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Nitrogen management strategies to improve growth and yield of cashew

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Abstract
The study was carried on the Nitrogen management strategies to improve growth and yield of cashew at Regional Horticultural Research and Extension Centre, University of Horticultural Sciences Campus, GKVK, Bengaluru during the years 2016-17, 2017-18 and 2018-19. The factorial randomized complete block design consisting of twelve treatments and three replications to know the comparative efficacy of nitrogenous fertilizers and their levels on growth and yield of cashew. The growth parameters like trunk girth and canopy spread decreased with increase in levels of nitrogen while plant height increased. However, the flowering laterals were maximum and cashew nut yield per plant was higher in100% RDN level. Among the sources, N applied through 25% FYM + 75% urea (8.48 kg plant^{-1}) followed by 100% RDN through Calcium ammonium nitrate (CAN) produced higher yields (8.32 kg plant^{-1}). In interaction of levels and sources, 100% RDN through CAN was found to be superior (8.38 kg plant^{-1}) followed by 100% RDN through vermicompost (8.24 kg plant^{-1}) compared to other sources of combination.

Keywords: Cashew, N sources, CAN, urea, ammonium sulphate, FYM and vermicompost

Introduction
Cashew (*Anarcadium occidentale* L.) is a tropical and sub-tropical tree. The plant is native to tropical central and South America from where Portuguese introduced it to India in 16th Century but later adapted well in Indian condition. It is grown in Goa, Karnataka, coastal regions of Maharashtra, Kerala in the West Coast, Tamil Nadu, Andhra Pradesh, Odisha and West Bengal. The highest productivity is recorded in Kerala and Maharashtra. The higher yield in Maharashtra are primarily due to the fact that cashew production is of recent origin and the major part of the plantations have been established with high yielding clone material. Even the orchards raised from seeds are from selected progenies.

India is the largest producer, processer, consumer and exporter of cashew in the world (Elakkiya *et al.*, 2017) [1] which Occupies an area of 10.30 lakh hectares in the country with a production of 9.98 lakh metric tonnes (Mahantesh Nayak and Manjunatha Paled, 2018) [5]. Cashew productivity can be enhanced by nutrient management. Increasing affordability by the consumers, demand for cashew continues to increase due to its nutrition value. Cashew is the major earning crops in India. The cashew yield recorded in India and Karnataka is very low (6-8 kg tree^{-1}) due to imbalanced application of fertilizers and manures, where manuring is not a regular practice in the exiting orchards (Maruthi Prasad *et al.* 2015) [6]. Among several constraints to cashew yield, nutrition plays a vital role in improvement of the yield of cashew nut. As cashew tree is a regular bearer, hence, considerable amount of nutrients is removed every year from the soil.

The major nutrient requirement of cashew plant is application of Nitrogen followed by potassium and phosphorus is needed in lesser quantity. Nitrogen and phosphorus are major important nutrients during the pre-bearing stage along with potassium. In order to achieve sustainable yield, it is essential to supply major nutrients (N: P: K) in the soil. The cashew tree responds better to application of major nutrients, though the responses are significantly affected by plant age, the genotype utilized, the conditions of cultivation, soil and climate and of the crop management (Vanlauwe *et al.* 2002) [8]. In India, application of fertilizers is comparatively very limited in cashew. Under this situation, it is necessary to access the effect of different sources and levels of nitrogen on growth and yield of cashew. Hence, the experiment was undertaken to initiate on nitrogen management of cashew at Regional

Horticultural Research and Extension Centre, University of Horticultural Sciences Campus, GKVK, Bengaluru with an objective to study the impact of levels and sources of nitrogen on productivity of cashew.

