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Integrated Nutrient Management in Pongamia + Castor Agrisilvi System

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ABSTRACT

Field experiments were conducted during *kharif* 2010 and 2011 in sandy loam soils at Hyderabad to study the influence of integrated nutrient management in castor grown under Pongamia. The treatments mainly comprise of combination of organic (neem cake and farmyard manure) and inorganic(urea) nitrogenous fertilizers in different proportions applied to castor crop grown in the alleys of Pongamia (five year old).There was significant response to the INM treatments over control in all the parameters during both the years. Higher seed yield, stalk yield, nitrogen content, N, P and K uptake from the soil were reported in the treatment wherein 75 % recommended nitrogen was applied through urea and 12.5 % nitrogen through organic source neem cake and 12.5 % through farm yard manure but, similar results were observed in 100 % recommended nitrogen applied in the form of urea. The influence of INM on oil content was found non significant.

Key words : Agrisilvi system, Biofuel, Integrated nutrient management.

One of the need based alternative land use system replacing the traditional farming system is a tree based system of cropping *i.e.,* agroforestry which acts as sustainable land management system especially in dryland areas. *Pongamia pinnata* is a multipurpose tree species (MPTS) and it is a good nitrogen fixing tree also.Since the gestation period is high in *Pongamia* and because of wider spacing between the trees, the interspace can be effectively used for intercropping. Castor (*Ricinus communis* L.) being one of the important non edible oil seed crop of the country and state as well, is largely cultivated under rainfed condition. The average yields of the crop were 1346 kg ha^{-1} and 510 kg ha^{-1} for India and Andhra Pradesh, respectively (CMIE, 2010) which was regarded as very low though occupying first rank in area in the country. For improved production of castor, application of required quantities of fertilizer is imperative through sustained soil health. Soil fertility build up through agroforestry and practice of integrated nutrient management were suggested as potential means to increase the soil fertility especially in drylands (Reddy *et al.* 1991). For higher yields of castor in drylands suitable management practices like integrated nutrient management, soil and moisture conservation strategies should be adopted.

Keeping in view of above aspects, the present study is planned to find out the influence of different combinations of organic manures and inorganic fertilizers on growth and yield of *Pongamia* + Castor agri-silvi system.

MATERIAL AND METHODS

Field experiments were conducted during *kharif* 2009-10 and 2010-11 in sandy loam soils at students' farm, College of Agriculture, Rajendranagar, Hyderabad. The soil was sandy loam in texture and neutral in soil reaction (p^H-7.2), low in organic carbon (0.52) and available nitrogen (139 kg ha^{-1}) and medium in available phosphorous (49 kg ha^{-1}) and potassium(144 kg ha^{-1}). The experiment was laid out in Randomized block design with nine treatments viz., T1-Control; T2-100% Recommended dose of Nitrogen (RDN) (Inorganic);T3-75% RDN (Inorganic); T4-75% RDN (Inorganic) + 25% RDN (FYM); T5-75% RDN (Inorganic) + 25% RDN (Neem cake); T6-75% RDN (Inorganic) + 12.5% RDN (FYM) +12.5% RDN (Neem cake); T7-50% RDN (Inorganic) + 25% RDN (FYM); T8-50% RDN (Inorganic) + 25% RDN (Neem cake); T9-50% RDN (Inorganic) + 12.5% RDN (FYM) +12.5% RDN (Neem cake)

Table 1. Seed yield, stalk yield and oil content of castor as influenced by INM treatments.

Treatments	Seed yield (kg/ha)		Stalk yield (kg/ha)		Oil content (%)	
	I year	II year	I year	II year	I year	II year
T1-Control	136	120	589	587	52.11	52.37
T2-100% Recommended Dose of Nitrogen (RDN) (Inorganic)	350	320	1402	1362	50.26	50.63
T3-75% RDN (Inorganic)	184	154	682	656	51.38	52.53
T4-75% RDN (Inorganic) + 25% RDN (FYM)	229	208	912	883	51.99	50.96
T5-75% RDN (Inorganic) + 25% RDN (Neem cake)	350	324	1363	1347	50.87	50.78
T6-75% RDN (Inorganic) + 12.5% RDN (FYM) +12.5% RDN (Neem cake)	367	346	1456	1424	52.22	52.43
T7-50% RDN (Inorganic) + 25% RDN (FYM)	196	166	753	733	51.76	51.64
T8-50% RDN (Inorganic) + 25% RDN (Neem cake)	213	182	798	771	52.08	51.98
T9-50% RDN (Inorganic) + 12.5% RDN (FYM) +12.5% RDN (Neem cake)	231	194	837	804	52.26	52.07
S.Em.±	15	10	39	35	0.80	1.64
CD (P=0.05)	43	31	112	87	NS	NS

