green manure has its own importance as it lowers the cost of production maintains soil health and is easily available to the small and marginal farmers. Diversification of existing rice-wheat system with medicinal plant based cropping system to make it more profitable as well as to sustain soil health deserves top priority.

Therefore taking all these facts into consideration, the present study was undertaken to evaluate the effect of INM on soil fertility, nutrient uptake and yield in rice-European dill cropping system.

MATERIALS AND METHODS

The field experiment was conducted during kharif and rabi seasons of 2002-03 in the *Tarai* belt of Uttaranchal situated at 29°N latitude, 79°30´ E longitude and at an altitude of 243.83 m above the mean sea level. The soil of the experimental field was clay loam classified as mollisol. The initial properties of soil of experimental field were as follows: pH-7.87, EC - 0.40dS m^{-1}, BD-1.24 Mg m^{-3}, CEC-15.78 cmol (p+)kg^{-1}, OC-0.74%, Available N-203.5 kg ha^{-1}, Available P-26.6 kg ha^{-1}, Available K-195.8 kg ha^{-1}, Sand-36%, Silt-28%, Clay-36% and Texture- Clay loam.

The experiment was conducted having eight treatments replicated thrice in both rice and European dill crop. The treatments were Control(N = 0, P = 0, K = 0), Soil test based fertilizer(STF), FYM @ 10 t/ha + rest amount of fertilizer (FYM+RF), Green manure (cow pea) + rest amount of fertilizer (GM+RF), Agronomic recommended fertilizers (AF), Biofertilizer (Azolla in rice and Azotobacter in European Dill) + rest amount of fertilizers (Azolla + RF), Green manure (cowpea) + crop residue of previous crop + rest amount of fertilizers (GM+CR+RF) and FYM @ 10t/ha + green manure (cowpea) + crop residue of previous crop + biofertilizer + rest amount of fertilizers (FYM+GM+CR+Azolla +RF).

Well decomposed FYM @ 10 t/ha on dry weight basis was incorporated into the field 25 days before transplanting of paddy. Cowpea was grown and incorporated *in situ* after 35 days in the plots receiving green manure treatment. *Anabaena azollae* was applied in rice @ 5 t/ha (90% moisture) while *Azotobacter chroccocum* was applied to European dill @ 10^3 live cells per seed using jaggery solution as adherent.

Percent organic carbon estimated by modified Walkley and Black method (Jackson, 1967). Available-N estimated by alkaline $KMnO_4$ method (Subbiah and Asija, 1956). Available-P as per method of Olsen *et al.* (1954). Available-P by neutral normal ammonium acetate method of Hanway and Heidel (1952).

RESULTS AND DISCUSSION

Percent Organic Carbon

The percent organic carbon of soil estimated initially, after harvest of rice and European dill are presented in Table-1 and depicted in Fig. 1. The organic carbon content of soil varied significantly after harvest of both the crops. It was observed that the treatment FYM+GM+CR+Azolla+RF caused significantly higher organic carbon content which was at par with FYM+RF, GM+RF and GM+CR+RF treatments. Significantly lower values were obtained in control, STF and AF treatments. The organic carbon content of soil increased over initial value in all treatments except Control after harvest of both the crops. The higher organic carbon content in INM treatments may be because of addition of organic sources in the form of FYM, green manure and crop residue (Das *et al.*, 2001). The organic carbon content of soil was more after harvest of European dill crop compared to rice crop which may be due to additive effect of European dill leaf fall well before maturity leading to higher activity of soil microflora because of narrow C/N ratio of bio-organics added.

Available Nutrients

The available N, P and K (Table-1) in soil varied significantly after the harvest of rice and European dill crop (Fig. 2, 3 & 4). Treatment FYM+GM+CR+Azolla+RF had significantly higher available-N which was at par with FYM+RF, GM+RF and GM+CR+RF treatments. At the end of cropping system, treatments having integrated nutrient sources showed an increasing trend of available-N compared to initial value. The STF, AF and Control had significantly lower available N, P and K compared to other treatments which showed a decreasing trend in availability of nutrients over initial value.

