International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 1127-1130

Received: 20-05-2018
Accepted: 22-06-2018

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Response of nutrient management practices on yield attributes and yield of pearl millet (*Pennisetum glaucum* L.) under *Melia dubia* based Agri-silvi system

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Abstract
Field experiment was conducted during *kharif,* 2017 to study the effects of nutrient management practices on yield attributes and yield of pearl millet intercropped in *Melia dubia* based agri-silvi system. The experiment was laid out in randomized block design with three replication and eight treatments viz., T_1- Control (no fertilizer and manure), T_2-100% RDF (80-40-30 NPK kg ha^{-1}) through normal urea, T_3-100% RDF through neem coated urea, T_4-75% RD N + 25% N Poultry manure, T_5-75% RD N + 25% N FYM, T_6-75% RD N + Pongamia green leaf manure @ 10 t ha^{-1}, T7-75% RD N + *Azotobacter* @ 500 g ha^{-1}, T_8-Sole crop without trees (100% RDF). Results of the experiment showed that sole crop without trees recorded significantly higher yield attributes, grain yield and stover yield followed by 100% RDF through neem coated urea. But, among organic sources, application of 75% RD N + Pongamia green leaf manure @ 10 t ha^{-1} significantly influenced the yield attributes, grain yield and stover yield of pearl millet in *Melia dubia* based agri-silvi system followed by 75% RDF + 25% N through Poultry manure.

Keywords: Pearl millet, *Melia dubia*, agroforestry, nutrient management

Introduction
Pearl millet (*Pennisetum glaucum*) is grown in arid and semi-arid regions of India for both grain and fodder in over 7.12 m ha (Agricultural Statistics at a Glance, 2016) [1]. In India, it is the fifth most important cereal grain crop next to rice, wheat, maize and sorghum. It is an imperative drought escaping cereal crop. Pearl millet grain is more nutritious and the grain contains 11-19 % protein, 69.4 % carbohydrates and 3.0-4.6% fat and also has good amount of phosphorous and iron (Reddy *et al.*, 2016) [2]. Main reason for low productivity of this crop is water and nutritional stresses. One of the easiest ways for boosting productivity of pearl millet is the use of balanced fertilizers to the undernourished crop. Importance of the pearl millet in low cost agriculture of small and marginal farmers was highlighted during annual pearl millet workshop held at Junagadh Agricultural University on 23 March 2013 (ICAR 2013) [3]. In the workshop, pearl millet was described as a future crop under climate change scenario. Tolerance to drought and heat and better adaptability of pearl millet to climate change has been reported from African Sahel (CO_2 Science, 2011) [5].
Increased use of fertilizers without organic recycling has not only aggravated multi-nutrient deficiencies in soil-plant-system but also detrimental to soil health and has created environmental pollution. Judicious combination of organic manures and chemical fertilizers depending upon the availability, nature and properties of the soil and crops to be grown would not only maximize the crop production and improve the quality of agricultural produces but would also help in maintaining the soil fertility (Madhavi Lata *et al.*, 2014) [5]. Use of chemical fertilizers like neem coated urea inhibits the nitrification rate which is intended to improve the efficiency or uptake of N by plants and reduces NO_3^- and N_2O release into the environment (Hala *et al*., 2014) [6].
Due to harsh and fragile ecology of arid and semi-arid region, required to identify or develop economic and viable land use system. In such situation, agri-silvi system, particularly during initial 5-6 years have ample scope to exploit the interspaces of the trees for growing arable crops. (Aariff Khan and Krishna, 2016) [7]. Among different tree species, *Melia dubia* has been screened as one of the best alternate of pulpwood species (Parthiban *et al.*, 2009) [8].

It belongs to the family Meliaceae, commercially known as Malabar Neem and is locally called as Malabar Vepa. It is a large deciduous and fast growing tree with wide spreading branches, straight and tall bole. *M. dubia* with its multi-various uses like pulpwood, timber, fuel wood and plywood can fit as a suitable species for agro and farm forestry plantation programme (Saravanan *et al*., 2013) [9].
Keeping this background in view, an experiment was conducted to assess the influence of nutrient management practices on yield and yield attributes of pearl millet in *Melia dubia* based agri-silvi system.

