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Effect of Green Manure and Nutrient Management on Castor (*Ricinus communis* L.) Nutrient Content and Soil Fertility

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ABSTRACT: A field experiment was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat during the two consecutive kharif seasons of the years 2020-21 and 2021-22 on "Effect of Integrated Nutrient Management on nutrient content of Castor (*Ricinus Communis* L.) and soil fertility". There were twenty treatment combinations comprising four green manuring treatments. Growing of sunhemp as green manuring crop give significantly highest N and P content in seed and stalk of castor and N, P and K uptake by stalk of castor. Significantly improvement in organic carbon and available N by different green manuring treatments. Application of 100% RDF + Banana pseudostem sap @1.5% as foliar spray at 30, 60 and 90 DAS give Significantly higher N and P content in seed and stalk, N, P and K uptake by seed and stalk and available N. while combined application of green manuring and nutrient management treatments were found non-significant influence on, nutrient content in seed and stalk, nutrient uptake by seed and stalk and maintain soil fertility status in soil after harvest of castor. The result indicated that growing of sunhemp at 45 DAS as green manure crop followed by sowing of castor with application of 75% recommended dose of fertilizers (90:28:00 N: P_2O_5:K_2O/ha) + 1.5% foliar spray of banana pseudostem sap at 30, 60 and 90 days after sowing improve nutrient content and maintain soil fertility status. So, green manuring has become increasingly relevant in contemporary agriculture due to its multifaceted benefits, aligning with sustainable and environmentally conscious farming practices.

Keywords: Green manure, nutrient content and soil fertility.

INTRODUCTION

Castor is an industrially important non-edible oilseed crop widely cultivated in the arid and semi-arid regions of the world. India, Brazil and China are the most important castor-growing countries in the world. At present, India is the world leader in castor production. The area during the year 2021-22 was 8.11 lakh ha with the production of 17.95 lakh tonnes and productivity of 2228 kg/ha (Anonymous, 2022). In Gujarat, the area under castor during the year 2021-22 was 6.52 lakh ha with the production of 15.47 lakh tonnes and productivity of 2371kg/ha (Anonymous, 2022). In Gujarat, castor is mainly grown in the Banaskantha, Mehsana, Patan and Sabarkantha districts of North Gujarat.

The use of chemical fertilizers alone may not keep race with time in maintaining soil health for sustaining productivity. Growing concern about the sustainability of oilseed-based cropping systems coupled with rising costs of chemical fertilizers has renewed interest in the use of organic manures along with green manuring. The economic significance of organic manures has gained momentum in recent years, because of their utilization as a renewable source of energy, their effects on maintaining soil fertility, increasing nutrient use efficiency, improving soil physical conditions and their role in getting a sustainable yield of crops. The integrated approach of nutrient supply by inorganic and organic fertilizers is gaining importance because this system not only reduces the use of costly inorganic fertilizers but is also an environment friendly approach. Besides these, it also involves green manuring and off-farm waste recycling with the overall objective of sustainable production, maintaining resources and environmental quality (FAO, 1988).

Green manuring is a practice of ploughing or turning into the soil un-decomposed fresh green plant tissue to improve the fertility status and physical structure of the soil. Unlike synthetic N fertilizer, legumes utilized as green manures represent a potentially renewable source of on-farm biologically fixed N and may also fix and add a large amount of carbon to cropping systems. The plant material is mostly of leguminous plants like sunhemp (*Crotalaria juncea*), dhaincha (*Sesbania aculeate, Sesbania rostrata*), cowpea (*Vigna unguiculata*) and cluster bean (*Cymposis tetragonoloba*) etc. Banana is the most important fruit crop widely cultivated in India mainly for fruit

purposes. But after the fruit harvest, a huge quantity of pseudostems are generated as waste. Pseudostem sap contains essential macro and micronutrients, growth-promoting substances like cytokinin and GA_3 (Gibberellic Acid) and it can use as an organic nutritive supplier to the crops to increase their crop growth and yield. This nutritive enriched sap can be applied to the plants as the foliar spray to enhance the plant growth and yield, and it is one of the most cost-effective fertilizers can found naturally. Farmers require advance or experts' knowledge to take decision during; soil preparation, seed selection, fertilizer management, pesticide management, water scheduling, weed management etc. (Saleem et al., 2021).