Material and Methods

The field experiment was conducted at Regional Horticultural Research and Extension Centre, University of Horticultural Sciences Campus, GKVK, Bengaluru during the years 2016-17, 2017-18 and 2018-19 in the existing cashew (Dhan variety) plantation of 8 years old. The experiments laid out in factorial randomized complete block design consisting twelve treatments with three replication. The cashew cultivars were planted in 2010 and maintained at a plant density of 156 trees/ha with a spacing of 8.0 m x 8.0 m. The cashew nut yield was taken as kg per plant. The cumulative annual rainfall received during 2017, 2018 and 2019 is 758.8, 727.8, and 899.1 mm, respectively. Among different months, September, October and August received maximum amount of rainfall (273.4, 159.0 & 149.3 mm, respectively during 2017). Whereas, during 2018, May and September month received maximum of 229.4 and 153.6 mm. September and August received maximum (186.6 & 172.2 mm, respectively) in 2019 (Table 1 & Fig. 1). The initial soil sample analyzed for various parameters by adopting standard procedures. The soil of the study area is sandy loam in texture with acidic in soil reaction (pH of 6.0). Initial soil available nitrogen was low (225 kg ha^{-1}), available phosphorus was low (16.5 kg ha^{-1}) and medium in potassium (145 kg ha^{-1}). This study was carried out with specific objectives to find out effect of different source of nitrogen on growth and yield of cashew. The biometric observations on growth and yield of cashew were calculated per tree yield adopting standard procedure. The analysis and interpretation of the data was done using Fisher's method of analysis technique (Gomez and Gomez, 1984).

Result and discussion

The three years pooled data presented in Table 2 showed that the nitrogen levels and application of various nitrogen sources significantly affect the yield of cashew. However, did notshowed significant results for trunk girth, plant height and canopy spread.

Trunk girth was found to be non significant with respect to levels of nitrogen. However application of 100 per cent RDN recorded numerically higher truck girth (57.76 cm) compared to 125 per cent RDN (56.54). With respect to sources of nitrogen fertilizers, trunk girth was found to be non significant. Whereas, application of 25% FYM + 75% urea recorded numerically higher truck girth (59.61 cm) compared to other source of nitrogen. Interaction effect was found to be non significant. Treatment combination of 100% RDN through CAN recorded numerically higher trunk girth (62.11) as compared to rest of the treatment combinations. Similar trend was observed with respect to plant height and canopy spread in levels of nitrogen. With respect to sources of nitrogen fertilizer, plant height and canopy spread were found to be non significant with application of FYM recorded numerically more plant height (4.64 m) and application of CAN observed more canopy spread (6.16 m) compared to other treatments. Interaction effect were found to be non significant with respect to plant height and canopy spread. However, application of 100% RDN through VC recorded numerically higher plant height (4.67 m) and more canopy spread (6.26) among the other treatment of interactions (Table 2 & Fig. 2).

The number of lateral flowers per square meters was maximum in 100% RDN (13.36) among the levels. Whereas among the N sources the maximum number of lateral flowers per square meters was recorded in 25% FYM + 75% urea (13.54) followed by CAN (12.93) significantly higher compare to other treatments. Among interaction 100% RDN through CAN (13.89) followed by 100% RDN through VC (13.48) recorded significantly higher number of lateral flower per square meters over other interactions.

With regard to levels of nitrogen, cashew nut yield is found to be non significant, yield decreased with increased nitrogen levels. However, application of 100% RDN resulted in numerically higher cashew nut yield (8.21 kg $plant^{-1}$) compared to 125% RDN (8.04 kg $plant^{-1}$). Among the levels and different source of nitrogen, significantly higher cashew nut yield was noticed in 25% FYM + 75% urea (8.48 kg $plant^{-1}$) and on par with application of CAN (8.32 kg $plant^{-1}$) compared to other treatment combination. Within the interactions, the treatment combination of 100% RDN through CAN recorded higher cashew nut yield (8.38 kg $plant^{-1}$) followed by 100% RDN through VC (8.24 kg $plant^{-1}$) recorded significantly higher yield compared to all other treatment combinations (Table 3 & Fig. 3). Might be due to availability of nutrients in the soil and further absorption of nutrient by the plant during establishment period of the plants. Hence, there should be an appropriate nutrient supplementation to sustain the higher yield. Nitrogen fertilizer therefore, considered as a better option in increasing fertilizer use efficiency and providing a more balanced supply of nutrients (Hammed *et al.* 2011; Gajbhiye *et al.* 2016; Fernadez, 2001) [4, 3, 2]. Vanlauwe *et al.* (2002) [8] reported that balanced application of major nutrient result into synergy and improved conservation and synchronization of nutrient release and crop. However, nitrogen application significantly influences the yield of nuts. With increasing nitrogen levels, the concentration of N,P,K and Ca in all plant parts increases.

