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## Green manuring practices and nitrogen levels on growth and yield of maize

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### Abstract

A field experiment was conducted at Main Agricultural Research Station, Dharwad on medium black soil during Kharif-2015. There were 13 treatment combinations consisted of sunnhemp and cowpea brown manuring or green manuring with 100, 75 and 50% RDN. The experiment was laid out in RBD design, with three replication. Significantly higher plant height (212.8 cm), leaf area index (5.44), drymatter production in leaves (48.0 g plant<sup>-1</sup>) and stem (78.6 g plant<sup>-1</sup>) at 90 DAS, grain weight per cob (128.4 g cob<sup>-1</sup>), grain number per cob (562.4), grain yield (5,758 kg ha<sup>-1</sup>) stover yield (8.78 t ha<sup>-1</sup>) and net returns (₹ 49763 ha<sup>-1</sup>) were recorded with maize + sunnhemp (1:2) green manuring with 100% RDN as compared to the other except maize + sunnhemp (1:2) green manuring with 75% RDN where they remained at par.

**Keywords:** Maize, green manures, nitrogen and brown manuring

### Introduction

Maize (*Zea mays L.*) is known as “Queen of Cereals” because of its high production potential and wider adaptability. In the present day agriculture, emphasis is being laid on the maximization of agricultural productivity per unit area per unit time through multiple cropping systems. But this approach of continuous cropping exhausts the nutrients from the soil. Good yield on a sustainable basis can be obtained, provided soil quality and health is maintained with adequate supply of macro and micronutrients. Fertilizers and different types of bulky organic manures such as, farmyard manure and compost are normally used to increase the productivity of the land. But inadequate supply of these bulky organic sources of nutrients in required quantities is the major constraint in their large scale use in agriculture to maintain soil fertility. Hence, green manuring being a low cost practice is an alternate way to improve soil fertility status. It has received a new impetus in recent years with an urgent need for increased food production in the country (Virdi *et al.*, 2005) [8].

Leguminous green manure adds N to crop through biological fixation and slow release of N from decomposing green manure residues may be well timed to supply N requirement of companion crop or a subsequent crops (Cherr *et al.*, 2006) [2]. Depending upon the species and locations, green manure crops supply 40 to 120 kg N/ha (Shivaram *et al.*, 1991) [6]. *In situ* intercropped green manure crop of sunnhemp has been proved promising to generate adequate quantity of organic matter with favourable effects on improving the soil physical, chemical and biological properties, which are often deteriorated under intensive cropping (Channagouda *et al.*, 2015) [1]. The carbon in organic matter is a source of energy for microbes, improvement in beneficial microbial activities are also expected leading to better root and shoot growth, grain yield and quality. Therefore, in order to achieve enhanced and sustained yield through improvement of soil productivity, there is a need to work out proper management techniques to grow the green manure crops.

### Material and methods

The field experiment was carried out at Main Agricultural Research Station, Dharwad, during kharif 2015 to study the “Green manuring practices and nitrogen levels on growth and yield of maize”.

The experiment was laid out in Randomized Complete Block Design with three replications. There were 13 treatment combinations namely maize + sunnhemp (1:2) brown manuring with 100% RDN (T<sub>1</sub>), maize + sunnhemp (1:2) brown manuring with 75% RDN (T<sub>2</sub>), maize + sunnhemp (1:2) brown manuring with 50% RDN (T<sub>3</sub>), maize + sunnhemp (1:2) green manuring with 100% RDN (T<sub>4</sub>), maize + sunnhemp (1:2) green manuring with 75% RDN (T<sub>5</sub>), maize + sunnhemp (1:2) green manuring with 50% RDN (T<sub>6</sub>), maize + cowpea (1:2) brown manuring with 100% RDN (T<sub>7</sub>), maize + cowpea (1:2) brown manuring with 75%

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RDN ( $T_8$ ), maize + cowpea (1:2) brown manuring with 50% RDN ( $T_9$ ), maize + cowpea (1:2) green manuring with 100% RDN ( $T_{10}$ ), maize + cowpea (1:2) green manuring with 75% RDN ( $T_{11}$ ), maize + cowpea (1:2) green manuring with 50% RDN ( $T_{12}$ ) and sole maize (no green manuring) with 100% RDN ( $T_{13}$ ). The soil was medium deep black soil with pH 7.10 and the available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O contents were 252.0, 32.5 and 293 kg ha<sup>-1</sup>, respectively. The gross plot size was 5.4 m × 3.5 m and net plot size was 3.6 m × 2.4 m.