Considering the importance of green manuring and INM on castor crop with a view to sustainable utilization of resources and reducing the cost of cultivation, present investigation was carried out to study the Effect of green manure and nutrient management on Castor nutrient content and soil fertility.

MATERIALS AND METHODS

The field experiment was laid out in Plot No. B-6 during Kharif season of the years 2020-21 and 2021-22 at Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha (at 24º19' N, 72º19' E 154.52 m above the mean sea level) to study the effect of Effect of green manure and nutrient management on Castornutrient content, uptake and soil fertility. The climate of this region is sub-tropical monsoon type and falls under the semi-arid region. The total rainfall received during the crop growth period of the first year (2020-21) was 1180.5 mm with rainy days of 37 and in the second year (2021-22) was 487 mm with rainy days of 27. The average rainfall of Sardarkrushinagar is 712.7 mm.The weekly mean evaporation ranged from 2.7 to 7.6 mm with an average of 5.3 mm during the year 2020-21 and 3.3 to 7.9 mm with an average of 5.7 mm during the year 2021-22. This showed that the average evaporation did not vary during both the years 2020-21 and 2021-22 of experimentation. To assess the physico-chemical properties of the soil of the experimental field, the soil samples were taken randomly from different spots of the experimental field to a depth of 0-15 before layout considering all possible precautions for soil sampling. The soil analysis data presented in Table 1 indicated that the soil of the experimental plot was loamy sand in texture having pH (7.58) and EC (0.16 dS/m) at 0-15 cm soil depth during 2020-21. Analysis showed that the experimental soil was low in organic carbon (0.34%) and available nitrogen (162.8 kg/ha), medium in phosphorus (39.2 kg/ha) and high in potassium (254.3) status. The castor, sunhemp, cluster bean and cowpea variety are GCH 8, Local, GG2 and GC 4 respectively.

Twenty treatment combination of green manuring and nutrient management viz., Control (No green manuring) + 100% RDF (G_0N_1), Control (No green manuring) + 75% RDF + Banana pseudostem sap @1% as foliar spray at 30, 60 and 90 DAS (G_0N_2),Control (No green manuring) + 75% RDF + Banana pseudostem sap @1.5% (G_0N_3), Control (No green manuring) + 100% RDF + Banana pseudostem sap @1% (G_0N_4), Control (No green manuring) + 100% RDF + Banana pseudostem sap @1.5% (G_0N_5), Sunhemp + 100% RDF (G1N1), Sunhemp + 75% RDF + Banana pseudostem sap @1% (G_1N_2), Sunhemp + 75% RDF + Banana pseudostem sap @1.5% (G_1N_3), Sunhemp + 100% RDF + Banana pseudostem sap @1% (G_1N_4), Sunhemp + 100% RDF + Banana pseudostem sap @1.5% (G_1N_5), Cluster bean + 100% RDF (G_2N_1), Cluster bean + 75% RDF + Banana pseudostem sap @1% (G_2N_2), Cluster bean + 75% RDF + Banana pseudostem sap @1.5% (G_2N_3), Cluster bean + 100% RDF + Banana pseudostem sap @1% (G_2N_4), Cluster bean + 100% RDF + Banana pseudostem sap @1.5% (G_2N_5), Cowpea + 100% RDF (G_3N_1), Cowpea + 75% RDF + Banana pseudostem sap @1% (G_3N_2), Cowpea + 75% RDF + Banana pseudostem sap @1.5% (G_3N_3), Cowpea + 100% RDF + Banana pseudostem sap @1% (G_3N_4), Cowpea + 100% RDF + Banana pseudostem sap @1.5% (G_3N_5) were tested in split-plot design with three replications. Among the total nitrogen, one-third of the recommended dose of nitrogen was applied in the form of urea and the entire dose of phosphorus through DAP was applied as a basal dose at the time of sowing. After fertilizer application, the furrows were covered with soil in such a way that the furrows remained partly opened for dibbling of seed. The remaining dose of nitrogen was top-dressed in three equal splits from urea according to soil moisture availability.

