Original Research Article

Effect of Integrated Use of Manures and Fertilizers on Physico-chemical Properties of Soil and Yield of Coconut (*Cocos nucifera L.*)

ABSTRACT

A field experiment was conducted during 2014-15 and 2015-16 in a thirty years old coconut garden of cultivar Pratap at the farm of Asond block, Central Experiment Station, Wakawali, Dr.Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Tal.-Dapoli, Dist.- Ratnagiri (M.S.). The experiment was laid out in Randomized Block Design comprising ten treatments replicated thrice. The treatments were applied in three splits (*viz*., Stage I- June, Stage II- October and Stage III- February) in a year. The soil samples were collected periodically before fertilizers application and analyzed for different physico-chemical properties (*viz*., pH, EC and organic carbon). The yield of each palm was recorded throughout the year under experimental plot. The year wise yield was worked out and analyzed statistically.

The application of RDN through FYM at 25 kg/palm/year + Neem Cake at 15 kg/palm/year + Vermicompost at 6 kg/palm/year (T_{10}) recorded significant increase in pH, EC and organic carbon content in soil of coconut orchard. Also the physico-chemical properties of soil found to be improved during second year over the first year of experimentation. The application of RDF + Azadirachtin + Micronutrients through briquettes (Treatment T_5) received highest yield of coconut. Therefore, it is concluded that the application of RDF along with Azadirachtin and Micronutrients through Konkan Annapurna Briquettes in three splits (i.e. June, October and February) is beneficial for increasing the yield of coconut.

(Keywords:INM, Coconut, Soils, Physico-chemical Properties, Yield and Maharashtra)

1. INTRODUCTION:

The coconut (*Cocos nucifera* L.) palm eulogized as “Kalpavriksha” and “Tree of Heaven”, it provides not only edible parts but also fuel, shelter, medicine and employment to the millions of people in tropics.In India, coconut is grown in 19 states and 3 union territories, mostly along the coastal region of the country. The area under coconut in Ratnagiri district (M.S.) is 4,549 hectares with an annual production of 409.41 lakh nuts and average productivity of 9,001 nuts ha^{-1} (Anonymous, 2015). The coconut palm requires balanced fertilization of NPK; the response of N and K was common while response of P was under certain conditions. Palms with larger yield potential need higher dose of NPK. Worldwide people realized that pure chemical farming undermines the natural mechanism operating in the ecosystem and often leads to soil degradation, pollution of ground water and eutrophication of water bodies with nitrates, phosphates and pesticides (Upadhyay *et al.,* 1998). Organic manures are important in sustaining soil productivity especially for a perennial crop like coconut, which requires continuous supply of nutrients.

It has therefore, integrated nutrient management been always considered for best fertilizationof crops. Therefore, considering all these facts, present study was undertaken.

2. MATERIALS AND METHODS:

The experiment was conducted during 2014-15 and 2015-16 in a thirty years old coconut garden of cultivar Pratap at the farm of Asond block, Central Experiment Station, Wakawali, Dr.Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Tal.-Dapoli, Dist.- Ratnagiri (M.S.) which is located at 17.68337^0 N latitude and 73.27761^0 E longitudes with an altitude of 250 m MSL. The research station receives very highannual average rainfall of 3500 mm in rainy days. The soils of experimental site are well drained, sandy clay loam in texture, slightly acidic in reaction with low electrical conductivity and high in organic carbon content. The soil is medium in available nitrogen, low in available phosphorus and high in available potassium content. Kaolinite is the dominant clay mineral in this soil.

