Forage Res., **50**(3) : pp. 292-297 (2024) **http://forageresearch.in**

YIELD AND NUTRIENT DYNAMICS OF FODDER COWPEA INTERCROPPED IN COCONUT GARDEN

SOWJANYA JAKKAMPUDI* AND SHARU S. R.

College of Agriculture, Kerala Agricultural University,
Vellayani, Thiruvananthapuram- 695 522
**(e-mail: sowjanyajakkampudi@gmail.com)*

(Received: 15 November 2024; Accepted: 30 December 2024)

SUMMARY

The present investigation entitled "Effect of Spacing and Nutrient Management on yield, plant nutrient uptake and soil nutrient availability in fodder cowpea intercropped in coconut garden" was conducted during *Rabi* 2022 at Instructional Farm, College of Agriculture Vellayani to standardize the spacing and nutrient requirement for fodder cowpea intercropped in coconut garden. The experiment was laid out in randomized block design with two factors, namely spacing (S) [s_1- 20 cm × 15 cm, s_2- 30 cm × 15 cm, s_3- 40 cm × 15 cm and s_4- broadcasting)] and nutrient levels (N) [n_1-75% POP (18.75: 45: 22.5 kg N: P_2O_5: K_2O/ha), n_2 100% POP (25: 60: 30 kg N: P_2O_5: K_2O/ha), n_3 125% POP (31.25: 75: 37.5 kg N: P_2O_5: K_2O/ha)] with three replications. The experimental plot was red sandy loam, acidic in reaction, medium in organic carbon, low in available nitrogen, high in available phosphorus and medium in available potassium status. The treatment, s_2 recorded the highest, green fodder yield per plant, dry fodder yield per plant, per day productivity and N P K uptake. The treatment n_3 resulted in higher, green and dry fodder yield per plant, per day productivity and N P K uptake by plant. The treatment combination, s_2n_3 recorded the highest per day productivity**,** N uptake and P uptake.

Key words: Fodder cowpea, nutrient management, green fodder yield per plant, per day productivity and nutrient uptake

The livestock sector is a crucial component of Indian agriculture, playing a significant role in sustaining livelihoods. With a steadily increasing livestock population, the demand for feed and fodder has risen, putting immense pressure on the country's limited resources. Feed cost constitute about 65-70% of the total expenditure in the livestock industry, making its profitability highly dependent on the availability and quality of feed and fodder. However, the area allocated to fodder cultivation in India remains minimal, covering only 8.4 million hectares, resulting in a substantial reduction in green and dry fodder availability (Bhagmal *et al.,* 2011). The increasing pressure on agricultural land to meet the growing population's demand for food and nutritional security leaves little scope for expanding the area under fodder crops (Manoj and Shekara, 2020). To overcome these challenges, intercropping is a promising practice that offers multiple advantages, such as efficient resource utilization, suppression of pest population, improved soil health, conservation of natural resources, increased fodder production, and overall system sustainability (Maitra *et al.,* 2020).

Fodder cowpea a versatile leguminous crop, is widely cultivated in tropical and subtropical regions for its high-quality green fodder, which is rich in protein and essential nutrients. Beyond its value as a fodder crop, it provides multiple benefits, including serving as an excellent cover crop, enhancing soil fertility through nitrogen fixation, suppressing weeds and improving soil organic matter and structure (Kumar *et al.,* 2023). Furthermore, its adaptability to partial shade makes it ideal for intercropping systems, particularly with perennial crops like coconut.

Optimizing productivity and quality in intercropping systems requires careful management of key factors such as spacing and nutrient application. Proper spacing ensures efficient light interception, minimizes root competition and enhances the utilization of resources like water and nutrients. Effective nutrient management ensures the availability of essential macro and micronutrients required for optimal growth, which directly influence fodder yield and per day productivity.