Representative samples were taken from each net plot after the harvest of the crop for the estimation of N, P and K content. N, P, K was determination by Micro Kjeldahl's method (Jackson, 1974), Vanadomolybdo phosphoric acid yellow color method (Jackson, 1974) and Flame Photometer method (Jackson, 1974) respectively.The soil samples were drawn from 0-15 cm depth before experimentation (initial) at first year and after harvest of the crop during both the years were oven-dried at 105°C, and then sieved through a 2 mm size sieve. The initial composite soil sample was analysed for different physico-chemical properties like EC, pH, organic carbon, N, P, and K. The soil samples collected after the harvest of castor crops in both the years were used for the determination of EC, pH, organic carbon, available N, available P_2O_5 and available K_2O by following Potentiometry (1:2.5), Conductometry (1: 2 soil:water), Walkley and Black's method (Walkley & Black 1934), Alkaline Potassium Permanganate method (Subbiah and Asija 1956), 0.5 M sodium bicarbonate (1:20) and determined calorimetrically (Olsen *et al*., 1954) and neutral ammonium acetate (1:5) and determined by the flame photometer method (Jackson, 1973) respectively.

Banana pseudostem sap. Foliar application of enriched banana pseudostem sap @1% and 1.5% was done at 30, 60 and 90 DAS as per the treatments. This product is patented as a brand name of Nauroji, by Navsari Agricultural University, Navsari, Gujarat.

Table 1: Chemical composition of banana pseudostem sap.

Content of nutrients							
pH	**Total N (%)**	**TotalP (ppm)**	**Total K (ppm)**	**Total Fe (ppm)**	**Total Mn (ppm)**	**Total Zn (ppm)**	**Total Cu (ppm)**
4.5	0.857	175	1150	86.09	6.73	4.61	0.97

Note: Banana pseudostem sap @ 1% and 1.5%foliar spray at 30, 60 and 90 DAS

The statistical analysis was carried out as described by Panse and Sukhatme (1985). The values of calculated "F" were worked out and compared with the value of table "F" at 5 % level of significance. The pooled analysis of the 2 years data was carried out as per procedure suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Effect of green manuring

Nutrient content in seed and stalk of castor. Incorporation of sunhemp as a green manuring recorded significantly higher N and P content in seed of (3.322, 3.411 and 3.366%), (1.013, 0.990 and 1.002%) and stalk of (1.113, 1.107 and 1.110%), (1.113, 1.107 and 1.110%) during first year, second year and in pooled results, respectively. Which were remained statistically at par with cowpea in case of N and P content in seed (3.231 and 3.251%, 0.973, 0.992 and 0.982%) during 2020-21 and 2021-22 and stalk (1.078, 1.057 and 1.068%, 0.212, 0.209 and 0.211%)) and incorporation of sunhemp also remained at par with cluster bean for N and P content in stalk (1.044, 1.031 and 1.037%) and (0.210%) during first year, second year and in pooled analysis whereas first year in case of P content in castor stalk. Significantly lower N content in seed (3.097, 3.029 and 3.063%), P content ((0.948, 0.916 and 0.932%) in seed whereas in case of stalk lower N content (0.984, 0.983 and 0.983%) and P in stalk (0.195, 0.200 and 0.198 %) was recorded control (No green manuring) during first year, second year and in pooled results. K content (%) in seed and stalk of castor were observed non-significant due to different green manuring during both the years of study as well as in pooled analysis.

In situ green manuring improves physical, chemical and biological conditions of the soil by adding higher quantity of green biomass. Green manure crops added huge quantity of nitrogen in the soil. This might have promoted growth of root as well as their functional activity resulting in higher extraction of nitrogen from soil environment to aerial parts. The results of present investigation are in close agreements with the findings of Chauhan (2016); Patil (2016); Joshi (2021). Incorporation of sunhemp and cowpea as a green manure crop add more P into soil than cluster bean and control (No green manuring) treatments. As well as these crops have higher green biomass and P content. Better growth of crop with these crops extracted more amount of P from soil resulted into higher P content (%) in seed and stalk of castor. The results of present investigation are in close agreements with the findings of Chavan *et al*. (2010); Patil (2016).