and replicated thrice. The requisite amount of nitrogen was applied through urea as per the treatments based on the recommended dose *i.e.,* 60 kg N ha^{-1}. Nitrogen was applied in three equal splits, first dose as basal and the remaining doses at 30 and 60 days after sowing (DAS). Whereas uniform dose of 40 kg P_2O_5 and 30 kg K_2O per hectare were applied through single superphosphate and muriate of potash, respectively as basal dose to all the experimental plots. The amount of rainfall received during crop growth period was 920.3 mm in 62 rainy days during the 1^{st} year and 878.8 mm in 55 rainy days during the second year which is adequate for normal growth of crop. The vegetative stage of crop was healthy due to uniform distribution of rains but the incessant rains received during crop growth coincided with flowering and capsule formation stages during second year and resulted in severe incidence of castor semilooper and *Botrytis,* this in turn affected the seed yield of castor drastically and hence low yields were recorded in the second year of the experiment. Nitrogen content in FYM and neem cake was 0.83 % and 5.62 % on dry weight basis respectively.

The results of physico-chemical analysis revealed that the soil was sandy loam in texture and neutral in soil reaction, low in organic carbon, low in available nitrogen (139 kg ha^{-1}) and high in available phosphorous (49 kg ha^{-1}) and medium in available potassium (144 kg ha^{-1}).

RESULTS AND DISCUSSION

Seed yield, stalk yield and oil content

Among the treatments, significantly higher seed yield and stalk yield was recorded with the application of 75% RDN through urea and 12.5% RDN through FYM and 12.5% RDN

Table 2. Nutrient content in soil and plant uptake of castor as influenced by INM treatments.

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)		Available nitrogen content (kg/ha) after harvest	
	I year	II year	I year	II year	I year	II year	I year	II year
T1-Control	27.3	24.1	6.4	5.3	28.4	27.4	142.2	138.8
T2-100% Recommended Dose of Nitrogen (RDN) (Inorganic)	41.3	39.6	8.6	7.4	43.0	41.2	156.2	153.3
T3-75% RDN (Inorganic)	33.0	30.2	6.9	6.0	29.7	27.9	151.6	147.7
T4-75% RDN (Inorganic) + 25% RDN (FYM)	34.7	32.6	9.0	7.1	38.7	37.3	174.1	170.0
T5-75% RDN (Inorganic) + 25% RDN (Neem cake)	36.1	34.7	8.3	7.5	38.6	37.4	174.1	170.5
T6-75% RDN (Inorganic) + 12.5% RDN (FYM) +12.5% RDN (Neem cake)	48.3	46.5	8.9	8.0	43.3	41.5	176.2	173.6
T7-50% RDN (Inorganic) + 25% RDN (FYM)	35.0	33.1	9.2	7.1	40.1	38.4	158.1	154.5
T8-50% RDN (Inorganic) + 25% RDN (Neem cake)	36.9	35.8	8.2	7.6	39.2	37.5	159.1	157.4
T9-50% RDN (Inorganic) + 12.5% RDN (FYM) +12.5% RDN (Neem cake)	38.9	37.6	8.9	7.6	38.7	37.2	167.3	164.6
S.Em.±	1.67	1.34	0.58	0.33	1.85	1.45	5.70	4.61
CD (P=0.05)	4.97	3.83	1.73	1.00	5.52	4.39	17.11	14.32

through neem cake, but was on par with 100% RDN through urea and 75% RDN through urea and 25% RDN through neem cake (Table 1). These results were in agreement with the findings of Reddy et al. (1993) and Rao et al. (2000). Nitrogen content and N, P, K uptake was higher with 75% RDN through urea and 12.5% RDN through FYM and 12.5% RDN through neem cake over control, and it was followed by 100% RDN through urea. However the influence of INM on oil content was found non significant. Raghavaiah and Babu (2000) also reported similar results. Significant increase in the seed yield and stalk yield was recorded in the INM treatments over the control. However, harvest index was not influenced by INM treatments. The influence of INM on the oil content of castor was found non significant. Similar results were also observed by Baby and Reddy (1998). But the oil yield per hectare was significantly higher with the application of 75% RDN through urea and 12.5% RDN through FYM and 12.5% RDN through neem cake over all the other treatments. The influence of integrated nutrient management treatments on growth and yield of *Pongamia* was found non significant (Table 3). The effect may be seen over a long run.

Soil fertility

Integrated nutrient management practices have brought about significant differences in the available nitrogen content in the soil after harvest over control (Table 2). The available nitrogen content was significantly higher in T_6 (75% RDN-Inorganic + 12.5% RDN-FYM +12.5% RDN - Neem cake) and it was on par with T_4 (75% RDN-Inorganic + 25% RDN-FYM), T_5 (75% RDN-Inorganic + 25% RDN - Neem cake) and T_9 (50% RDN-Inorganic + 12.5% RDN-FYM +12.5% RDN-Neem cake).