Two seeds per hill were dibbled 5 cm deep in furrows at a spacing of 90 cm × 14 cm and in between two rows of maize, two rows of sunnhemp or cowpea seeds were sown at 5 cm spacing in sunnhemp (seed rate of 25 kg ha<sup>-1</sup>) and 10 cm spacing in cowpea (seed rate of 25 kg ha<sup>-1</sup>). Recommended dose of P<sub>2</sub>O<sub>5</sub> (50 kg ha<sup>-1</sup>) and K<sub>2</sub>O (25 kg ha<sup>-1</sup>) in the form of DAP and MOP, respectively were applied as basal at the time of sowing and N was applied as basal (50%) and top dressing (50%) at 30 DAS as per the treatments. Sunnhemp and cowpea were grown as intercrop at 1:2 row proportion in maize, which was planted at 90 cm × 14 cm spacing to maintain recommended plant density. As per treatments sunnhemp and cowpea green manure crops were partially incorporated through inter cultivation at 30 DAS and both the green manure crops were sprayed with 2-4,D at 0.5 kg ai ha<sup>-1</sup> and killed for brown manuring.

## Results and discussion

Growing sunnhemp two rows between maize and its incorporation in the soil at 30 DAS with 100% RDN produced significantly higher grain yield (5758 kg ha<sup>-1</sup>), stover yield (8.78 t ha<sup>-1</sup>), higher number of grains per cob (562.4) and grain weight per cob (128.4 g cob<sup>-1</sup>) as compared to the other treatments (Table 1). There was no significant difference observed with number rows per cob, test weight and harvest index. Higher productivity in maize with sunnhemp green manuring was attributed higher moisture content and decompose faster than cowpea. Further, both sunnhemp and cowpea partially incorporation green manure treatments were found significantly superior to sunnhemp and cowpea brown manuring. The practice of partially incorporation of sunnhemp and cowpea green manures was found superior to brown manuring as the decomposition of sunnhemp and cowpea was rapid in green manuring as compared to brown manuring. In brown manuring treatments much of the green manure residue remained on the surface and did not decompose completely. In green manuring addition of the extra nitrogen and other nutrients resulted in better growth and yield of maize. Nitrogen credits for a previous legume crop or in combination with other site specific information are often used to reduce fertilizer N recommendations (Lory *et al.*, 1995) [4]. Significantly higher grain and stover yield in green manuring treatments was attributed to higher growth and yield components.

The relative improvement of yield components in green manured maize could be related to the increased dry matter production and its distribution in reproductive parts at harvest. The dry matter production in leaves (57.3 g plant<sup>-1</sup>), stem (84.2 g plant<sup>-1</sup>), reproductive parts (255.9 g plant<sup>-1</sup>) and total dry matter production (387.4 g plant<sup>-1</sup>) were recorded significantly higher in maize + sunnhemp (1:2) green manuring with 100% RDN. The dry matter production is again the function of leaf area, leaf area index and leaf area duration. Significantly higher leaf area (68.52 dm<sup>2</sup> plant<sup>-1</sup>), leaf area index (5.44), leaf area duration (148.65) at 90 DAS were obtained with treatment receiving maize + sunnhemp (1:2) green manuring with 100% RDN with inter cultivation to partially mix green manure into soil. Similar results were obtained by Dasareddi (1998) [3] who reported higher leaf area, LAI, dry matter accumulation and grain yield of maize with different legumes for green manuring over sole maize. Significantly higher plant height (212.8 cm) and SPAD value (39.4) at 90 DAS were obtained with treatments receiving maize + sunnhemp (1:2) green manuring with 100% RDN compared to other treatments.

Significantly higher net returns was obtained with maize + sunnhemp (1:2) green manuring with 100% and 75% (₹ 49763 and 48171 ha<sup>-1</sup> respectively) and at par with maize + sunnhemp (1:2) green manuring with 50% RDN (₹ 42605 ha<sup>-1</sup>), maize + cowpea (1:2) green manuring with 50% RDN (₹ 42593 ha<sup>-1</sup>) and sole maize (no green manuring) with 100% RDN (₹ 44000 ha<sup>-1</sup>) which were on par (Table 3). This can be attributed to higher gross income as a result of higher yield of maize obtained as a result of improvement in soil physical and chemical properties, better moisture conservation and low weed population. Whereas, the lowest net return (₹ 31436 ha<sup>-1</sup>) was recorded with maize + cowpea (1:2) brown manuring with 50% RDN. Similar results were also reported by Sujata *et al.* (2008) [7] and Rajashekharappa *et al.* (2013) [5] reported higher profitability of sunnhemp green manuring treatment and they attributed it to higher grain yield of maize obtained as a result of improvement in soil physical and chemical properties, better soil moisture conservation and low weed population. Significantly higher benefit: cost ratio (2.39) was recorded with sole maize (no green manuring) with 100% RDN compared to other treatments, this can be attributed to lower cost of cultivation. However, it was on par with maize + sunnhemp (1:2) green manuring with 100% RDN (2.38) and maize + sunnhemp (1:2) green manuring with 75% RDN (2.35).