Table 1: Rainfall data from January to December (2017-2019)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2017	0.0	0.0	3.1	20.0	114.9	11.7	20.4	149.3	273.4	159.0	5.0	2.0	758.8
2018	0.0	3.0	62.2	37.0	229.4	29.6	62.6	97.8	153.6	29.2	20.6	2.8	724.8
2019	0.0	24	0	22.8	126.4	88.3	34.2	172.2	186.6	233	10	1.6	899.1

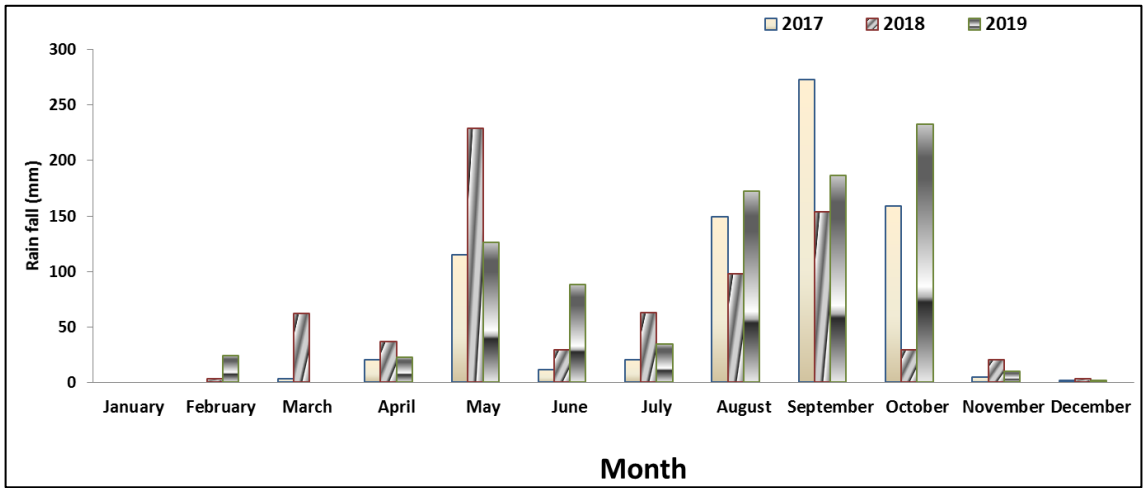

Fig 1: Monthly meteorological data during crop growth period (2017-2019)

Table 2: Influence of levels and sources of nitrogen on trunk girth, plant height and canopy spread of cashew