Available nutrients (N, P, K) in soil of INM treated plots were found higher after the harvest of European dill compared to rice. The enriched soil nutrient status after the harvest of European dill may be because of addition of leaf litter as a result of complete senescence of leaves towards harvest which added organic matter to the soil and residual effect of bio-organics added at the start of experiment lead to higher available nutrient status. This indicates that European dill crop added more easily decomposable organic matter to soil compared to rice in the present investigation. The available N was higher in treatments

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Table 1: Effect of INM on soil fertility status in rice – European dill cropping system

Treatment	OC (%)			N (kg ha^{-1})			P(kg ha^{-1})			K (kg ha^{-1})		
	Initial	After Rice	After E. Dill	Initial	After Rice	After E. Dill	Initial	After Rice	After E. Dill	Initial	After Rice	After E. Dill
Control		0.70	0.73		187.4	166.5		20.8	13.5		188.3	181.0
STF		0.82	0.94		194.1	179.7		26.1	22.8		192.0	226.2
FYM+ RF		0.97	1.12	203.5	208.8	231.5	26.6	32.3	34.2		213.5	245.3
GM+RF		0.93	1.11		208.3	222.2		31.8	28.2		210.3	245.0
AF	0.74	0.87	0.95		191.9	218.4		27.1	31.4	195.8	189.2	223.2
Azolla+RF		0.86	0.98		203.2	212.6		26.5	30.4		197.0	232.0
GM+CR+RF		0.94	1.10		206.7	227.5		31.4	35.7		216.3	247.5
FYM+GM+CR+Azolla+RF		0.99	1.14		215.6	239.3		34.8	37.2		223.8	254.8
CD at 5 %		0.06	0.12		6.91	17.66		4.58	5.56		20.80	21.97