MATERIALS AND METHODS

The field experiment was conducted at Instructional Farm, College of Agriculture Vellayani during *Rabi* 2022 Vellayani, Thiruvananthapuram, Kerala, India. The experimental field was geographically located at 8°25'42.726''N latitude and 76° 59'16.314''E longitude, at an altitude of altitude of 29 m above MSL. The mean maximum and minimum temperature ranged from 30.3°C to 31.9 °C and 21°C to 23°C respectively and mean RH I and RH II ranged from 90.4 per cent to 93.6 per cent and 70.6 per cent to 79.6 per cent, respectively, with a mean evaporation of 2.0 mm per day. Mean bright sunshine hours varied from 2.1 h to 7.3 h. A total rainfall of 50 mm was received during the experimental period. The experiment was laid out in randomized block design with three replications. The treatments consisted of two factors, namely spacing (S) (s_1- 20 cm × 15 cm, s_2- 30 cm × 15 cm, s_3- 40 cm × 15 cm and s_4- broadcasting) and nutrient levels (N) [n_1-75% POP (18.75: 45: 22.5 kg N: P_2O_5: K_2O ha^{-1}), n_2 100% POP (25: 60: 30 kg N: P_2O_5: K_2O ha^{-1}), n_3 -125% POP (31.25: 75: 37.5 kg N: P_2O_5: K_2O ha^{-1})]. FYM @ 10 t ha^{-1}, was uniformly applied to all the plots at the time of final preparation of land.

The yield characters *viz*., green fodder yield per plant, dry fodder yield per plant were recorded at harvest. The fresh weight of observational plants from the respective treatments were recorded and the average was worked out for green fodder yield per plant. The observational plants harvested separately were first shade dried and then oven dried at 65°C till constant weight was achieved. The dry weights of these samples were taken and dry fodder yield per plant was calculated and expressed as g per plant. The per day productivity was computed as follows and expressed as t/ha/d.