The experiment was laid outin Randomized Block Design comprising ten treatments (*viz*., T_1- Absolute Control (No manure, no fertilizer), T_2- Recommended Dose of Fertilizers (RDF) only, T_3- Application of RDF through briquettes, T_4- Application of RDF + Azadirachtin through briquettes, T_5- Application of RDF + Azadirachtin + Micronutrients through briquettes, T_6- Application of RDF + Neem oil through briquettes, T_7- Application of RDF through briquettes and neem cake at 15 kg/palm, T_8- Application of RDF + Root feeding with Azadirachtin 5 % @ 7.5 mL + 7.5 mL water, T_9- Application of RDF + Drenching with Eriophyid smash 250 mL/ 20 L of water and T_{10}- RDN through FYM at 25 kg/palm/year + Neem cake at 15 kg/palm/year + Vermicompost at 6 kg/palm/year) replicated thrice. Two palms for each treatment were selected at Farm of Asond Block, C.E.S. Wakavali, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Dist.- Ratnagiri during 2014-15 and 2015-16. The treatments were applied in three splits (*viz*., Stage I- June, Stage II- October and Stage III- February) in a year.

Soil samples were collected periodically before fertilizers application and analyzed for different physico-chemical properties (*viz*., pH, EC and organic carbon). The pH and EC in soil was determined by potentiometriclly and conductometrically as per the procedure given by Jackson(1973) while, organic carbon was determined by Walkley and Black's wet digestion method as described by Black(1965). The yield of each palm was recorded throughout the year under experimental plot. The year wise yield was worked out and analyzed statistically for Randomized Block Design by following the standard procedures given by Panse and Sukhatme (1967).

3. RESULTS AND DISCUSSION:

From the data presented in Table1, it is clearly observed that the physico-chemical properties of soil in coconut orchard were improved due to application of manures and fertilizers during both the years of experimentation. The treatments receiving application of RDN through FYM at 25 kg/palm/year + Neem Cake at 15 kg/palm/year + Vermicompost at 6 kg/palm/year (T_{10}) and application of RDF through briquettes and neem cake at 15 kg/palm (T_7) showed the maximum improvement in pH of soil. An overall the mean soil pH during first year and second year ranged between 5.46 to 5.89 and 5.43 to 6.04, respectively. In comparison of both years an increasing trend of soil pH was noticed from first year to second year due to application of organic manures in treatments T_{10} and T_7. In general, due to application of organic manure like FYM, neem cake and vermicompost soil pH was found to be increased over rest of the treatments including recommended dose of fertilizers (T_2) during both years of the experiment. The soil samples in all treatments were 'moderately to slightly acidic' in reaction as per the ratings given by Bangar and Zende (1978).The increase in pH of acid soil due to addition of organic manures is attributed to the deactivation of Fe^{3+} and concomitant release of basic cations during their decomposition (Lal and Mathur, 1988). Similar results were also recorded by Temgire (2007) and Maheswarappa*et al*. (2014) in lateritic soils of coconut orchard due to application of manures and fertilizers.

In case of electrical conductivity (Table 2), it did not much more influenced due to application of manure and fertilizers through different treatments applied during both the years of experiment. The electrical conductivity of soil during first year and second year varied between 0.062 to 0.102 dS m^{-1} and 0.073 to 0.118 dS m^{-1}, respectively. There is slight increase in electrical conductivity of soil due to application of all treatments of manures and fertilizes over absolute control. Comparatively, the electrical conductivity of soil during second year was increased over first year. The electrical conductivity of soil in all treatments was low and having no any potential threat to the productivity of the soils to crop growth.It was also observed that the electrical conductivity of soil was significantly increased due application of manures and fertilizers over absolute control during both the years. In general, the soil samples under all treatments were found under 'normal' (i.e. < 1.0 dS m^{-1}) class of electrical conductivity based on the ratings given by Seth (1967) indicating low salt concentration in these soils.Increase in electrical conductivity with application of organic manures and fertilizers were also reported by Diwale (2012) and Bhosale (2016) for lateritic soils of Konkan.

