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Studies on The Impact of Both Organic and Inorganic Sourced Nutrients on Growth And Yield Of Arabica Coffee (*Coffeea Arabica* L.)

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ABSTRACT
Arabica coffee (Coffeea arabica L.) prefers cool and high altitude. The phenotypic nature of the coffee was dwarf, stout and bushy. The optimum growth and development was recorded at the temperatures ranging between 20-27°C. It prefers cool climate and adequate shade. The dwarf and stout stature of the plant makes the provision to cultivate it under high density planting. The nutrient recycling in the perennial plantation was also in phased and continuous. Hence, keeping its stature and climatic condititions, a field experiment was incepted with the integrated approaches with the application of both plant and animal based nutrient sources along with the application of synthetically manufactured recommended dosage of fertilizers in high density planted arabica coffee at Coffee Research Substation, Chettalli, Kodagu distinct Karnataka during 2019-20. The results revealed that integrated application of 100 % recommended dose of nitrogen along with 25 % N through goat manure resulted significantly higher plant height (113.37 cm), number of primary branches (13.37 plant^{-1}), number of secondary branches (11.0 plant^{-1}), stem girth (5.03 cm), number of leaves (15.33 branch $^{-1}$), total number of nodes (11.0 branch^{-1}), crop bearing nodes (10.67 branch^{-1}), bush spread (118.56 cm), length of the longest primary (118.25 cm), number of berries (21.0 node^{-1}) and clean coffee yield of 1605.08 kg ha^{-1}.
***Key words**: Arabica coffee, clean coffee, dried leaf compost, goat manure, high density, RDFq*

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INTRODUCTION

Coffee is one of highest foreign exchange earning commodity of India. India is the 3rd largest producer and exporter in Asia and also it is the 6th largest producer and 5th largest exporter in the world. The country accounts to the tune of 3.14 per cent (2019-2020) of the global production. The Indian coffee export was remarkably increased during 2021-2022 since the covid-2019. The export value during the fiscal year stood at 3, 95,716 tonnes and the total foreign exchange earned was $950 million [4]. Coffee being a perennial plant extracts huge amounts of nutrients, these could be refinished by external application and through recycling the locally available resources like small ruminants manure (goat manure) and dried leaf litter compost. Imposition of goat manure in acidic [6].
soils lend a hand in the increase of soil pH [8] that makes the plant to absorb higher amount of nutrients from both the soil as well as from applied nutrient and resulted in higher plant growth and yield. The plant origin manures (leaf litter compost) has almost all forms of nutrients required for growth and development and they perform well when served in bulk quantities. These plant and animal based nutrient sources acts as the reservoirs of nutrients, moisture and nutrient releasing enzymes along with development of tolerance in crop plants during climatic vagaries [5]. Synthetic fertilization was worsen and apathetically impart physical and chemical properties of soil whereas with the practice of the integrated management approaches augmented the organic matter content by 4.41 per cent and produced healthy crops [10].

MATERIAL AND METHODS

The field experiment was conducted at Coffee Research Sub Station (CRSS), Chettalli, Kodagu District, Karnataka, India, from January 2019 to December 2020. The geographical coordinates of the station are

24.1 ° to 12.° 23' 13.8' N latitude and 75 ° 50" to 11.8' to 75° 50" 42.1" E longitude and the station is situated at an altitude of 1034 meters above the mean sea level (MSL). The required quantity of goat manure and leaf litter compost applied based on N as per the treatments. The experiment was initiated with the inclusion of fifteen treatments wherein the recommended fertilizer dosage of 120:90:120 kg ha^{-1} NPK was treated as standard control (T_1). The remaining treatments including 125 per cent, 75 per cent and addition of goat manure and dry leaf compost from 25 per cent to 75 per cent based on the N composition was fixed and the same were applied during the pre blossom and post blossom period. The design adopted was randomized block design with three replications. After the treatments imposition, the growth and development of both vegetative parameters of plant height (cm), stem girth (cm), no. of primaries and no. of secondary branches were recorded during pre blossom period and reproductive parameters of total number of nodes $branch^{-1}$, number of berries $node^{-1}$, fresh weight of 100 ripened berries (g) and clean coffee yield ($kgha^{-1}$) were recorded in post blossom period.

