Effect of crop geometry and nitrogen level on growth of multicut fodder sorghum based intercropping system

Prasanth RC, NS Venkataraman, T Ragavan and J Prabhakaran

Abstract
A field experiment was conducted at D block of central farm, Agricultural College and Research Institute, Madurai, Tamil Nadu during 2018-2019, to optimize the crop geometry and assess the nitrogen level for multicut fodder sorghum (CoFS-31) based intercropping system. The main plot treatments were divided with crop geometry of 30x15 and 45x15cm as sole fodder sorghum, (45+15) x15cm and (60+30) x15cm as paired row system with inter crop. In sub plots nitrogen level of 75, 100 and 125 per cent RDF of N were assigned. The experimental results revealed that growth parameters viz., plant height and number of tillers, were significantly increased under (60+30) ×15 cm paired row system of planting with inter crop along with application of 125 per cent RDF of N.

Keywords: Fodder sorghum (CoFS-31), paired row system, nitrogen, intercrop

Introduction
India is the largest country which is having 529.7 millions of livestock population (Anon., 2010) [2]. The total area under fodder crops is 6.6 m ha which constitutes about 4% of cultivated area and is insufficient to meet the fodder requirement of existing livestock. It is often not possible to set aside arable land for fodder production alone, as cultivable land is not enough for food grain production. Agriculture land is shrinking day by day as it is used for non-agricultural purposes. It is rather inevitable to accommodate fodder production in existing crops/cropping systems.

It is estimated that India’s animal population will reach nearly 1350 million by 2020 AD and food requirement of the country is expected to be around 300 million tons (Anon., 2005) [1]. This additional production has to come from existing land of cultivated area (143.8 m ha). The only option available is time and space utilization in agriculture through intercropping (Sankaran and Rangasamy, 1990) [9]. There is ample inter-space in widely spaced crops like grain maize, sorghum, bajra, hybrid cotton, red gram etc., which can be advantageously used to raise short duration pulse crops such as fodder cowpea or multi-cut fodder crops without much reduction in the main crop yields.

Sorghum is one of the widely adopted forage crops due to its high yielding ability, better nutritive value and suitability for ratooning. It occupies maximum area among different fodder crops (Hazarika, 1998 and Grewal et al., 2005) [6]. Multicut fodder sorghum is more advantageous in many ways such as high yield in short period, saving in terms of seed and land preparation. In multicut management, the stem thickness decreases gradually and improves palatability of the fodder too. Therefore, it is very popular among the fodders (Grewal et al., 2005) [6].

Cowpea (Vigna unguiculata L.) is gaining importance as a fodder legume crop and is grown during summer and kharif seasons. It is a heavy forage yielder raised as a pure crop or in association with cereals like maize, sorghum and bajra, so as to enrich their nutritive value due to its higher protein content. Besides, it also improves the fertility status of soil and reduces the nitrogen requirement of companion or succeeding crop in rotation, by fixing atmospheric nitrogen through their nodules. The feeding value of cowpea forage is high and superior to other legumes. It has around 13-18 per cent protein, 18-26 per cent crude fiber and 2-3 per cent crude fat. It provides highly palatable, succulent and quality fodder (Bish et al., 2001) [3]. Hence the present study was taken up for evaluatry optimum crop geometry and assessing nitrogen levels for multicut fodder sorghum Co (FS)-31 based intercropping system.
Materials and Methods

The field experiment was conducted in field no. D-62 of central farm, Agricultural College and Research Institute, Madurai during kharif 2018. The farm is geographically located in the southern zone of Tamil Nadu at 9° 54' N latitude, 78° 54' E longitude and at an altitude of 147 m above mean sea level. The soil pH and EC was 8.1 and 0.17 dsm⁻¹. The nutrient status of the soil during the start of experiment was medium in available nitrogen (324 kg ha⁻¹), medium in available phosphorus (16 kg ha⁻¹), high in available potassium (295 kg ha⁻¹) and low soil organic carbon content (0.44 per cent). Multicut fodder sorghum variety Co (FS)-31 and fodder cowpea variety Co (FC)-8 were used for the experiment. The experiment was laid out in split plot design with three replications. The different crop geometry was kept in main plot and nitrogen levels were kept in sub plot. The treatment details are given below.