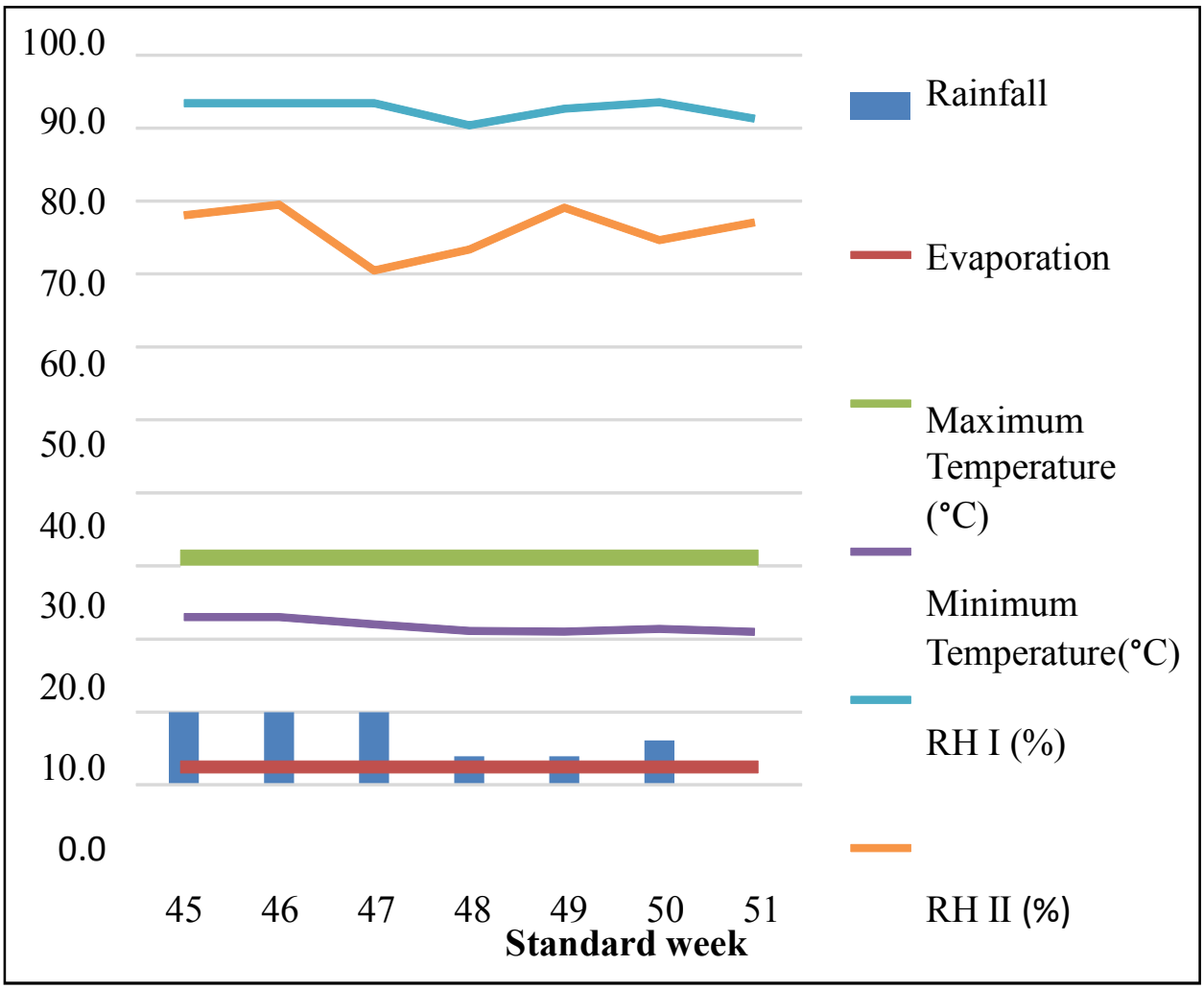

Fig. 1a. Weather data during the crop season *Rabi* 2022 (November-December).

Per day productivity = Green fodder yield/Crop duration

Plant samples at harvest were analyzed for total N, P and K content. The plant samples were shade dried for two days to reduce the moisture content and then oven dried at 65±5°C. After drying, samples were ground to fine powder. The finely ground samples were weighed accurately, subjected to acid digestion and used for the determination of N, P and K. The nitrogen content in plant was estimated by the modified micro Kjeldahl method (Jackson, 1973). The phosphorus content in plant was estimated colorimetrically after wet digestion and colour development using vanadomolybdate phosphoric yellow colour method and the intensity of colour was read using a spectrophotometer (Jackson, 1973). The potassium content in plant was estimated using a flame photometer (Jackson, 1973).

The nitrogen uptake was calculated by multiplying the nitrogen content of the plant with the dry matter produced and expressed as kg/ha. The phosphorus uptake was calculated by multiplying the phosphorus content of the plant with the dry matter produced and expressed as kg/ha. The potassium uptake was calculated by multiplying the K content of the plant with the dry matter production and expressed as kg/ha.

For analysis of soil before the experiment, soil samples were collected from the experimental area to a depth of 15 cm, dried under shade and composite soils were prepared by quartering. After the harvest of the crop, the composite samples were drawn from each plot and were shade dried for the analysis of organic carbon, available nitrogen, available phosphorus, and available potassium. The available nitrogen content was estimated by alkaline potassium permanganate method (Subbiah and Asija, 1956), the available phosphorus content was estimated by Bray's colorimetric method (Jackson, 1973), and available potassium by neutral normal ammonium acetate method (Jackson, 1973) and organic carbon content by Walkley and Black rapid titration method (Walkley and Black, 1934).

TABLE 1
Chemical properties of soil of the experimental site

Parameters	Content	Rating
Soil reaction	5.26	Moderately acidic
EC (dS/m)	0.12	Normal
Organic carbon (%)	0.53	Medium
Available N (kg/ha)	265	Low
Available P (kg/ha)	35	High
Available K (kg/ha)	115	Low

The data were statistically analyzed in GRAPES software (Gopinath *et al*, 2020) and the treatment means were compared at 5 per cent probability level.