Effect of nutrient management. significantly higher N and P content in seed (3.277, 3.292 and 3.284%, 0.998, 0.996 and 0.997%) and stalk of castor (1.088, 1.077 and 1.083%, 0.217, 0.215 and 0.216%) were obtained with application of 100% RDF + banana pseudostem sap @1.5% as foliar spray at 30, 60 and 90 DASand was at par with 100% RDF + banana pseudostem sap @1% as foliar spray at 30, 60 and 90 DAS *i.e*. 3.248, 3.225 and 3.236% N content in seed, P content in seed (0.976 and 0.975 during first and second year)and 1.084, 1.058 and 1.071% N, P content in stalk (0.215, 0.211 and 0.213%) during first year, second year and pooled results. Application of 75% RDF + banana pseudostem sap @1.5% as foliar spray at 30, 60 and 90 DAS also remained at par during first year for N content (3.197%) in seed and during both the years as well as in pooled analysis for N content (1.060, 1.048 and 1.054%) in stalk of castor. Whereas, Application of 75% RDF + banana pseudostem sap @1% at 30, 60 and 90 DAS also remained at par (0.211%) during first year in case of P content in stalk. K content in seed and stalk of castor (%) was found non-significant due to different nutrient management practices during 2020-21, 2021-22 and in pooled analysis. Similarly, significantly the lower N and P content in seed (3.182, 3.194 and 3.188%, 0.942, 0.938 and 0.940%) and stalk (1.012, 1.007 and 1.010%, 0.195, 0.199 and 0.197 %) was recorded with application of 100% RDF during 2020-21, 2021-22 and in pooled results. Overall, optimum rate of organic and inorganic fertilizers exhibited significantly more N content in seed and stalk.

Application of 100 % or 75% RDF along with either banana pseudostem sap @1.5% or @1% as foliar spray at 30, 60 and 90 DAS resulted in higher values of N content (%) in seed and stalk. The beneficial effects under these treatments might be due to the fact that plants absorbed N proportionately in higher amount because the pool of available nutrients already increased in the soil from applied nutrition and application of banana pseudostem sap rich in almost all beneficial nutrients, source of N which readily soluble and liquid form, one of the important compounds in banana pseudostem sap was readily available to the plants directly influencing the N content in plants. These results are in agreement with those of Kumar and Kanjana (2009); Gudadhe *et al.* (2017). This might be due to the fact that application of inorganic fertilizer either through 75 % or 100% RDF with banana pseudostem sap improves the absorption of P by plant roots and their transportation towards foliage and later on translocation in the seed by various metabolic activities. Banana pseudostem sap also helped in increase the uptake of P due to release of growth-

promoting substances improve the absorption of nutrients from the soil.

Interaction effect. Interactions between various green manuring and nutrient management treatments were found non-significant during both the years and on pooled results with respect to N, P and K content (%) in seed and stalk of castor.

Table 2: Effect of green manuring and nutrient management practices on N, P and K content in seed of castor.

Treatments		N (%)			P (%)			K (%)		
		2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
[A]	**Main plot: Green manuring (G):**									
	G_0: Control (No green manuring)	3.097	3.029	3.063	0.948	0.916	0.932	1.047	1.066	1.057
	G_1: Sunhemp	3.322	3.411	3.366	1.013	0.990	1.002	1.107	1.099	1.103
	G_2: Cluster bean	3.188	3.149	3.168	0.936	0.965	0.950	1.104	1.072	1.088
	G_3: Cowpea	3.231	3.251	3.241	0.973	0.992	0.982	1.103	1.098	1.101
	S.Em.±	0.036	0.050	0.031	0.012	0.014	0.009	0.017	0.019	0.013
	C.D.(P=0.05)	0.123	0.173	0.094	0.04	0.05	0.03	NS	NS	NS
	C.V.%	4.30	6.02	5.23	4.64	5.55	5.12	6.00	6.86	6.44
[B]	**Sub-plot: Nutrient management (N):**									
	N_1: 100% RDF	3.182	3.194	3.188	0.942	0.938	0.940	1.059	1.051	1.055
	N_2: 75% RDF + Banana pseudostem sap @1%	3.143	3.165	3.154	0.958	0.956	0.957	1.099	1.082	1.091
	N_3: 75% RDF + Banana pseudostem sap @1.5%	3.197	3.174	3.185	0.964	0.964	0.964	1.108	1.087	1.097
	N_4: 100% RDF + Banana pseudostem sap @1%	3.248	3.225	3.236	0.976	0.975	0.975	1.091	1.093	1.092
	N_5: 100% RDF + Banana pseudostem sap @1.5%	3.277	3.292	3.284	0.998	0.996	0.997	1.095	1.105	1.100
	S.Em.±	0.033	0.029	0.022	0.012	0.012	0.008	0.016	0.018	0.012
	C.D.(P=0.05)	0.094	0.084	0.062	0.03	0.03	0.02	NS	NS	NS
Interaction:										
G × N		NS	NS	NS	NS	NS	NS	NS	NS	NS
Y × G		-	-	NS	-	-	NS	-	-	NS
Y × N		-	-	NS	-	-	NS	-	-	NS
Y × G × N		-	-	NS	-	-	NS	-	-	NS
C.V.%		3.51	3.14	3.33	4.23	4.21	4.22	5.11	5.72	5.42