RESULTS AND DISCUSSION

Growth characters

Integrated application of nitrogen through inorganic fertilizer and organic sources significantly influenced the growth characters of Arabica coffee under high density plantation (Table1). Higher plant height (113.70 cm), stem girth (5.03 cm), number of primary branches (13.37 $plant^{-1}$) and secondary branches (11.00 $plant^{-1}$) were recorded with the application of 125 % nitrogen through 100 % RDN via inorganic fertilizer and 25 % N via goat manure (T_4). This was followed integrated application of 75 % RDN via inorganic fertilizer + 50 % N via goat manure (T_5) and integrated application of 100 % RDN via inorganic fertilizer + 25 % N via dried leaf compost (T_{10}) and statistically comparable with each other. However, the lower plant height, girth and number of primary and secondary branches were recorded with the application of 75 per cent recommended dose of inorganic fertilizer application (T_3).

The better performance of integrated application was due to the counteraction of the adverse effects of inorganic fertilizers by the organic manures and the continuous liberal supply of nutrients satisfying the demand of the coffee crop with the balanced flow of nutrient flux. The enhanced vegetative growth in plants was may be due to the higher dosage of N availability and its supply during pre blossom period. The goat manure aids in the reduction of soil pH and creates the ideal soil reaction and also may be due to the higher microbial load facilitated with the application of goat manure. The results were in similar line with the findings of application of goat dung @ of 20t ha^{-1}in perennial fruit crop has resulted in the increased plant height, stem girth, number of branches, Adejobi *et al.* [1] and Adejoblk *et al.* [2] also opined that combined application organic manures of cocoa pod husk ash and goat dung @ of 5.0 t ha-1 both has resulted in the increased growth parameters of coffee seedlings and also soil and leaf nutrient composition. Organic sourced nutrients application in organic farming systems for long term was resulted in the better soil properties than the conventional methods in coffee as revealed by [14]. Application of both chemical and organic sources (75 kg NPS ha-1 + 2.5 tons of vermicompost) has resulted in the higher grain yield of soybean [7].

Yield attributes

Significant variation in the yield contributing characters of arabica coffee existed due to the integrated nitrogen management practices (Table 2). Among the various treatments, application of 100% recommended dose of N + 25% N on equivalent basis of goat manure (T_4) significantly recorded more number of nodes (11.28 $branch^{-1}$), number of berries (21.00 $node^{-1}$) and fresh weight of 100 ripened berries (199.26 g). Integrated application of 75 % RDN via inorganic fertilizer + 50 % N via goat manure (T_5) and integrated application of 100 % RDN via inorganic fertilizer + 25 % N via dried leaf compost (T_{10}) were stood next in merit and were statistically on par among themselves. Application of 75 per cent N through inorganic fertilizer (T_3) registered lower total number of nodes (5.84 $branch^{-1}$), number of berries (9.62 $node^{-1}$) and fresh weight of 100 ripened berries (144.23 g).

Clean coffee yield

Significant difference in clean coffee yield was observed among the integrated nitrogen management practices (Table 2.). The treatment 100 % recommended dose of N + 25% N on equivalent basis of goat manure application (T_4) showed its superiority in registering higher clean coffee yield of 1605.08 kg ha^{-1}. This was followed by treatment T_5 (application of 75 % RDN via inorganic fertilizer + 50 % N via goat manure) with clean coffee yield of 1504.21 kg ha^{-1} and treatment T_{10} (application of 100 % RDN via inorganic fertilizer + 25 % N via dried leaf compost) with the clean coffee yield of 1492.65 kg ha^{-1} and these treatments were at par with each other. The increase in clean coffee yield of treatment T_4 was 26 per cent higher than treatment T_1. The lower clean coffee yield of 898.37 kg ha^{-1} was observed with the application of 75 % recommended dose of nitrogen through inorganic fertilizer (T_3).

Application of goat manure reduces the soil acidity by alleviating the aluminum toxicity and helps in the release of phosphorus by the activity of soil beneficial microbes and it intern promotes the blossom and berries growth and development. The combined application of both macro and micro nutrients along with farm yard manure was resulted in higher grain yield of sesame [12, 13]. Application of goat manure @ of 20 t ha-1 was more advantageous than at the lower doses in acidic soils [8]. The mean number of berries branch^{-1}, number of berries node^{-1} and fresh weight of 100 berries was maximum in treatment T_4 (199.26 g). Application of goat manure alleviates the soil acidity and act as a soil acidity alleviating agent and released higher quantities of phosphorus and potash which enhanced the formation of more number of berries and leads to increase in the weight of the berries and clean coffee yield. The coffee yields were found to be positive and significant soil nutrient status and soil pH, organic carbon and available P,KS and also ca and Mg as revealed with the findings of Nagaraja *et al*. [12], Coffee being perennial fruit crop requires higher dosage of N and K for the maximum canopy development, nodes formation and berries development and enlargement as noticed with the findings of Jafer David [9] and the practice of mixed and organic nutritional management was highly beneficial than the chemical farming in coffee. The higher nitrogen concentration (105.02 mg NO_3 Kg^{-1}) and higher organic carbon per cent (4.4%) was recorded in mixed and organic farming plots under coffee cultivation as studied by Juan *et al*. [10]. Greater plant height, number of branches and yield attributes were significantly higher with the integrated nutrient management (FYM 5.0 t ha-1 +Rhizobium+PSB+KSB) [3].