The data given in Table 3, clearly explain that application of manures and fertilizers significantly increased organic carbon content of soil in all stages of both the years of experimentation. The organic carbon content in soil during first year and second year was ranged between 1.57 to 2.36 per cent and 1.47 to 2.73 per cent, respectively.The maximum built up of soil organic carbon in soil was noticed due to application of treatments receiving application of RDN through FYM at 25 kg/palm/year + Neem Cake at 15 kg/palm/year + Vermicompost at 6 kg/palm/year (T_{10}) and application of RDF through briquettes and neem cake at 15 kg/palm (T_7) and during both the years of trial.In comparison of both years, an increasing trend of soil organic carbon was noticed from first year to second year due to application of organic manures in treatments T_{10} and T_7.

The soil samples in all treatments were categorized under 'very high' class (ratings by Bangar and Zende, 1978) showing presence of excess amount of organic carbon content in the soils of coconut orchards.

The improvement in organic carbon content of soil in organic manure treated plots might be ascribed to direct addition of organic matter through organic manures and also due to addition of considerable amount of leaf litter of crops. High amount of organic carbon content in these soils might be attributed to luxurious growth of grasses and vegetation due to high rainfall and thus addition of organic matter through litter, residues and cover crops and thereby subsequent increased humification (Preethi *et al*., 1998).An increase in organic carbon content of soil due to the application of various organic manures were noted by Hapse*et al.* (1993), Kadam (2000), Yaduvanshi (2003), Gedam *et al.* (2008), Gadade (2007), Yadav *et al*. (2009) and Diwale (2012) for different soils.

Effect on Yield:

The data given in Table 4, clearly explain that the yield of coconut significantly increased due to application of manures and fertilizers in both the years of trial i.e. 2014-15 and 2015-16. The application of RDF + Azadirachtin + Micronutrient through briquettes (T_5) recorded significantly higher nut yield (125.33 and 129.50 nuts palm^{-1} year^{-1}) over rest of the treatments during both years of experimentation, respectively except treatments T_8 and T_9. Treatment T_5 was at par with treatments T_8 and T_9. The lowest yield was recorded by the treatment T_1 (Absolute control).

An overall the nut yield of coconut during first year and second year ranged between 85.33 to 125.33 nuts palm^{-1} year^{-1} and 84.67 to 129.50 nuts palm^{-1} year^{-1}, respectively. In comparison of both years an increasing trend of nut yield from first year to second year was noticed due to application of manures and fertilizers. The increase in nut yield during second year might be due to combined effect of manures and fertilizers applied during second year as well as the residual impact of manures and fertilizers applied during first year.

In general, due to application of manure and fertilizers through different treatments the nut yield in coconut orchard was found to be increased over absolute control during both years of the experiment.The increase in nut yield with integration of organics with fertilizers was attributed to increased female flowers and nut setting per cent due to improved availability of nutrients to coconut.

The beneficial response of manures and fertilizers over absolute control to yield might be attributed to the availability of sufficient amount of plant nutrients throughout the year to the crop, improvement of soil environment resulting in higher root proliferation leading to better absorption of moisture and nutrients, plant vigour and ultimately higher yield. After proper decomposition and mineralization, the manures supplied available nutrients directly to the plants and also had solubilising effect on fixed forms of nutrients in soil (Sinha *et al.,* 1981).

Similar results of higher nut yield with integrated use of manures and fertilizers also reported by Temgire (2007) and Talashilkar*et al*. (2008).

4. CONCLUSION:

On the basis of data obtained from the present investigation, it could be concluded that the application of RDN through FYM at 25 kg/palm/year + Neem Cake at 15 kg/palm/year + Vermicompost at 6 kg/palm/year in three splits (i.e. June, October and February) is beneficial for improving physico-chemical properties of soil of coconut orchard.The application of RDF + Azadirachtin + Micronutrients through briquettes (Treatment T_5) receiving highest yield along with maximum net return and B:C ratio. Therefore, it is concluded that the application of RDF along with Azadirachtin and Micronutrients through Konkan Annapurna Briquettes in three splits (i.e. June, October and February) is beneficial for increasing the yield of coconut.