Note: foliar spray of Banana pseudostem sap @1% and 1.5% at 30, 60 and 90 DAS

Table 3: Effect of green manuring and nutrient management practices on N, P and K content in stalk of castor.

Treatments		N (%)			P (%)			K (%)		
		2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
[A]	**Main plot: Green manuring (G):**									
	G_0: Control (No green manuring)	0.984	0.983	0.983	0.195	0.200	0.198	0.288	0.294	0.291
	G_1: Sunhemp	1.113	1.107	1.110	0.219	0.215	0.217	0.312	0.298	0.305
	G_2: Cluster bean	1.044	1.031	1.037	0.210	0.202	0.206	0.301	0.297	0.299
	G_3: Cowpea	1.078	1.057	1.068	0.212	0.209	0.211	0.302	0.296	0.299
	S.Em.±	0.019	0.023	0.015	0.004	0.003	0.002	0.006	0.005	0.004
	C.D.(P=0.05)	0.067	0.081	0.047	0.012	0.011	0.007	NS	NS	NS
	C.V.%	7.15	8.71	7.96	6.52	5.72	6.14	7.67	6.53	7.13
[B]	**Sub-plot: Nutrient management (N):**									
	N_1: 100% RDF	1.012	1.007	1.010	0.195	0.199	0.197	0.291	0.291	0.291
	N_2: 75% RDF + Banana pseudostem sap @1%	1.029	1.031	1.030	0.207	0.203	0.205	0.301	0.298	0.299
	N_3: 75% RDF + Banana pseudostem sap @1.5%	1.060	1.048	1.054	0.211	0.203	0.207	0.299	0.297	0.298
	N_4: 100% RDF + Banana pseudostem sap @1%	1.084	1.058	1.071	0.215	0.211	0.213	0.306	0.297	0.302
	N_5: 100% RDF + Banana pseudostem sap @1.5%	1.088	1.077	1.083	0.217	0.215	0.216	0.306	0.298	0.302
	S.Em.±	0.020	0.015	0.013	0.003	0.003	0.002	0.006	0.005	0.004
	C.D.(P=0.05)	0.059	0.044	0.036	0.009	0.009	0.006	NS	NS	NS
Interaction:										
G × N		NS	NS	NS	NS	NS	NS	NS	NS	NS
Y × G		-	-	NS	-	-	NS	-	-	NS
Y × N		-	-	NS	-	-	NS	-	-	NS
Y × G × N		-	-	NS	-	-	NS	-	-	NS
C.V.%		6.68	5.12	5.96	5.07	5.10	5.08	6.95	5.85	6.43

Note: foliar spray of Banana pseudostem sap @1% and 1.5% at 30, 60 and 90 DAS

Effect of green manuring and nutrient management on available nutrient in soil

Effect of green manuring. It is evident from the data that Soil EC and pH was not significantly influence by different green manuring treatments during both the years as well as on pooled basis. Significantly higher organic carbon (%) in soil after harvest of castor was registered with incorporation of sunhemp crop as a green manuring (0.321, 0.331 and 0.326%) and it remained at par with cowpea (0.317, 0.320 and 0.319%) during the year 2020-21, 2021-22 and in pooled results. Incorporation of sunhemp and cowpea as green manuring purpose recoded higher organic carbon (%) status in soil after harvest of castor crop might be due to higher quantity of green biomass incorporation in soil as compared to control (No green manuring). Similar results were also reported by Chavan *et al.* (2010); Chauhan (2016); Joshi (2021).