From the results, it was inferred that integrated application of 125 per cent N through 100 % N via inorganic fertilizer and 25 per cent N on equivalent basis of goat manure significantly increased the growth characters, yield contributing characters and final clean coffee yield of Arabica coffee in high density planted arabica coffee.

Table 1. Impact of both organic and inorganic sourced nutrients on plant height (cm), stem girth (cm) no. of primaries and no. of secondary branches in high density planted arabica coffee (*Coffea arabica* L).

Treatments	Plant height (cm)	Stem girth (cm)	No. of primary branches	No. of secondary branches
T_1- Control (100 % Recommended dose of N)	93.25	3.65	8.65	7.25
T_2 - 125% RDN	101.00	4.10	10.25	8.65
T_3 - 75% RDN	71.25	2.25	3.95	3.12
T_4 - 100% RDN +25 % N through goat manure	113.70	5.03	13.37	11.00
T_5- 75% RDN + 50 % N through goat manure	107.45	4.53	11.93	9.85
T_6 - 50% RDN +75 % N through goat manure	93.02	3.51	8.41	7.09
T_7 - 75% RDN + 25 % N through goat manure	99.85	3.95	10.05	8.35
T_8 - 50% RDN +50 % N through goat manure	87.18	3.25	7.02	6.00
T_9 - 50% RDN + 25 % N through goat manure	80.93	2.85	5.41	4.82
T_{10} - 100% RDN +25 % N through dried leaf compost	107.10	4.50	11.75	9.73
T_{11} - 75% RDN + 50 % N through dried leaf compost	100.50	4.02	10.17	8.47
T_{12} - 50% RDN +75 % N through dried leaf compost	87.12	3.18	6.85	5.85
T_{13} - 75% RDN + 25 % N through dried leaf compost	93.10	3.58	8.57	7.16
T_{14} - 50% RDN +50 % N through dried leaf compost	80.25	2.74	5.28	4.75
T_{15} - 50% RDN + 25 % N through dried leaf compost	80.06	2.69	5.15	4.62
SE (d)	**2.83**	**0.11**	**0.25**	**0.22**
CD(p=0.05)	**5.80**	**0.22**	**0.52**	**0.45**

Table 2 Impact of both organic and inorganic sourced nutrients on total no. of nodes branch^{-1}, no. of berries node^{-1}, fresh wt. of 100 ripened berries and clean coffee yield in high density planted arabica coffee (*Coffea arabica* L)

Treatments	Total Number of Nodes branch^{-1}	Number of berries node^{-1}	Fresh weight of 100 ripened berries (g)	Clean coffee yield (kgha^{-1})
T_1- Control (100 % Recommended dose of N)	8.52	16.02	173.32	1275.21
T_2 - 125% RDN	9.33	17.85	182.45	1389.65
T_3 - 75% RDN	5.84	9.62	144.23	898.37
T_4 - 100% RDN +25 % N through goat manure	11.28	21.00	199.26	1605.08
T_5- 75% RDN + 50 % N through goat manure	10.33	19.48	191.85	1504.21
T_6 - 50% RDN +75 % N through goat manure	8.39	15.72	171.45	1268.97
T_7 - 75% RDN + 25 % N through goat manure	9.18	17.65	180.65	1378.67
T_8 - 50% RDN +50 % N through goat manure	7.85	14.21	164.21	1167.52
T_9 - 50% RDN + 25 % N through goat manure	7.15	12.21	156.12	1061.21
T_{10} - 100% RDN +25 % N through dried leaf compost	10.22	19.41	190.21	1492.65
T_{11} - 75% RDN + 50 % N through dried leaf compost	9.27	17.77	181.85	1381.21
T_{12} - 50% RDN +75 % N through dried leaf compost	7.78	14.05	163.21	1165.23
T_{13} - 75% RDN + 25 % N through dried leaf compost	8.46	15.85	172.65	1271.24
T_{14} - 50% RDN +50 % N through dried leaf compost	7.02	12.05	155.21	1059.23
T_{15} - 50% RDN + 25 % N through dried leaf compost	6.94	11.91	154.62	1057.32
SE(d)	**0.26**	**0.47**	**5.24**	**38.55**
CD (p=0.05)	**0.53**	**0.97**	**-**	**78.96**

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