RESULTS AND DISCUSSION

Green fodder yield and dry fodder yield per plant

Yield and yield attributes were significantly influenced by spacing and nutrient levels represented in Table 2. The highest green fodder yield per plant (94.39 g), dry fodder yield per plant (15.26 g) were achieved with s_2. The improvement in green and dry fodder yield per plant may be due to better aeration more availability of moisture, nutrients and better interception of solar radiation. Moreover better uptake of nutrients was observed with the spacing of 30 cm x 15 cm . Optimum spacing, therefore proved to be more favorable for increased fodder yield compared to narrow and wider spacing. Similar findings were reported by Sivaprasad and Singh (2017) and Manjunath *et al* (2013) in fodder sorghum. Among nutrient levels, n_3 led to the highest green fodder yield per plant (93.18 g), dry fodder yield per plant (15.81 g). The increased fodder yield may be due to higher nutrient dose which resulted in higher uptake and positive interaction among nutrients that were utilized to synthesize proteins, enzymes and other essential components. Similar results in yield parameters were also reported by Fayique (2019) in fodder ricebean.

Per day productivity

Per day productivity revealed the rate of crop growth was significantly influenced by spacing and nutrient management represented in Table 2. The highest per day productivity (0.29 t/ha/d), was achieved with optimum spacing of 30 cm x 15 cm. Among nutrient levels, the highest per day productivity (0.24 t/ha/d), was obtained with the highest dose of nutrients. Among interactions, the highest per day productivity (0.35 t $ha^{-1}d^{-1}$), was recorded with s_2n_3. This might be due to increased green and dry fodder production. This is in conformity with the findings of Sharu (2016) in palisade grass.

Plant Analysis

Spacing had significant effect on nutrient uptake by fodder cowpea represented in Table 2.

TABLE 2
Effect of spacing and nutrient levels on N, P and k uptake, green and dry fodder yield per plant and per day productivity in fodder cowpea

Observations	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)	Green fodder yield/plant (g)	Dry fodder yield/ plant (g)	Per day productivity (kg/ha/d)
Spacing(S)						
s_1 (20 cm x 15 cm)	37.28	4.62	33.39	80.92	12.96	0.24
s_2 (30 cm x 15 cm)	63.55	5.80	40.94	94.39	15.26	0.29
s_3 (40 cm x 15 cm)	49.21	4.81	38.48	86.12	13.76	0.25
s_4 (broadcasting)	27.15	3.33	29.65	73.16	11.79	0.20
SEm (±)	2.19	0.19	2.12	2.50	0.34	0.01
CD (0.05)	6.422	0.568	6.223	7.321	0.993	0.02
Nutrient levels (N)						
n_1 (75% POP)	30.69	3.57	32.09	74.05	11.12	0.21
n_2 (100% POP)	41.31	4.54	34.19	83.71	13.39	0.24
n_3 (125% POP)	60.89	5.82	40.57	93.18	15.81	0.28
SEm (±)	1.90	0.17	1.84	2.16	0.29	0.01
CD (0.05)	5.562	0.492	5.389	6.34	0.86	0.02
Spacing x Nutrient levels (S x N)						
s_1n_1	31.23	3.42	33.30	75.93	11.43	0.22
s_1n_2	35.54	4.51	31.19	79.00	12.60	0.23
s_1n_3	45.07	5.94	35.70	87.83	14.83	0.26
s_2n_1	41.95	4.41	35.22	76.73	11.37	0.23
s_2n_2	55.70	5.11	37.50	98.73	15.90	0.29
s_2n_3	93.01	7.89	50.10	107.70	18.50	0.35
s_3n_1	29.13	3.66	32.62	81.43	12.33	0.22
s_3n_2	45.60	5.04	37.89	82.83	13.17	0.24
s_3n_3	72.89	5.74	44.95	94.10	15.77	0.30
s_4n_1	20.47	2.78	27.23	62.10	9.33	0.18
s_4n_2	28.39	3.51	30.17	74.27	11.90	0.20
s_4n_3	32.59	3.72	31.54	83.10	14.13	0.21
SEm (±)	3.79	0.34	3.68	4.32	0.59	0.01
CD (0.05)	11.123	0.984	NS	NS	1.72	0.04

NS- Not significant
n_1:75% (18.75:45:22.5 kg N: P_2O_5: K_2O/ha), n_2: 100% POP (25:60:30 kg N: P_2O_5: K_2O/ha) , n_3: 125% POP (31.25:75:37.5 kg N: P_2O_5: K_2O/ha).