Green manuring with sunhemp registered significantly higher available N of 241.08, 244.32 and 242.70 kg/ha in soil after harvest of castor during first year, second year and in pooled results, respectively. Which was

remained statistically at par with cowpea (229.76 and 234.45 kg/ha) during first and second year. Whereas, effect of different green manuring did not cause their significant effect on available P_2O_5 and K_2O (kg/ha) after harvest of the crop during both the years and on pooled results.Incorporation of sunhemp and cowpea used as green manuring registered higher available N status in soil after harvest of castor crop might be due to higher quantity of N added in soil due to huge quantity of green biomass added to the soil and fix atmospheric N before incorporation in the soil. Similar results are also reported by Chaudhari (2014); Patil (2016); Joshi (2021).

Effect of nutrient management. Application of different nutrient management treatments was maintaining Soil EC, pH and soil organic carbon content after harvest of the castor crop. Significantly higher available N in soil after harvest of castor of 238.22, 240.82 and 239.52 kg/ha was recorded with 100% RDF alone but it remained at par with 100% RDF + banana pseudostem sap @1% at 30, 60 and 90 DAS of 232.55, 236.21 and 234.38 kg/ha during 2020-21, 2021-22 and in pooled results, respectively. Application of 100% RDF + banana pseudostem sap @1.5% at 30, 60 and 90 DAS also remained statistically at par during 2021-22. This might be owing to addition of organic matter along with inorganic fertilizer which might augmented more mineralization and increased nutrient status. Sunnhemp and cowpea being a leguminous crop decomposed quickly and release organic acid. Similar results have also been reported by Chavan *et al.* (2005); Singhal *et al*. (2015); Gudadhe *et al.* (2017); Joshi (2021). Different nutrient management treatments maintaining the status Soil available of P_2O_5 and K_2O (kg/ha) in soil after harvest of the castor.

Interaction effect. Interaction effects among different green manuring and nutrient management practices were found non-significant with respect to Soil EC, pH, organic carbon content (%), Available N, P_2O_5 and K_2O in soil after harvest of castor crop during 2020-21, 2021-22 and on pooled basis.

Table 4: Effect of green manuring and nutrient management practices on organic carbon content in soil after harvest of castor.

Treatments			Organic carbon (%)		
			2020-21	2021-22	Pooled
[A]	Main plot: Green manuring (G):				
	G_0:	Control (No green manuring)	0.282	0.286	0.284
	G_1:	Sunhemp	0.321	0.331	0.326
	G_2:	Cluster bean	0.297	0.305	0.301
	G_3:	Cowpea	0.317	0.320	0.319
		S.Em.±	0.004	0.005	0.003
		C.D.(P=0.05)	0.013	0.017	0.009
		C.V.%	4.81	5.97	5.43
[B]	Sub-plot: Nutrient management (N):				
	N_1:	100% RDF	0.301	0.308	0.304
	N_2:	75% RDF + Banana pseudostem sap @1%	0.302	0.310	0.306
	N_3:	75% RDF + Banana pseudostem sap @1.5%	0.305	0.309	0.307
	N_4:	100% RDF + Banana pseudostem sap @1%	0.307	0.311	0.309
	N_5:	100% RDF + Banana pseudostem sap @1.5%	0.308	0.315	0.311
		S.Em.±	0.004	0.004	0.003
		C.D.(P=0.05)	NS	NS	NS
Interaction:					
G × N			NS	NS	NS
Y × G			-	-	NS
Y × N			-	-	NS
Y × G × N			-	-	NS
C.V.%			4.62	4.68	4.65

Note: foliar spray of Banana pseudostem sap @1% and 1.5% at 30, 60 and 90 DAS

Table 5: Effect of green manuring and nutrient management practices on Soil EC and pH after harvest of castor.