Treatments	Trunk girth (cm)				Plant height (m)				Canopy spread(m)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Factor A: Levels of N												
L_1: 100% RDN	51.56	58.61	63.11	57.76	4.04	4.61	4.67	4.44	5.43	5.76	6.68	5.96
L_2: 125% RDN	49.00	56.78	63.83	56.54	4.04	4.47	4.70	4.40	5.05	5.40	6.44	5.63
S.Em.±	1.44	1.31	1.62	1.46	0.18	0.16	0.09	0.14	0.27	0.26	0.25	0.26
CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Factor B: Sources of N												
S_1 Urea for N levels	50.00	58.33	65.50	57.94	3.82	4.33	4.62	4.26	5.45	5.82	6.53	5.93
S_2 CAN for N levels	50.33	57.33	67.50	58.39	4.23	4.76	4.53	4.51	5.79	6.15	6.55	6.16
S_3 Ammonium sulphate for N levels	47.17	54.50	61.50	54.39	4.08	4.48	4.55	4.37	5.04	5.36	6.30	5.57
S_4 FYM for N levels	50.00	57.50	61.84	56.45	4.42	4.80	4.70	4.64	5.08	5.41	6.76	5.75
S_5 Vermicompost for N levels	50.83	57.33	60.17	56.11	3.85	4.40	4.73	4.33	4.88	5.22	6.77	5.62
S_6 FYM + Urea (1:3 N) for N levels	53.33	61.17	64.34	59.61	3.83	4.45	4.99	4.42	5.20	5.52	6.45	5.72
S.Em.±	2.49	2.26	2.81	2.52	0.32	0.27	0.16	0.25	0.47	0.45	0.43	0.45
CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction												
L_1S_1 100% RDN through urea	52.33	58.33	68.33	59.66	3.43	3.97	4.33	3.91	5.17	5.55	6.98	5.90
L_1S_2 100% RDN through CAN	57.67	64.00	64.67	62.11	4.00	4.47	4.73	4.40	5.73	6.07	6.93	6.24
L_1S_3 100% RDN AS (ammonium sulphate)	47.67	55.00	62.67	55.11	4.17	4.53	4.63	4.44	5.12	5.43	6.15	5.57
L_1S_4 100% RDN through FYM	48.33	56.00	57.00	53.78	4.40	4.77	4.77	4.65	5.85	6.23	6.17	6.08
$L_1S_5$100% RDN through VC	53.33	62.00	65.67	60.33	4.37	4.70	4.93	4.67	5.82	6.10	6.87	6.26
L_1S_6 100% RDN through 75% N by urea + 25% N by FYM	50.00	58.33	60.33	56.22	3.87	4.33	4.80	4.33	5.02	5.28	7.00	5.77
L_2S_1 125% RDN through urea	49.00	56.33	64.00	56.44	4.20	4.73	4.90	4.61	5.73	5.95	6.08	5.92
L_2S_2 125% RDN through CAN	48.33	56.33	66.67	57.11	4.47	5.05	4.33	4.62	5.62	6.08	6.88	6.19
L_2S_3 125% RDN through AS (ammonium sulphate)	46.67	54.00	60.33	53.67	4.00	4.43	4.47	4.30	4.97	5.28	6.45	5.57
L_2S_4 125% RDN through FYM	51.67	59.00	66.67	59.11	4.43	4.83	4.63	4.63	5.15	5.53	6.52	5.73
L_2S_5 125% RDN through VC	51.67	58.33	60.00	56.67	3.33	4.07	4.53	3.98	4.15	4.48	6.65	5.09
L_2S_6 125% RDN through 32% by FYM +93% by Urea	46.67	54.67	65.33	55.56	3.80	4.57	5.17	4.51	4.58	4.93	6.02	5.18
S.Em.±	3.53	3.20	3.97	3.57	0.45	0.39	0.22	0.35	0.66	0.63	0.61	0.63
CD@5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Influence of levels and sources of nitrogen on and number of lateral flower/m^2 and Cashew nut yield of cashew

Treatments	Number of lateral flower/m^2				Cashew nut yield (kg/plant)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Factor A: Levels of N								
L_1: 100% RDN	11.07	14.00	15.00	13.36	8.05	8.00	8.57	8.21
L_2: 125% RDN	10.25	13.25	13.72	12.41	7.82	7.85	8.45	8.04
S.Em.±	0.14	0.21	0.22	0.19	0.17	0.15	0.17	0.17
CD @ 5%	0.41	0.63	0.66	0.57	NS	NS	NS	NS
Factor B: Sources of N								
S_1 Urea for N levels	10.71	13.96	14.60	13.09	7.56	7.50	8.69	7.92
S_2 CAN for N levels	10.96	14.33	13.50	12.93	8.00	8.09	8.88	8.32
S_3 Ammonium sulphate for N levels	10.00	12.96	14.10	12.35	7.79	7.70	8.59	8.03
S_4 FYM for N levels	10.63	13.33	13.55	12.50	6.92	6.99	7.87	7.26
S_5 Vermicompost for N levels	10.50	13.38	14.75	12.88	7.40	7.48	8.26	7.71
S_6 FYM + Urea (1:3 N) for N levels	11.17	13.79	15.65	13.54	8.31	8.35	8.79	8.48
S.Em.±	0.24	0.37	0.39	0.33	0.15	0.18	0.19	0.17