Optimum spacing of 30 cm x 15 cm resulted in the highest N uptake (63.55 kg/ha), P uptake (5.8 kg/ha), whereas K uptake (40.93 kg/ha) was on par with s_3 (40 cm x15 cm). This might be due to better establishment of root system and functioning of root nodules due to wider space available to plants and also higher dry matter yield which resulted in more uptake of nutrients. Similar results of higher uptake of nutrients in optimum spacing were reported in fodder cowpea by Yashas (2016), Malagi (2005), Bhavya *et al.* (2014).

Nitrogen, phosphorus and potassium uptake were notably affected by nutrient application represented in Table 2. The application of nutrients at 125% POP resulted in the highest N uptake (60.89 kg/ha), P uptake (5.82 kg/ha) and K uptake (40.57 kg/ha). This enhanced nutrient uptake could be attributed to the improved nutrient availability in the root zone, facilitated by the higher application of nutrients and enhanced root activity. Similar results in the uptake of NPK were reported Kumar *et al.* (2013) in fodder cowpea and Rathore *et al.* (2015).

The interaction between spacing and nutrient levels notably impacted nutrient uptake represented in table 2. The highest N uptake (93.01 kg ha^{-1}), P uptake (7.89 kg ha^{-1}) was the highest in s_2n_3. Specifically, the spacing configuration of 30 cm × 15 cm with 125% POP exhibited the highest nitrogen uptake which might be due to better nutrient availability in the root zone during the crop growing period and higher dry matter production. Yashas (2016) reported similar findings in fodder cowpea, demonstrating increased nutrient uptake in 30 cm spacing with 125% POP compared to other treatment combinations.