Treatments			EC (dS/m)			pH		
			2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
[A]	Main plot: Green manuring (G):							
	G_0:	Control (No green manuring)	0.145	0.146	0.145	7.48	7.47	7.48
	G_1:	Sunhemp	0.135	0.138	0.137	7.29	7.37	7.33
	G_2:	Cluster bean	0.140	0.142	0.141	7.41	7.43	7.42
	G_3:	Cowpea	0.136	0.141	0.138	7.38	7.40	7.39
		S.Em.±	0.003	0.003	0.002	0.08	0.09	0.06
		C.D.(P=0.05)	NS	NS	NS	NS	NS	NS
		C.V.%	8.09	8.36	8.23	4.21	4.77	4.50
[B]	Sub-plot: Nutrient management (N):							
	N_1:	100% RDF	0.142	0.145	0.144	7.44	7.43	7.43
	N_2:	75% RDF + Banana pseudostem sap @1%	0.136	0.140	0.138	7.40	7.43	7.41
	N_3:	75% RDF + Banana pseudostem sap @1.5%	0.138	0.139	0.138	7.41	7.42	7.41
	N_4:	100% RDF + Banana pseudostem sap @1%	0.139	0.141	0.140	7.38	7.41	7.39
	N_5:	100% RDF + Banana pseudostem sap @1.5%	0.141	0.143	0.142	7.33	7.41	7.37
		S.Em.±	0.002	0.002	0.002	0.07	0.07	0.05
		C.D.(P=0.05)	NS	NS	NS	NS	NS	NS
Interaction:								
G × N			NS	NS	NS	NS	NS	NS
Y × G			-	-	NS	-	-	NS
Y × N			-	-	NS	-	-	NS

Y × G × N	-	-	NS	-	-	NS
C.V.%	6.18	5.23	5.72	3.18	3.32	3.25

Note: foliar spray of Banana pseudostem sap @1% and 1.5% at 30, 60 and 90 DAS

Table 6: Effect of green manuring and nutrient management practices on Soil Available N, P_2O_5 and K_2O after harvest of castor.

Treatments		N (kg/ha)			P_2O_5 (kg/ha)			K_2O (kg/ha)		
		2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
[A]	**Main plot: Green manuring (G):**									
	G_0: Control (No green manuring)	212.16	215.40	213.78	39.99	41.08	40.54	246.04	247.85	246.94
	G_1: Sunhemp	241.08	244.32	242.70	42.43	44.05	43.24	249.24	254.86	252.05
	G_2: Cluster bean	223.47	226.19	224.83	41.07	42.03	41.55	248.94	250.53	249.73
	G_3: Cowpea	229.76	234.45	232.11	41.48	43.28	42.38	246.54	252.43	249.48
	S.Em.±	3.83	4.08	2.80	0.84	0.96	0.64	4.37	4.33	3.08
	C.D.(P=0.05)	13.26	14.13	8.63	NS	NS	NS	NS	NS	NS
	C.V.%	6.55	6.87	6.72	7.85	8.71	8.31	6.83	6.67	6.75
[B]	**Sub-plot: Nutrient management (N):**									
	N_1: 100% RDF	238.22	240.82	239.52	43.63	45.13	44.38	250.67	253.36	252.01
	N_2: 75% RDF + Banana pseudostem sap @1%	217.30	221.31	219.31	39.06	40.05	39.56	249.37	251.80	250.59
	N_3: 75% RDF + Banana pseudostem sap @1.5%	215.67	218.66	217.16	38.18	39.63	38.90	248.22	251.37	249.80
	N_4: 100% RDF + Banana pseudostem sap @1%	232.55	236.21	234.38	43.13	44.60	43.87	245.68	249.86	247.77
	N_5: 100% RDF + Banana pseudostem sap @1.5%	229.34	233.46	231.40	42.21	43.65	42.93	244.51	250.69	247.60
	S.Em.±	2.78	3.18	2.11	0.66	0.78	0.51	3.65	4.29	2.82
	C.D.(P=0.05)	8.02	9.15	5.97	NS	NS	NS	NS	NS	NS
Interaction:										
G × N		NS	NS	NS	NS	NS	NS	NS	NS	NS
Y × G		-	-	NS	-	-	NS	-	-	NS
Y × N		-	-	NS	-	-	NS	-	-	NS
Y × G × N		-	-	NS	-	-	NS	-	-	NS
C.V.%		4.26	4.78	4.53	5.58	6.32	5.97	5.11	5.91	5.53

Note: foliar spray of Banana pseudostem sap @1% and 1.5% at 30, 60 and 90 DAS

CONCLUSIONS

Incorporation of sunhemp at 45 DAS as green manure crop followed by sowing of castor with application of 75% recommended dose of fertilizers (90:28:00 N: P_2O_5: K_2O kg/ha) + 1.5% foliar spray of banana pseudostem sap at 30, 60 and 90 days after sowing was improved Nutrient content in castor crop as well as improve fertility status of the soil.