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Table 1.Effect of integrated use of manures and fertilizers on pH of soils in coconut orchard

Treat. No.	Treatments	2014-15				2015-16			
		Stage I	Stage II	Stage III	Mean	Stage I	Stage II	Stage III	Mean
T_1	Absolute Control (No manure, no fertilizer)	5.58	5.50	5.44	**5.51**	5.44	5.50	5.53	**5.49**
T_2	Recommended Dose of Fertilizers (RDF) only	5.52	5.44	5.43	**5.46**	5.47	5.40	5.44	**5.44**
T_3	Application of RDF through briquettes	5.79	5.70	5.49	**5.66**	5.47	5.41	5.42	**5.43**
T_4	Application of RDF + Azadirachtin through briquettes	5.59	5.59	5.51	**5.56**	5.48	5.54	5.53	**5.52**
T_5	Application of RDF + Azadirachtin + Micronutrient (B) through briquettes	5.56	5.54	5.36	**5.49**	5.54	5.74	5.46	**5.58**
T_6	Application of RDF + Neem oil through briquettes	5.50	5.60	5.46	**5.52**	5.37	5.47	5.45	**5.43**
T_7	Application of RDF through briquettes and neem cake at 15 kg/palm	5.64	5.84	6.00	**5.83**	6.02	5.76	5.85	**5.88**
T_8	Application of RDF + Root feeding with Azadirachtin 5% @ 7.5 mL + 7.5 mL water	5.49	5.69	5.50	**5.56**	5.48	5.54	5.50	**5.51**
T_9	Application of RDF + Drenching with Eriophyid smash 250 mL/20 L of water	5.73	5.60	5.49	**5.61**	5.49	5.52	5.53	**5.51**
T_{10}	RDN through FYM at 25 kg/palm/year + Neem cake at 15 kg/palm/year + Vermicompost at 6 kg/palm/year	5.54	6.05	6.07	**5.89**	6.12	5.98	6.01	**6.04**
	SE ±	**0.11**	**0.05**	**0.06**		**0.05**	**0.06**	**0.02**	
	CD @ 5 %	**N.S.**	**0.15**	**0.19**		**0.14**	**0.18**	**0.07**	

Note: Stage-I of first year is the initial stage and the values given under Stage-I of first year are irrespective of treatments

Table 2. Effect of integrated use of manures and fertilizers on electrical conductivity (dS m^{-1}) of soil in coconut orchard

		Stage I	Stage II	Stage III	Mean	Stage I	Stage II	Stage III	Mean
T_1	Absolute Control (No manure, no fertilizer)	0.065	0.060	0.061	**0.062**	0.078	0.072	0.068	**0.073**
T_2	Recommended Dose of Fertilizers (RDF) only	0.060	0.059	0.079	**0.066**	0.088	0.079	0.070	**0.079**
T_3	Application of RDF through briquettes	0.088	0.071	0.106	**0.088**	0.124	0.088	0.076	**0.096**
T_4	Application of RDF + Azadirachtin through briquettes	0.078	0.066	0.126	**0.090**	0.140	0.103	0.080	**0.108**
T_5	Application of RDF + Azadirachtin + Micronutrient (B) through briquettes	0.082	0.092	0.099	**0.091**	0.088	0.100	0.111	**0.100**
T_6	Application of RDF + Neem oil through briquettes	0.082	0.086	0.100	**0.089**	0.111	0.117	0.086	**0.105**
T_7	Application of RDF through briquettes and neem cake at 15 kg/palm	0.081	0.086	0.096	**0.088**	0.139	0.118	0.084	**0.114**
T_8	Application of RDF + Root feeding with Azadirachtin 5% @ 7.5 mL + 7.5 mL water	0.096	0.096	0.115	**0.102**	0.109	0.117	0.095	**0.107**
T_9	Application of RDF + Drenching with Eriophyid smash 250 mL/20 L of water	0.091	0.093	0.110	**0.098**	0.135	0.112	0.107	**0.118**
T_{10}	RDN through FYM at 25 kg/palm/year + Neem cake at 15 kg/palm/year + Vermicompost at 6 kg/palm/year	0.090	0.081	0.089	**0.087**	0.116	0.108	0.121	**0.115**
	SE ±	**0.007**	**0.004**	**0.007**		**0.009**	**0.007**	**0.005**	
	CD @ 5 %	**N.S.**	**0.011**	**0.020**		**0.027**	**0.021**	**0.016**	