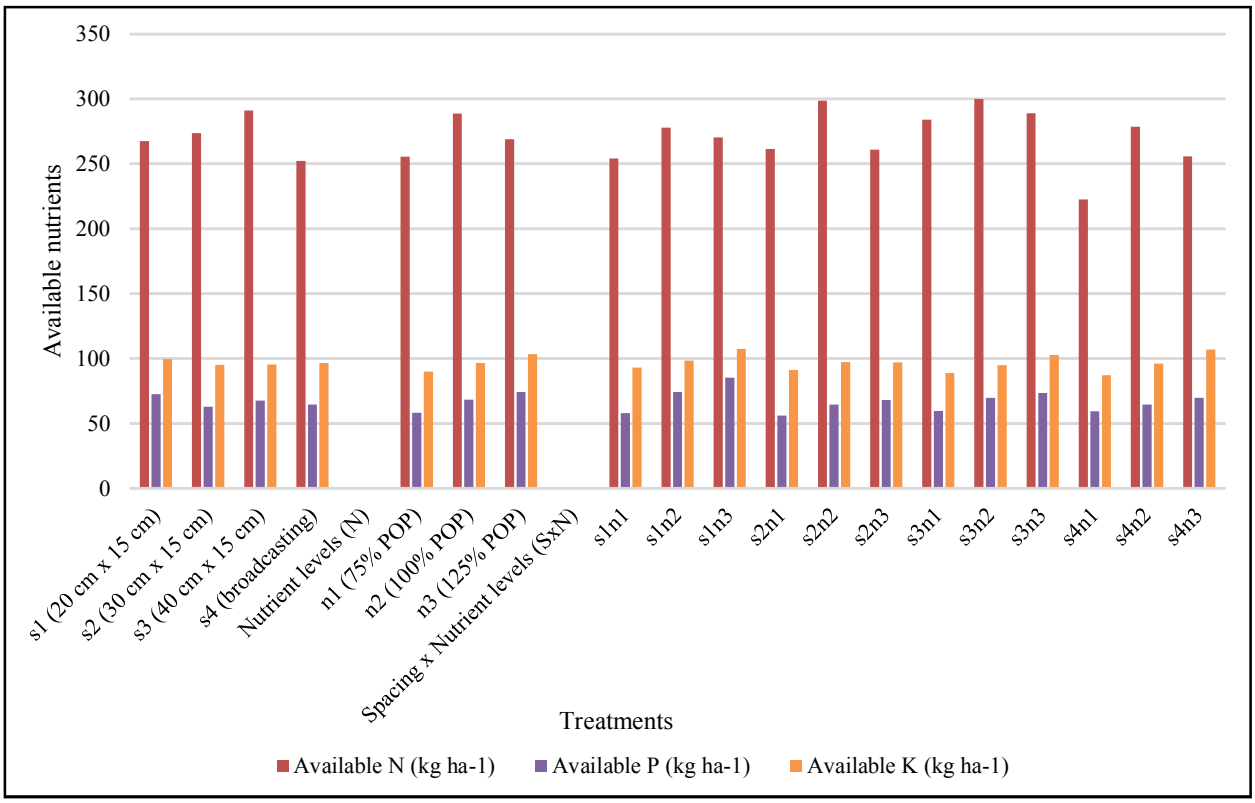

Fig. 2. Available nutrients in the soil after the experiment as influenced by spacing, nutrient levels, and their interaction during summer.

Soil Analysis

Spacing had a significant effect on soil fertility status after the experiment represented in Fig 2. Among spacing, s_3 led to elevated levels of available nitrogen (290.95 kg/ha). The non-exhaustive nature of fodder cowpea and the improved establishment of the root system and functioning of root nodules, possibly due to bacterial mobilization, might have favoured more atmospheric nitrogen fixation in the soil. Treatment s_1 exhibited the highest levels of available phosphorus (72.45 kg/ha) and available potassium (83.59 kg/ha). Narrow spacing recorded the highest available soil phosphorus and available soil potassium compared to wider spacing. This might be attributed to higher nutrient uptake by plants at wider spacing. Similar results in available soil nutrients were also reported by Kurubetta (2006) in cowpea and Among nutrient levels, n_2 recorded the highest available nitrogen (288.73 kg ha^{-1}). This observation might be due to optimum nutrient dose resulted in balanced availability of nitrogen and phosphorus, which, in turn, led to increased number of nodules and fresh nodule weight which ultimately contributed to the highest available soil nitrogen after the experiment. These findings align with the results reported by Bhavya *et al.* (2014). For available soil phosphorus and potassium, n_3 showed the highest value in *rabi* (74.13 kg/ha and 103.45 kg/ha). This outcome might be attributed to the increased application of nutrients, resulting in an enhanced nutrient status of the soil. Similar observations regarding available soil nutrients after the experiment were reported in palisade grass by Sharu (2016), Nigade *et al.* (2013), and Triveni *et al.* (2018).

The treatment combination of s_1n_3 (20 cm × 15 cm with 125% POP) recorded the highest available soil P (85.26 kg/ha) represented in Fig 2. This might be due to higher dose of fertilizer applied and less uptake of phosphorus which was responsible for more available P in soil. The slow release of fixed phosphorus might have contributed to increased soil phosphorus levels. Similar result in available soil nutrients was reported by Kurubetta (2006) in cowpea.

CONCLUSION

The result of the investigation indicated that fodder cowpea can be intercropped in coconut garden. Based on the study it can be concluded that spacing

of 30 cm x 15 cm along with nutrient recommendation of 31.25:75:37.5 kg N: P_2O_5: K_2O ha^{-1} (125% POP) as basal dose can be recommended for getting the highest green fodder and dry fodder yield in fodder cowpea intercropped in coconut garden during rabi season.

Future scope: Performance of cereal and legume-based fodder intercropping systems under varying levels of shade.

ACKNOWLEDGEMENT

The special thanks to Sharu, S. R.

REFERENCES

Bhagmal, S.K., A.K. Roy, S. Ahmed, and D.R. Malviya, 2011. Forage crops and grasses. *Handbook of Agriculture. ICAR (6th revised edition), New Delhi*, pp.1353-1417.

Bhavya, M. R., Y. B. Palled, Pushpalatha, M. Y. Ullasa and Nagaraj, R. 2014. Influence of seed rate and fertilizer levels on dry matter distribution and dry matter yield of fodder cowpea (cv. Swad). *Trends Biosci.* **7**: 1516-1521.