FUTURE SCOPE

— Long-term Monitoring: Extend the study over several more seasons to assess the sustainability and long-term impact of the integrated nutrient management and green manuring practices on castor cultivation and soil fertility.

— Crop Rotation Impact: Investigate the influence of the studied practices on subsequent crops in a rotational system to understand their broader effects on agroecosystems.

— Economic Analysis: Conduct economic evaluations to determine the cost-effectiveness and profitability of the recommended practices for farmers, considering factors such as input costs, yield increase, and market prices.

— Climate Resilience: Explore the adaptability of the proposed practices to varying climate conditions and their effectiveness in mitigating the impact of climate change on castor cultivation.

— Microbial Community Dynamics: Investigate the changes in soil microbial communities resulting from the implemented practices, as microbial activity plays a crucial role in soil health.

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REFERENCES

Anonymous (2022). State-wise area, production and productivity of castor seeds in India, 2019-20 to 2021-22. The Solvent Extractors Association of India.

Chaudhari, N. U. (2014). Influence of different green manuring crops and nitrogen management on yield and quality of *rabi* sweet corn (*Zea mays* L.) under north Gujarat Agro climatic condition. M.Sc. (Agri.) Thesis (Unpublished). Department of Agronomy, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

Chauhan, S. A. (2016). Integrated nutrient management in castor (*Ricinus communis* L.) under middle Gujarat conditions. Ph.D. (Agri.) Thesis (Unpublished), Anand Agricultural University, Anand.

Chavan, M., Pujari, B. T., Jalageri, B. R. and Surwenshi, A. (2010). Sustaining castor (*Ricinus communis* L.) Productivity by relative use of green manures and nitrogen levels. *Asian Journal of Soil Science*, *5*(1), 151-153.

FAO (1988). World Soil Resources Report 84, FAO, Rome.

Gudadhe, N., Thanki, J., Pankhaniya, R., Ardeshna, R. B. and Bavalgave, V. B. (2017). Response of *rabi* hybrid castor to rate and source of nitrogen with and without biofertilizer. *Indian Journal of fertilizers*, *13*(7), 42-46.

Jackson, M. L. (1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, pp. 183-192.

Jackson, M. L. (1974). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, pp. 327-350.

Joshi, J. (2021). Effect of nutrient management on potato preceded by green manure crops. Unpublished Ph.D. (Agri.) Thesis. Submitted to Department of Agronomy, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

Kumar, N. S. and Kanjana, D. (2009). Influence of integrated nutrient management practices on yield attributes, seed yield, oil yield and nutrient uptake of castor under irrigated conditions. *Indian Journal Agricultural Research*, *43*(3), 200-205.

Olsen, S. R., Cole, V. C., Watanble, P. S. and Dean, L. A. (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonate. *Chem. Abstr.*, *48*(16), Ab. 1598.

Panse, W. G. and Sukhatme, G. M. (1985). "Statistical methods for Agricultural Workers", I.C.A.R., New Delhi.

Patil, (2016). Performance of nutrient management in potato preceding by green manuring crops. Unpublished Ph.D. (Agri.) Thesis, submitted to Department of Agronomy, University of Agricultural Science, GKVK, Bangalore.

Saleem, H., Khan, A. R., Jilani, T. A., Sherani, J., Saddozai, U. K., Jilani, M. S., ... & Ullah, S. (2021). A Comprehensive Review on the Application of Diagnostic Expert Systems in the Field of Agriculture. *International Journal on Emerging Technologies, 12*(1), 304–316.

Singhal, V. K., Patel, G. G., Patel, D. H. and Saini, L. K. (2015). Effect of foliar application of water-soluble fertilizers on growth, yield and economics of vegetable cowpea production. *The Ecoscanan International Quarterly Journal of Environmental Sciences, 7*(Special issue), 79-83.

Subbiah, B. V. and Asija, G. L. (1956). A rapid procedure for determination of available nitrogen in soils. *Current Science, 31*, 259-260.

Walkley, A. J. and Black, I. A. (1934). Estimation of organic carbon by chromic acid titration method. *Soil Science, 37*(1), 29-38.

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