Table 3. Tree parameters of Pongamia as influenced by INM treatments (5 year old trees).

Treatments	Tree height (m)		Diameter at breast height (m)		Canopy spread E-W direction (m)		Tree(pod) yield (Kg/ha)	
	I yr	II yrr	I yr	II yr	I yr	II yr	I yr	II yr
T1-Control	4.61	4.62	9.24	9.27	4.49	4.58	3.28	3.30
T2-100% Recommended Dose of Nitrogen (RDN) (Inorganic)	4.85	4.85	8.96	9.06	4.52	4.64	3.68	3.70
T3-75% RDN (Inorganic)	4.82	4.82	9.27	9.37	4.36	4.44	3.75	3.80
T4-75% RDN (Inorganic) + 25% RDN (FYM)	4.06	4.07	9.69	9.78	4.16	4.26	3.36	3.40
T5-75% RDN (Inorganic) + 25% RDN (Neem cake)	4.36	4.36	9.51	9.62	4.12	4.28	3.78	3.90
T6-75% RDN (Inorganic) + 12.5% RDN (FYM) +12.5% RDN (Neem cake)	5.03	5.04	8.84	8.94	4.32	4.46	3.65	3.80
T7-50% RDN (Inorganic) + 25% RDN (FYM)	4.24	4.25	8.63	8.74	3.98	4.00	3.16	3.20
T8-50% RDN (Inorganic) + 25% RDN (Neem cake)	3.82	3.82	9.16	9.33	4.21	4.34	3.65	3.70
T9-50% RDN (Inorganic) + 12.5% RDN (FYM) +12.5% RDN (Neem cake)	4.81	4.82	9.01	9.18	4.51	4.62	3.54	3.60
S.Em.±	0.51	0.54	0.46	0.54	0.63	0.68	0.97	0.91
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

The available N content in soil after the harvest of crop ranged from 138.8 to 173.6 kg ha^{-1}. Available N was notably higher under all INM treatments including control than that of initial value (139). This may be attributed to low drymatter produced due to heavy rains and also due to the addition of leaf litter to the soil. Being a legume tree, *Pongamia* has ability to fix N, hence available N content further increased during both the years. Similar results were obtained by Rao (2005) and Vani (1995) in *Hardwickia binata* and *Faidherbia albida* based agri-silvi system respectively.

The higher available N content was also attributed to the use of organic manures like FYM and neem cake which slows down the mineralization of organic matter and thus increased the availability of nutrients. These results were in accordance with Mathukia and Modhwadia (1995) and Devi *et al.* (2002).

a) Plant Uptake of N, P and K at Harvest

Uptake of nitrogen, phosphorus and potassium by castor crop was significantly influenced by different integrated nutrient management treatments (Table 2).

Significantly higher nitrogen uptake by the castor crop was recorded in the T_6 (75% RDN-Inorganic + 12.5% RDN-FYM +12.5% RDN-Neem cake) (48.3 and 46.5 kg ha^{-1}) over T_2 (100 % RDN-Inorganic) (41.3 and 39.6 kg ha^{-1}) during both the years, respectively. Significantly lower nitrogen uptake was recorded in T_1 (control) (27.3 and 24.1 kg ha^{-1}). The higher uptake of nitrogen in T_6 treatment was attributed to high drymatter production in that treatment and also due to synergistic effect of FYM and neem cake where FYM on decomposition produces acids which played vital role in mineralization of nitrogen. Similar findings were recorded by Rao and Venkateshwarlu (1998), Reddy *et al.* (1993) and Pooran Chand *et al.* (2004).

Maximum phosphorus and potassium uptake by the castor crop was recorded in T_6 (75% RDN-Inorganic + 12.5% RDN-FYM +12.5% RDN-Neem cake) (8.9 and 8.0 kg ha^{-1} and 43.3 and 41.5 kg ha^{-1} respectively) and it was on par with all the INM treatments except with T_3 and control. The higher phosphorus uptake in T_6 (75% RDN-Inorganic + 12.5% RDN-FYM +12.5% RDN-Neem cake) was mainly attributed to the high drymatter production in that treatment and also due to the application of organic sources like FYM and neem cake. The minimum phosphorus and potassium uptake was recorded in T_1 (control) (6.4 and 5.3 during 1st year and 28.4 and 27.4 kg ha^{-1} during second year).

Hence it can be concluded that for improving the growth and yield of castor combined usage of organic manures (12.5 kg N through FYM and 12.5 Kg N through Neem cake) along with 75 % N through chemical fertilizers (45 kg Urea) in the Pongamia based alleycropping was found to be beneficial.

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