Gopinath, P.P., R. Parsad, B Joseph and V.S. Adarsh 2020: GRAPES: General R shiny Based Analysis Platform Empowered by Statistics. *https:// www.kaugrapes.com/ home. version1.0.0. DOI:10.5281/zenodo.492320.*

Jackson, M. L. 1973: Soil Chemical Analysis (2nd Ed.). Prentice Hall of India, New Delhi, 498.

Kumar, M., A. P. Singh, J. Prakash, T. P. S. Katiyar, R. Kumar and R. Bharose, 2013. Effect of phosphorus and molybdenum on yield and nutrient uptake by cowpea. *Asian J. Soil Sci.* **8**(2): 366-369.

Kumar, S., K. A. Gopinath, S. Sheoran, R. S. Meena, C. Srinivasarao, S. Bedwal, C.K. Jangir, K. Mrunalini, R. Jat, and C.S. Praharaj, 2023: Pulse-based cropping systems for soil health restoration, resources conservation, and nutritional and environmental security in rainfed agroecosystems. *Frontiers in Microbiology,* **13**: 1041124.

Kurubetta, K. D., 2006: Effect of time of sowing, spacing and seed rate on seed production potentiality and quality of fodder cowpea [*Vigna ungiculata* (L.) Walp]. M.Sc. (Ag) thesis, University of Agricultural Sciences, Dharwad. 85.

Maitra, S., 2020: Intercropping of small millets for agricultural sustainability in drylands: A review. *Crop Res.*, **55**(3&4): 162-171.

Malagi, S.C. 2005: Response of cowpea genotypes to plant density and fertilizer levels under rainfed vertisols. M.Sc. (Ag) thesis, University of Agricultural Sciences, Dharwad. 29-35.

Manjunatha, S. B., 2011: Response of multicut fodder sorghum (CoFS-29) to row spacings and nitrogen levels under irrigated condition M.Sc. (Ag) thesis, University of Agricultural Sciences, Dharwad. 28-39.

Manoj, K.N. and B.G. Shekara, 2020: Agronomic management practices for enhancing quality and productivity of fodder: A review. *Ind. J. Pure App. Biosci*, **8**(5): 403-410.

Nigade, R.D., S.R. Karad, and S.M. More, 2012: Agronomic manipulations for enhancing productivity of finger millet based on intercropping system. *Adv. Res. J. Crop Impr.* **3**(1): 8-10.

Rathore, D. K., R. Kumar, M. Singh, P. Kumar, N. Tyagi, C. Datt, B. S. Meena, P. G. Soni, T. Yadav and G. Makrana, 2015: Effect of phosphorus and zinc application on nutritional characteristics of fodder cowpea (*Vigna unguiculata*). *Indian J. Anim. Nutr.* **32**(4): 388-392.

Sharu, S. R. 2016. Production package of palisade grass (*Brachiaria brizantha* (Hochst ex a.Rich.) Stapf.). Ph.D. (Ag) thesis, Kerala Agricultural University, Thrissur. 346.

Shivprasad, M. and Singh, R., 2017: Effect of planting geometry and different levels of nitrogen on growth, yield and quality of multicut fodder sorghum (*Sorghum bicolor* (L.) Monech). *Journal of Pharmacognosy and Phytochemistry*, **6**(4): 896-899.

Subbaiah, B. V. and G. L. Asija, 1956: A rapid procedure for determination of available nitrogen in soil. *Curr. Sci.* **25**: 259-260.

Triveni, U., Y. S. Rani, T. S. S. K. Patro, N. Anuradha and M. Divya, 2018: Fertilizer responsiveness of short duration improved finger millet genotypes to different levels of NPK fertilizers. *Indian J. of Agric. Res.* **52**(1): 97-100.

Walkley, N. J. and C. A. Black, 1934: Estimation of soil organic carbon by the chromic acid titration method. *Soil Sci.* **37**: 29-38.

Yashas, C. S. 2016: Studies on Planting Geometry, Nitrogen and Phosphorus Levels on Forage Yield and Quality of Fodder Cowpea (*Vigna Unguiculata* (L.) Walp.). M.Sc. (Ag) thesis, University of Agricultural Sciences, GKVK, Bangalore, 30-60.