Material and Methods

A field experiment was conducted during *kharif*, 2017 at Agroforestry research block, AICRP on Agroforestry, Rajendranagar, Hyderabad, Telangana. The soil of the experimental field was sandy loam in texture with pH (6.23), EC (0.135 dS m^{-1}) and OC (0.77 %). The soil was medium in available nitrogen (287.6 kg ha^{-1}), low in available P_2O_5 (41.31 kg ha^{-1}) and medium in available potassium (214.0 kg ha^{-1}). The experiment was laid out in a randomized block design and replicated thrice, treatments comprised of Control ($T_{1,}$ no fertilizer and manure), 100% RDF through normal urea (T_2), 100% RDF through neem coated urea (T_3), 75% RD N + 25% N Poultry manure (T_4), 75% RD N + 25% N FYM (T_5), 75% RD N + Pongamia green leaf manure (PGLM) @ 10 t ha^{-1} (T_6), 75% RD N + *Azotobacter* @ 500 g ha^{-1} (T_7), Sole crop without trees (T_8, 100% RDF). T_1 to T_7 treatments are under *Melia dubia.*
Pearl millet was intercropped in *Melia dubia* of six years old wherein, the trees are at a spacing of 5 m x 4 m. Pearl millet was sown on 4^{th} July, 2017 and harvested on 6^{th} October. Pearl millet variety PHB-3 was planted at a spacing of 45 cm x 15 cm using seed rate of 5 kg ha^{-1}. The quantity of organic manures was applied as per the treatments. The N, P and K were applied through normal urea, neem coated urea, SSP and MOP as per the treatments. Entire dose of phosphate and potash and half dose of N were applied basally. The remaining half N was applied as split application at 30 DAS. *Azotobacter* @ 500 g ha^{-1} was applied as seed treatment to the treatment specified. At harvesting, 5 plants were sampled from the net plot to observe the yield attributes like productive tillers m^{-2}, earhead length, no. of grains earhead^{-1}, grain weight earhead^{-1} and test weight. To determine grain yield, ear heads from the net plot were harvested and sun dried. Threshing was done by beating the ear heads with sticks. The separated grains were cleaned, dried in sun to bring down the moisture content to 12%. To determine stover yield, stalks were cut at ground level and weighed after sun drying. The data were subjected to analysis of variance procedures as outlined for randomized block design factorial concept (Gomez and Gomez, 1984). Statistically significance was tested by F-value at 5 % level of probability and critical difference was worked out where ever the effect were significant.

Results and Discussion

Yield Attributes

The results revealed that yield attributing characters like productive tillers m^{-2}, ear head length, no. of grains ear head^{-1}, grain weight ear head^{-1} and test weight were significantly influenced by nutrient management practices (Table 1). Significantly, the highest productive tillers m^{-2} (34.1), ear head length (26.4 cm), number of grains ear head^{-1} (2426), grain weight ear head^{-1} (24.5 g) and test weight (11.02 g) was recorded by the treatment sole crop without trees (100% RDF) followed by 100% RDF through neem coated urea under *Melia dubia*. This might be due to highest level of nitrogen that attributed to the better filling of grains resulting into bold sized seeds and consequently highest test weight as well as all yield attributes. Among organic sources, 75% RD N + PGLM @ 10 t ha^{-1} (T_6) recorded significantly higher productive tillers m^{-2} (27.7), ear head length (23.8 cm), number of grains ear head^{-1} (2173), grain weight ear head^{-1} (20.0 g) and test weight (8.94 g) followed by 75% RD N + 25% N Poultry manure (T_4).
This could be due to efficient utilization and availability of nutrients from combined sources of either organic or inorganic fertilizers which increased tillers per plant, expansion of leaf lamina and chlorophyll content that ultimately provided greater sites for photosynthesis and diversion of photosynthates towards sink which caused increase in length of ear head, number of grains earhead^{-1} and weight of grains earhead^{-1}. Similar results were reported by Divya *et al*. (2017) [12]. The beneficial effect on yield attributes might also be due to increased supply of all the essential nutrients by PGLM, poultry manure and FYM that might have resulted in more synthesis of food and its subsequent partitioning to sink. The findings of present investigation are supported by Khan *et al*., (2000) [11].
Increased availability of nitrogen in soil through mineralization of pongamia green leaf manure could have triggered the production of new meristems which in turn develop into tillers. As green leaf manure supplies nutrients at slow rate for longer time it reduces tiller mortality and increases productive tillers m^{-2}. Similar results were obtained by Prasad *et al*. (2010) [13] with pongamia green leaf manure application.