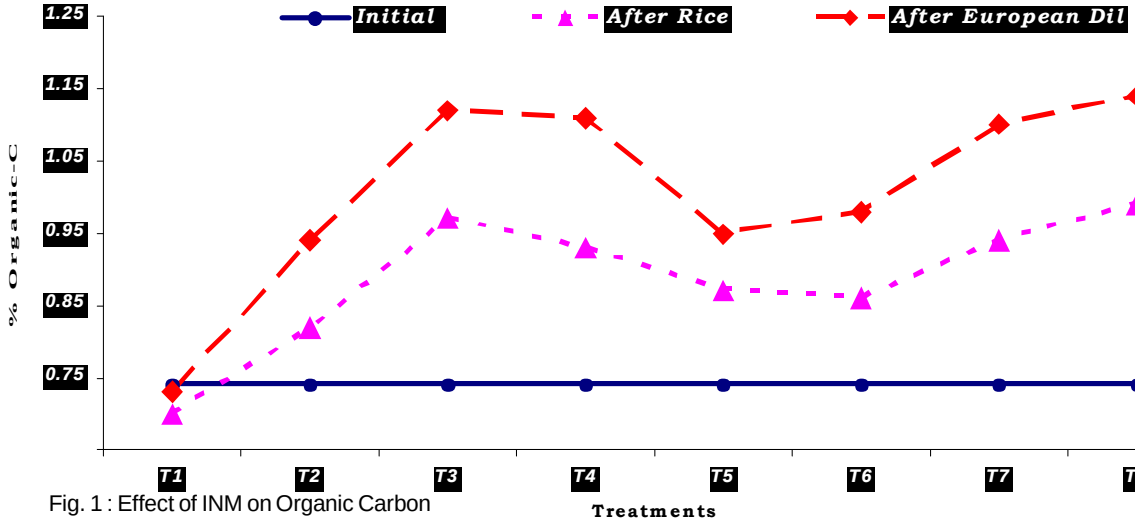

Fig. 1 : Effect of INM on Organic Carbon

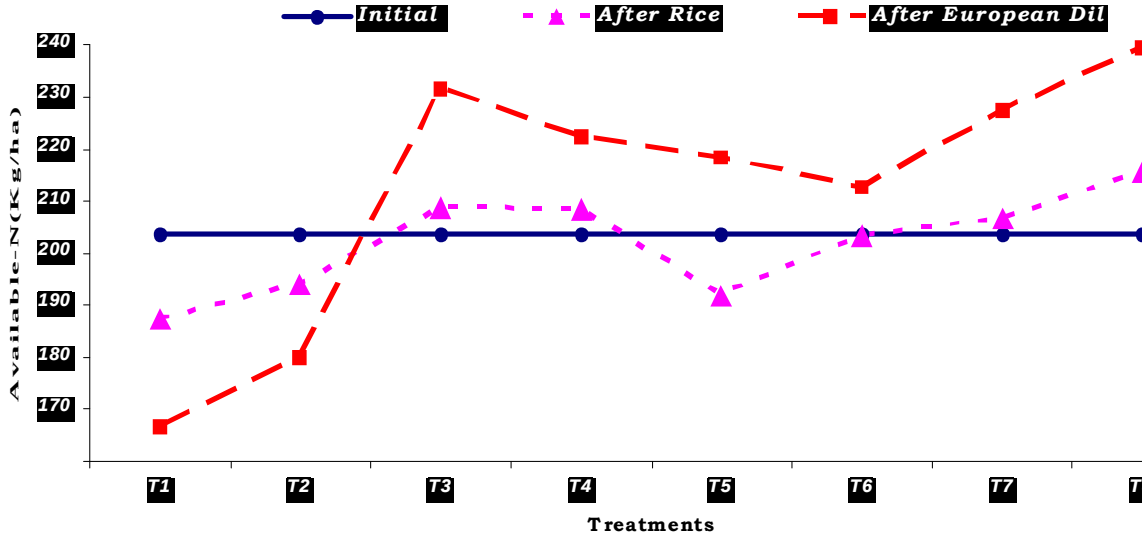

Fig.2 : Effect of INM on Available -N

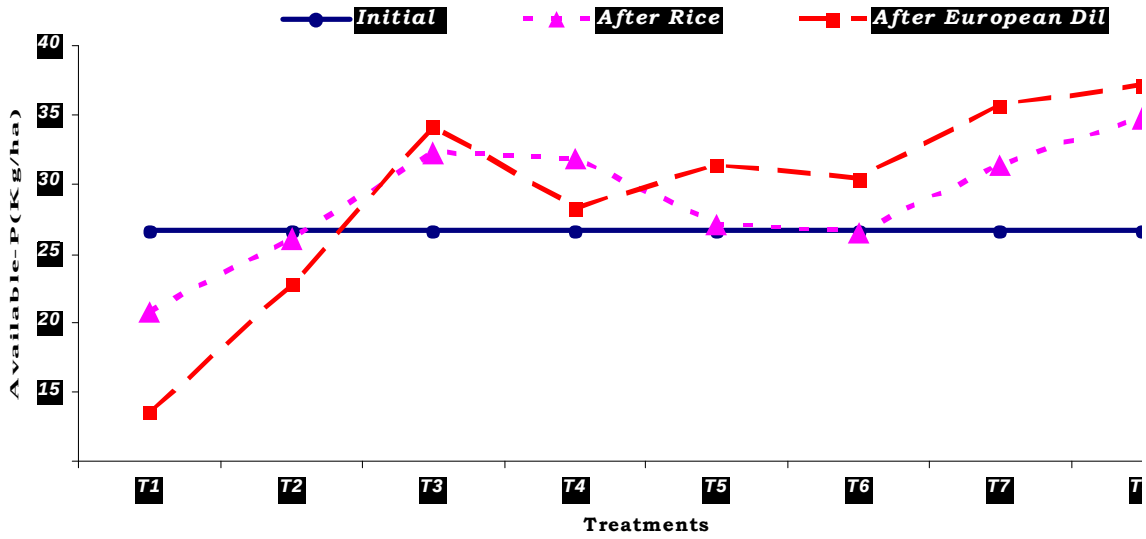

Fig.3 : Effect of INM on Available -P

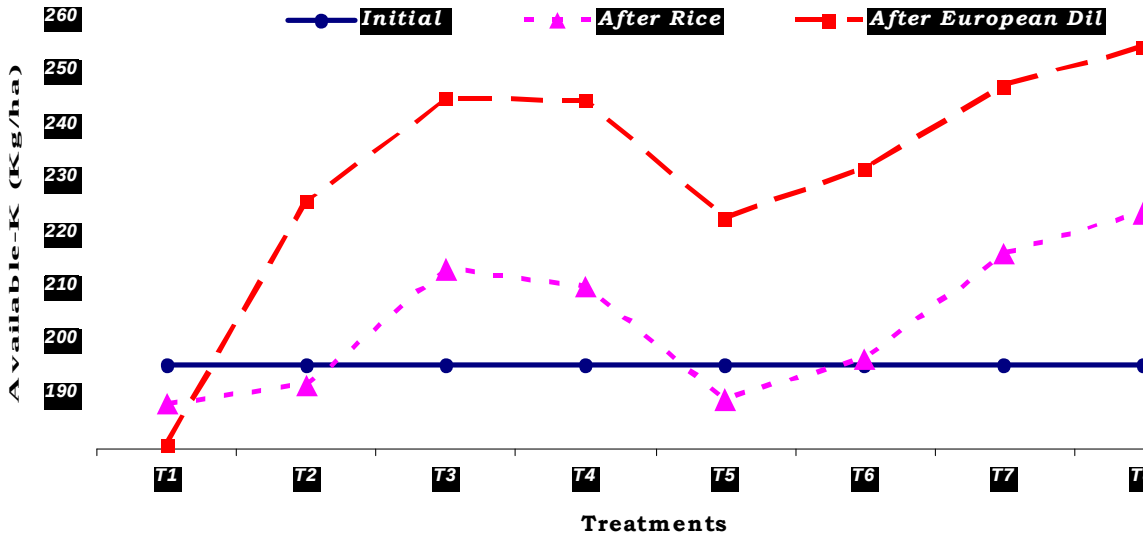

Fig.4 : Effect of INM on Available -K

Table 2 : Effect of INM on total nutrient-uptake in rice – European dill cropping system

Treatment	Rice			European dill		
	Total N Uptake (kg ha^{-1})	Total P Uptake (kg ha^{-1})	Total K Uptake (kg ha^{-1})	Total N Uptake (kg ha^{-1})	Total P Uptake (kg ha^{-1})	Total K Uptake (kg ha^{-1})
Control	50.16	21.16	60.93	19.14	6.53	41.69
STF	74.51	24.43	89.44	29.19	10.85	75.27
FYM+ RF	99.91	34.20	125.1	44.75	14.83	91.80
GM+RF	97.55	34.19	124.0	38.19	13.26	90.37
AF	79.75	28.63	97.39	33.07	10.88	74.06
Azolla+RF	85.70	28.61	109.58	37.29	11.74	78.84
GM+CR+RF	96.41	31.26	127.5	42.38	14.97	95.69
FYM+GM+CR+Azolla+RF	102.7	39.60	137.8	48.24	16.85	106.00
CD at 5 %	7.11	5.82	15.83	6.87	2.51	15.83

having FYM, green manure and crop residue which may be because of continuous mineralization at a slow rate due to microbial activity. Increase in available N might be attributed to direct addition of nitrogen through organic sources to available pool of soil. This resulted in greater multiplication of soil microbes which enhanced the conversion of organically bound N to inorganic forms (Tolanur and Badanur, 2003).

Nutrient Uptake