Note: Stage-I of first year is the initial stage and the values given under Stage-I of first year are irrespective of treatments

Table 3. Effect of integrated use of manures and fertilizers on organic carbon (%) of soil in coconut orchard

Treat. No.	Treatments	2014-15				2015-16			
		Stage I	Stage II	Stage III	Mean	Stage I	Stage II	Stage III	Mean

T_1	Absolute Control (No manure, no fertilizer)	1.51	1.49	1.70	**1.57**	1.51	1.43	1.46	**1.47**
T_2	Recommended Dose of Fertilizers (RDF) only	1.55	1.50	1.66	**1.57**	1.74	1.57	1.34	**1.55**
T_3	Application of RDF through briquettes	1.64	1.94	1.63	**1.74**	1.78	1.66	1.68	**1.71**
T_4	Application of RDF + Azadirachtin through briquettes	1.55	1.77	1.74	**1.69**	1.72	1.65	1.62	**1.66**
T_5	Application of RDF + Azadirachtin + Micronutrient (B) through briquettes	1.63	1.77	1.61	**1.67**	1.25	1.83	1.75	**1.61**
T_6	Application of RDF + Neem oil through briquettes	1.51	1.78	1.49	**1.59**	1.48	1.51	1.57	**1.52**
T_7	Application of RDF through briquettes and neem cake at 15 kg/palm	1.69	2.15	2.07	**1.97**	2.12	2.22	2.29	**2.21**
T_8	Application of RDF + Root feeding with Azadirachtin 5% @ 7.5 mL + 7.5 mL water	1.59	1.52	1.81	**1.64**	1.55	1.72	1.54	**1.60**
T_9	Application of RDF + Drenching with Eriophyid smash 250 mL/20 L of water	1.77	1.40	1.76	**1.64**	1.62	1.75	1.59	**1.65**
T_{10}	RDN through FYM at 25 kg/palm/year + Neem cake at 15 kg/palm/year + Vermicompost at 6 kg/palm/year	1.85	2.54	2.68	**2.36**	2.59	2.70	2.89	**2.73**
	SE ±	**0.09**	**0.09**	**0.08**		**0.12**	**0.09**	**0.06**	
	CD @ 5 %	**N.S.**	**0.26**	**0.24**		**0.36**	**0.26**	**0.18**	

Note: Stage-I of first year is the initial stage and the values given under Stage-I of first year are irrespective of treatments

Table 4. Effect of integrated use of manures and fertilizers on yield (nuts palm^{-1} year^{-1}) of coconut

Treat. No.	Treatments	2014-15	2015-16
T_1	Absolute Control (No manure, no fertilizer)	85.33	84.67
T_2	Recommended Dose of Fertilizers (RDF) only	98.67	104.50
T_3	Application of RDF through briquettes	102.17	114.17
T_4	Application of RDF + Azadirachtin through briquettes	112.50	117.67
T_5	Application of RDF + Azadirachtin + Micronutrient (B) through briquettes	125.33	129.50
T_6	Application of RDF + Neem oil through briquettes	103.33	113.00
T_7	Application of RDF through briquettes and neem cake at 15 kg/palm	114.83	116.67
T_8	Application of RDF + Root feeding with Azadirachtin 5 % @ 7.5 mL + 7.5 mL water	122.67	126.17
T_9	Application of RDF + Drenching with Eriophyid smash 250 mL/ 20 L of water	123.83	127.17
T_{10}	RDN through FYM at 25 kg/palm/year + Neem cake at 15 kg/palm/year + Vermicompost at 6 kg/palm/year	104.00	101.17
	SE ±	**3.43**	**3.31**
	CD @ 5 %	**10.19**	**9.84**