Table 1: Yield attributes and yield of pearl millet as influenced by nutrient management in *Melia dubia* based agri-silvi system

Treatments	Productive tillers m^{-2}	Earhead length (cm)	Grains earhead^{-1}	Grain weight earhead^{-1} (g)	Test weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1 Control	10.2	16.3	1251	9.9	6.47	852	1903
T_2 100% RDF through normal urea	24.2	22.2	1981	17.4	8.04	2340	4766
T_3 100% RDF through neem coated urea	30.6	25.2	2299	22.3	9.96	2920	4791
T_4 75% RD N + 25% N through Poultry manure	20.6	20.6	1846	14.4	7.76	1983	3952
T_5 75% RD N + 25% N through FYM	17.0	19.2	1580	14.2	7.60	1443	3483
T_6 75% RD N + PGLM @ 10 t ha^{-1}	27.7	23.8	2173	20.0	8.94	2667	4636
T_7 75% RD N + *Azotobacter* @ 500 g ha^{-1}	13.5	18.0	1433	12.1	7.50	1187	3095
T_8 Sole crop without trees (80-40-30 NPK kg ha^{-1})	34.1	26.4	2426	24.5	11.02	3182	5150

Mean	22.4	21.5	1868	16.9	8.41	2073	3977
S.Em ±	1.07	0.44	42	0.70	0.34	84	120
CD *(P=0.05)*	3.24	1.32	127	2.11	1.02	255	356

100% RDF = 80-40-30 kg NPK kg ha^{-1}

Grain and stover yield

Significantly higher grain and stover yield (Table 1) was obtained with sole crop without trees (3182 and 5150 kg ha^{-1}) followed by 100 % RDF through neem coated urea (2920 and 4791 kg ha^{-1}). Among integrated nutrient management practices adopted 75% RD N + PGLM @ 10 t ha^{-1} (T_6) recorded highest grain and stover yield (2667 and 4636 kg ha^{-1}) followed by 75% RD N + 25% N Poultry manure (1983 and 3952 kg ha^{-1}).

The percentage increase in grain yield with sole crop, 100% RDF through neem coated urea and 75% RD N + PGLM 10 t ha^{-1} over control was 273.47%, 243.89% and 213.03% respectively. The results further revealed that biofertilizer treatment also performed better than control. In terms of percentage, the increase was 39.32% with 75% RD N + *Azotobacter*.

The higher grain yield of pearl millet seemed to be the cumulative effect of yield attributes which was boosted by balanced nutrients supply. Similar results were reported by Barad *et al*. (2017) [14] and Ranveer Singh *et al*. (2013) [15]. Increased grain yield might also be due to the increased photosynthetic activity which resulted in higher accumulation of photosynthates and translocation to sink due to better source and sink channel which resulted in higher grain yield. The efficacy of inorganic fertilizer in improving grain yields was much pronounced when it was combined with organic manures. The increased vegetative growth and the balanced C: N ratio might have increased the synthesis of carbohydrates, which ultimately promoted the yield (Pratap *et al*., 2008) [16]. The variation in yield is attributed to improved growth and earhead characters that increased availability and absorption of nitrogen from soil which enhanced metabolic activities, translocation and synthesis of nutrients resulted in higher grain yield. The beneficial effect of nitrogen application through various sources on grain yield of pearl millet have also been reported by Meena *et al*. (2003) [17]. The conjunctive use of organic and inorganic sources has beneficial effect on physiological process of plant metabolism and growth, there by leading to higher grain yield. The easy availability of nitrogen due to mineralization of organics there by influence the shoot and root growth favouring absorption of other nutrients. Similar results were obtained by Yakadri and Reddy (2009) [18].

Reduced yield in pearl millet compared to sole crop may be ascribed due to competition for light, moisture and nutrients with suppressing effect on crops, reduced solar radiation on crop canopy. Similar results were reported by Prasad *et al*. (2011) [19] and Kumar *et al*. (2013).

The percentage increase in stover yield with sole crop, 100% RDF through neem coated urea, 100% RDF through normal urea, 75% RD N + PGLM 10 t ha^{-1} and 75% RD N + 25% N poultry manure over control was 170.62%, 167.58%, 150.45%, 129.90% and 107.67% respectively. The results further showed that the biofertilizer combination treatment also performed better than control. In terms of percentage, the increase was 62.64% with 75% RD N + *Azotobacter*.

Significant increase in stover yield with organics and inorganics together was attributed to build up of humus, organic carbon which improves the soil properties and increased availability of nutrients with addition of manure. These results are in line with the findings of Rajesh (2012). Higher stover yield under conjoint organic and inorganic sources were due to higher plant height, leaf area, dry matter accumulation, more nutrient availability and uptake. These results are in conformity with the results of Ghilotia *et al*. (2014) [22]. An increase in uptake of plant nutrients empowered the plant to manufacture more quantity of photosynthates resulting in more stover yield. Similar results were reported by Thumar *et al*. (2016) [23].

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