Main plot-Crop geometry (S)
- S₁: 30 × 15 cm: sole fodder sorghum
- S₂: 45 × 15 cm: sole fodder sorghum
- S₃: (45+15) × 15 cm: fodder sorghum and fodder cowpea under paired row system
- S₄: (60+30) × 15 cm: fodder sorghum and fodder cowpea under paired row system

Sub plot-Nitrogen levels (N)
- N₁: 75% N of RDF
- N₂: 100% N of RDF
- N₃: 125% N of RDF

RDF: Recommended Dose of Fertilizer (90:40:40 NPK/ha) and 45 kg of N alone after each cut at 45 days interval. Both the fodder sorghum and fodder cowpea seeds were simultaneously sown by dibbling. The spacing was adjusted based on the treatment. Two seeds were dibbled. Nitrogen, phosphorus and potassium were applied as urea, single super phosphate and muriate of potash, respectively. Full dose of phosphorus, potassium and 50% of nitrogen were applied during sowing as basal dose. Remaining 50% of nitrogen was applied at 30 DAS. After each harvest, nitrogen was applied based on treatment schedule (75%, 100% & 125%). The first cutting was taken at 65 DAS, second and third cuttings were taken at 45 days interval. The growth parameters like plant height and number of tillers were recorded at harvest. The data on there parameters studied during the course of investigation were subjected to statistical analysis in split plot design following the method suggested by Gomez and Gomez (1984).

Experimental Results and Discussion

The plant height is the expression of growth influenced by agronomic manipulation and also environment. Treatments differed significantly in the plant height with row spacing and intercropping. In the first cutting 45×15 cm sole sorghum recorded the highest plant height of 256.4 cm followed by 30×15 cm sole sorghum (244.3 cm). The lowest plant height of 213.4 cm was recorded in (45+15) × 15 cm paired row system with intercrop system. In the second cutting 45×15 cm sole sorghum was recorded the highest plant height of 244.2 cm followed by 234.5 cm in (60+30) × 15 cm paired row system with intercrop. The lowest plant height was 203.2 cm in (45+15) × 15 cm paired row planting with intercrop. Higher plant height was recorded with crop geometry of 45×15 cm sole fodder sorghum than fodder sorghum with inter cropping of fodder cowpea might be due to competition for light, space and nutrients.

In the third cutting, the S₄ treatment ((60+30) × 15 cm) recorded the highest plant height (197.9 cm) followed by ((45+15) × 15 cm) paired row system with intercrop and lowest plant height of 177.8 cm was recorded at 30×15 cm sole sorghum. The increased in height in the paired row system might be due to biological nitrogen fixation by legume fodder crops which enhanced the root biomass of legumes and improving the physical and chemical properties of the soil. Similar results were found by Sinsinwar, (1995) [12]. The plant height was significantly increased with the different level of nitrogen application. The highest plant height was recorded in 125 per cent RDF of nitrogen with the value of 256.8, 246.7 and 196.1 cm which was followed by application of 100 per cent RDF (N) with plant height of 235.8, 225.1 and 186.7 cm at first, second and third cuttings respectively. The lowest plant height of 208.6, 199.1 and 180.0 cm at first, second and third cutting respectively was recorded with 75 per cent RDF. The application of 125 per cent RDF of nitrogen has recorded the highest plant height; due to increased nitrogen accumulation in the plant and thereby increased protoplasmic constituents causing acceleration in cell division process resulting in luxuriant growth. Similar results were observed by Manjunatha et al., (2013) [8]. The interaction effect between crop geometry and nitrogen level was significantly influenced to plant height. In the first cutting highest plant height was observed under 45×15 cm sole sorghum with 125 per cent RDF of nitrogen (281.1 cm) followed by 30×15 cm sole sorghum and 125 per cent RDF of nitrogen (265.1 cm) and The lowest plant height of 187.9 cm was observed in (60+30) × 15 cm paired row system with intercrop and 75 per cent RDF of nitrogen and this was on par with (45+15) × 15 cm paired row system with intercrop and 75 per cent RDF of nitrogen (189.6 cm). In the second cutting, the combination of 45×15 cm sole sorghum with 125 per cent RDF of nitrogen showed highest plant height of 267.7 cm, this was followed by (60+30) × 15 cm paired row system of intercrop with 125 per cent RDF of nitrogen showing plant height of 254.2 cm and the combination with 30×15 cm sole fodder sorghum with 75 per cent RDF of nitrogen showed highest plant height of 178.9 cm. The third cutting, the treatment combination of (60+30) × 15 cm paired row system with intercrop and 125 per cent RDF of nitrogen showed the highest plant height of 215.3 cm, followed by 198.0 cm in S₃ and the lowest plant height of 165.4 cm
was recorded under 30×15 cm sole fodder sorghum in combination with 75 per cent RDF of nitrogen.