The data pertaining to total N, P and K uptake by rice and European dill crop presented in Table-2 varied significantly. The total N-uptake of rice crop in treatments FYM+GM+CR+Azolla+RF, FYM+RF, GM+RF and GM+CR+RF remained at par and caused significantly higher uptake compared to remaining treatments. The total P and K uptake of rice followed a similar trend.

In European dill crop treatment FYM+GM+CR+Azolla+RF was found to be at par with FYM+RF and GM+CR+RF treatments that caused significantly higher total N, P and K uptake compared to remaining treatments.

The uptake of nutrients (N, P and K) is a function of dry matter accumulation by crop. Increased uptake in INM treatments of both the crops was mainly because of better physical status of soil leading to higher availability of nutrients as observed in the present experiment (Table-1).

Yield

The data recorded for yield of rice and European dill presented in table-3 and depicted in Fig.5 varied significantly. The highest grain and straw yield of rice was recorded in FYM+GM+CR+Azolla+RF treatment which was found to be at par with FYM+RF, GM+RF and GM+CR+RF treatments compared to remaining treatments. The STF and AF treatments having inorganic sources alone had significantly lower grain and straw yield.

In European dill also significantly higher seed, straw and oil yields were observed in FYM+GM+CR+Azolla+RF treatment which was at par with FYM+RF, GM+RF and GM+CR+RF treatments.