CD @ 5%	0.70	NS	1.15	0.93	0.45	0.53	0.57	0.52
Interaction								
L_1S_1 100% RDN through urea	10.25	13.08	16.00	13.11	7.86	7.80	8.70	8.12
L_1S_2 100% RDN through CAN	11.83	14.83	15.00	13.89	8.11	8.20	8.82	8.38
L_1S_3 100% RDN AS (ammonium sulphate)	11.25	14.67	14.70	13.54	7.69	7.62	8.59	7.99
L_1S_4 100% RDN through FYM	11.25	14.00	14.10	13.12	7.02	7.32	8.05	7.46
$L_1S_5$100% RDN through VC	10.50	13.83	16.10	13.48	8.22	8.20	8.31	8.24
L_1S_6 100% RDN through 75% N by urea + 25% N by FYM	11.33	14.08	14.10	13.17	7.38	7.45	8.82	7.88
L_2S_1 125% RDN through urea	11.17	14.33	13.20	12.90	8.02	7.95	8.68	8.05
L_2S_2 125% RDN through CAN	11.42	13.75	15.20	13.46	7.50	7.59	8.94	8.01
L_2S_3 125% RDN through AS (ammonium sulphate)	11.08	14.00	12.30	12.46	7.82	7.85	8.58	8.08
L_2S_4 125% RDN through FYM	10.00	12.67	13.00	11.89	6.98	8.15	7.69	7.61
L_2S_5 125% RDN through VC	9.17	12.42	14.50	12.03	7.45	8.05	8.20	7.89
L_2S_6 125% RDN through 32% by FYM +93% by Urea	8.67	11.83	14.10	11.53	7.70	8.10	8.75	8.16
S.Em.±	0.34	0.52	0.54	0.47	0.16	0.16	0.17	0.16
CD@5%	1.00	1.54	1.61	1.38	0.46	0.46	0.50	0.47

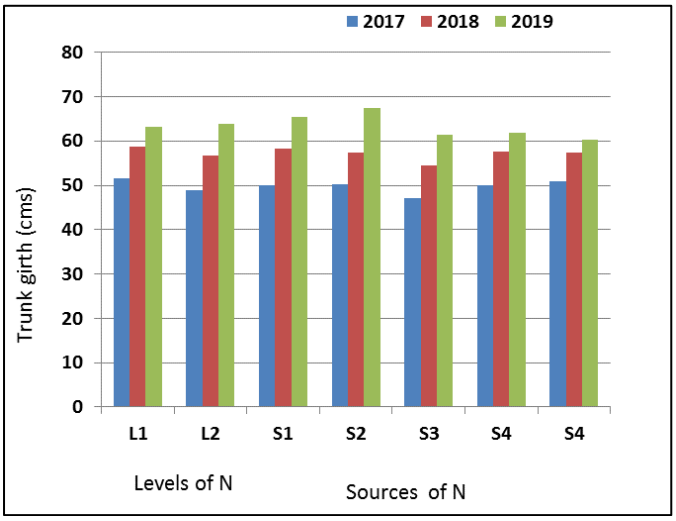

Fig 2: Growth of Cashew as influenced by levels and sources of Nitrogen

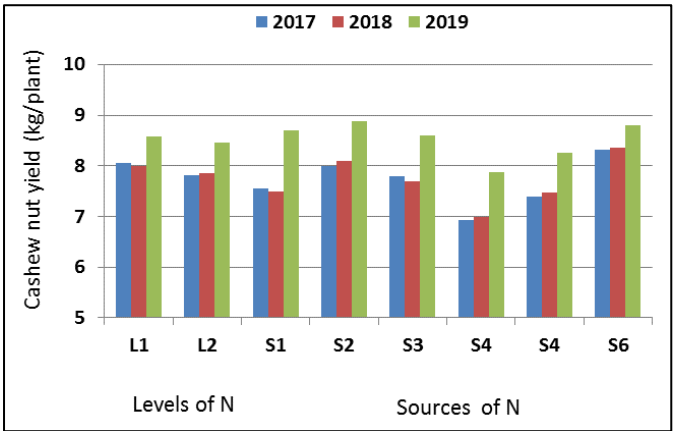

Fig 3: Cashew nut yield as influenced by levels and sources of Nitrogen

Conclusion

Integrated nutrient of both inorganic (recommended fertilizers) and organic nutrients (Vermicompost) increases the growth and nut yield in cashew as compared to application of sole inorganic or organic inputs. The results of the studies obtained clearly indicated that, growth parameters decreases with increase in nutrient levels and combination of 100% RDN through CAN recorded higher cashew nut yield which helps to maintain instant flow of nutrients in increasing crop yield.

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