**Number of Tillers Plant**

Tiller production was favourably influenced by crop geometry and nitrogen levels. The number of tillers per plant showed an increasing trend in each cutting. The number of tillers was recorded high under 45×15 cm sole fodder sorghum (11.1) followed by 30×15 cm sole fodder sorghum (8.4) and the lowest number of tillers (6.6) was observed under fodder sorghum + fodder cowpea intercropping in (45+15) × 15 cm paired row system in the first cutting. In the second cutting, the highest number of tillers was recorded in sole fodder sorghum 45×15 cm row spacing (18.3) followed by fodder sorghum + fodder cowpea with (60+30) × 15 cm paired row system and it was lower (13.6) in fodder sorghum + fodder cowpea intercropping under (45+15) × 15 cm paired row system. In the third cutting, higher number of tillers was obtained in (60+30) × 15 cm paired row system with intercrop (23.8) followed by (45+15) × 15 cm paired row system with intercrop, (20.8) this was on par with 45×15 cm sole fodder sorghum.

In first and second cutting, the highest number of tillers recorded with crop geometry of 45×15 cm sole fodder sorghum was due to its wider spacing of each plant resulting in more number of tillers. Similar results were found by Gill and Verma (1993) [4]. In third cutting the intercropping with crop geometry (60×30) × 15 cm paired row system was showed the highest number of tillers due to fixing up atmospheric nitrogen in the soil and increased uptake by plant due to legumes. Similar results were obtained by Singh and Arya (1999) [11].

The different levels of nitrogen showed significant influence on number of tillers. The higher number of tillers was recorded in 125 per cent RDF of nitrogen (10.5, 20.2 and 24.5) followed by 100 per cent RDF of nitrogen (7.9, 17.5 and 19.9) at first, second and third cutting respectively. The lower number of tillers was obtained with 75 per cent RDF of nitrogen (7.2, 13 and 16.6) at first, second and third respectively. There was significant increase in number of tillers for each increased in nitrogen level. More number of tillers were recorded under 125 per cent RDF of nitrogen than 100 per cent and 75 per cent might be due to positive effect on cell division and cell elongation that finally resulting on more vegetative growth. This was in accordance with the findings of Manjunatha et al., (2013) [8].

**Table 2: Effect of crop geometry and N levels on number of tillers of multicut fodder sorghum under intercropped condition**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>First cutting</th>
<th>Second cutting</th>
<th>Third cutting</th>
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<td>11.9</td>
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<td>0.41</td>
<td>0.61</td>
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</table>

**Main plot-Spacing**

| S₁ | - 30×15 cm: sole fodder sorghum | N₁ | - 75% N of RDF |
| S₂ | - 45×15 cm: sole fodder sorghum | N₂ | - 100% N of RDF |
| S₃ | - (45+15)×15 cm: fodder sorghum and fodder cowpea under paired row system | N₃ | - 125% N of RDF |
| S₄ | - (60+30)×15 cm: fodder sorghum and fodder cowpea under paired row system | | |

The Interaction effect was significant for the imposed treatments for the no. of tillers. In the first cutting higher number of tillers was noted in sole sorghum with 45×15 cm row spacing and 125 per cent RDF of nitrogen (11.9) and sole sorghum of 30× 15 cm row spacing and 125 per cent RDF of nitrogen. The lowest number of tillers was recorded in fodder sorghum + fodder cowpea under (45+15) × 15 cm paired row system (5.6). In the second cutting, the number of tillers was higher in the combination of sole fodder sorghum under 45×15 cm row spacing with 125 per cent RDF of nitrogen (22.0) followed by 30×15 cm sole sorghum with 125 per cent RDF of nitrogen combination (21.0). The number of tillers was lower (11.3) in (60+30) × 15 cm paired row system with intercrop and 75 per cent RDF of nitrogen. In the third cutting, the higher number of tillers was observed under (60+30) × 15 cm paired row system with intercrop and 125 per cent RDF of nitrogen (23.8) followed by (45+15) × 15 cm paired row system with intercrop and 125 per cent RDF of nitrogen (20.8). This was on par with sole sorghum under 45×15 cm and 125 per cent RDF of nitrogen. The lower
number of tillers was recorded in sole sorghum with 30×15 cm row spacing and 75 per cent RDF of nitrogen (13.0).

Conclusion
From the study it can be concluded that crop geometry of (60+30) ×15 cm paired row with 125% N ha⁻¹ was found to be optimum and produced higher plant height and maximum number of tillers in multicut fodder sorghum (CoFS-31) under irrigated condition.

References