The significantly higher yield obtained in INM treatments under rice-European dill cropping system might be attributed to the application of FYM, green manure, biofertilizer and crop residue combined with inorganic sources which enhanced the nutrient availability leading to higher uptake as observed in present experiment. These results are in accordance with the findings of Sharma and Mitra (1989).

Oil yield which is a function of seed yield and oil content of seed was significantly higher in INM treatments compared to STF, AF and control treatments. Therefore, significantly higher oil yield was recorded in INM treatments. Chopra *et al.* (1957), Randhawa *et al.* (1987) and Ativeer (1995) have also reported better response of European dill crop to organic and integrated use of nutrient sources.

On the basis of present study and the results obtained it may be concluded that integrated nutrient treatments having bio-organic sources like FYM, green manure (cowpea), crop residue and *Azolla* / *Azotobacter* enhanced nutrient availability which led to better nutrient uptake ultimately leading to increase in yield. Addition of bio-organic sources of nutrients also maintained good soil health. Thus experimental results advocate a superiority of integrated nutrient sources in rice-

Table 3: Effect of INM on yields in rice – European dill cropping system

Treatment	Rice		European dill		
	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})	Seed Yield (q ha^{-1})	Straw Yield (q ha^{-1})	Oil Yield (kg ha^{-1})
Control	38.87	36.16	4.60	15.63	10.17
STF	43.53	46.72	7.13	25.52	14.11
FYM+ RF	57.63	60.50	10.23	28.56	19.20
GM+RF	56.39	59.75	9.66	27.86	18.02
AF	46.77	49.04	8.79	25.09	15.88
Azolla+RF	47.41	54.84	8.06	25.68	16.72
GM+CR+RF	58.15	58.76	10.13	29.34	19.29
FYM+GM+CR+Azolla+RF	58.32	61.91	11.20	30.66	21.45
CD at 5 %	6.64	6.07	2.62	3.32	5.26

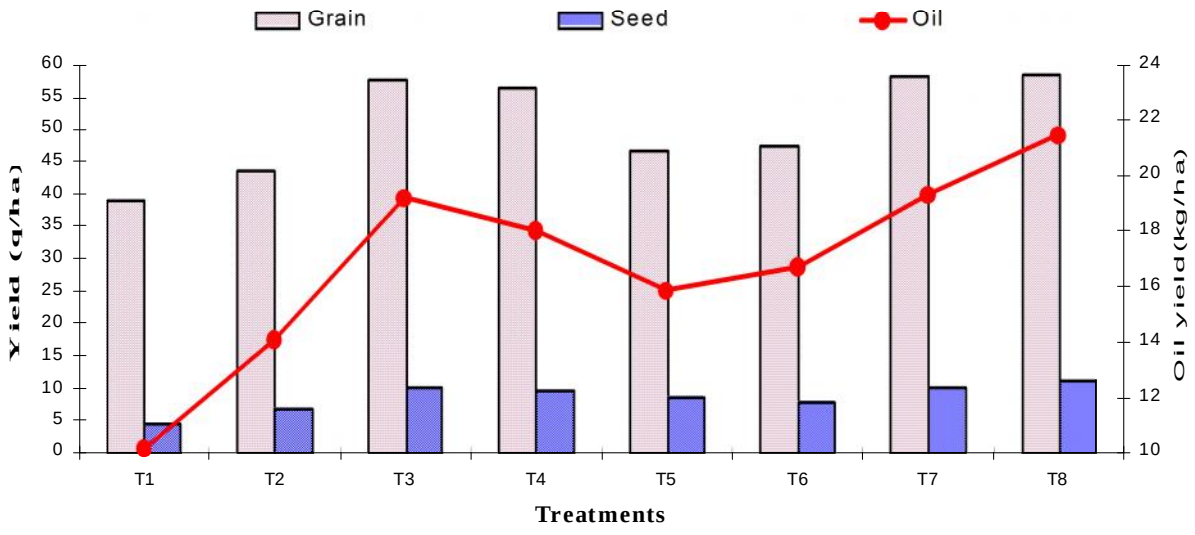

Fig.5 : Effect of INM on rice grain yield, seed and oil yield of European dill

European dill cropping system. Therefore, application of FYM + GM + CR + *Azolla* + RF treatment followed by GM +CR + RF or FYM + RF or GM + RF treatments are recommended for higher yield of rice-European dill cropping system.

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