Based on the results obtained, it may be concluded that maize + sunnhemp (1:2) green manuring with 100% and 75% RDN higher grain yield (5758 and 5624 kg ha<sup>-1</sup>, respectively) as compared to 100% RDN without green manuring, indicating saving 25% chemical fertilizers with improvement in soil fertility.

**Table 1:** Growth attribute of maize as influenced by green manuring practices and nitrogen levels in maize

| Treatment | At 90 DAS         |  |                 |                    |            | Dry matter production at harvest (g plant <sup>-1</sup> ) |      |       |
|-----------|-------------------|--|-----------------|--------------------|------------|---|------|-------|
|           | Plant height (cm) | Leaf area (dm <sup>2</sup> plant <sup>-1</sup> ) | Leaf area index | Leaf area duration | SPAD value | Leaves  | Stem | TDM   |
| $T_1$     | 186.5             | 56.63  | 4.49            | 114.67             | 31.7       | 40.5  | 68.9 | 324.2 |
| $T_2$     | 184.4             | 56.16  | 4.46            | 112.57             | 31.4       | 40.6  | 65.6 | 317.2 |
| $T_3$     | 181.2             | 53.30  | 4.23            | 106.51             | 27.6       | 38.0  | 62.7 | 311.1 |
| $T_4$     | 212.8             | 68.52  | 5.44            | 148.65             | 39.4       | 48.0  | 78.6 | 387.4 |
| $T_5$     | 204.0             | 64.16  | 5.09            | 129.10             | 37.5       | 46.0  | 76.4 | 379.3 |
| $T_6$     | 200.6             | 60.21  | 4.78            | 120.54             | 30.4       | 45.3  | 70.7 | 377.4 |

|                    |       |       |      |        |      |      |      |       |
|--------------------|-------|-------|------|--------|------|------|------|-------|
| T <sub>7</sub>     | 194.3 | 62.08 | 4.93 | 127.25 | 29.8 | 42.1 | 69.2 | 319.9 |
| T <sub>8</sub>     | 188.7 | 54.86 | 4.35 | 112.46 | 28.9 | 40.9 | 68.5 | 316.5 |
| T <sub>9</sub>     | 179.7 | 49.63 | 3.94 | 101.21 | 26.4 | 39.6 | 64.1 | 307.3 |
| T <sub>10</sub>    | 201.7 | 68.41 | 5.43 | 136.75 | 34.2 | 42.3 | 74.5 | 357.1 |
| T <sub>11</sub>    | 197.3 | 62.73 | 4.98 | 127.31 | 32.2 | 42.2 | 73.8 | 355.2 |
| T <sub>12</sub>    | 195.7 | 60.09 | 4.77 | 117.33 | 29.6 | 41.7 | 70.9 | 347.9 |
| T <sub>13</sub>    | 198.3 | 58.68 | 4.66 | 116.48 | 30.1 | 41.2 | 73.3 | 348.7 |
| S.Em. <sub>±</sub> | 4.55  | 3.17  | 0.25 | 5.54   | 1.95 | 1.37 | 2.86 | 7.67  |
| LSD (0.05)         | 14.06 | 9.78  | 0.77 | 17.12  | 6.02 | 4.24 | 8.82 | 23.67 |

T<sub>1</sub>: Maize + sunnhemp (1:2) brown manuring with 100% RDN, T<sub>2</sub>: maize + sunnhemp (1:2) brown manuring with 75% RDN, T<sub>3</sub>: maize + sunnhemp (1:2) brown manuring with 50% RDN, T<sub>4</sub>: maize + sunnhemp (1:2) green manuring with 100% RDN, T<sub>5</sub>: maize + sunnhemp (1:2) green manuring with 75% RDN, T<sub>6</sub>: maize + sunnhemp (1:2) green manuring with 50% RDN, T<sub>7</sub>: maize + cowpea (1:2) brown manuring with 100% RDN, T<sub>8</sub>: maize + cowpea (1:2) brown manuring with 75% RDN, T<sub>9</sub>: maize + cowpea (1:2) brown manuring with 50% RDN, T<sub>10</sub>: maize + cowpea (1:2) green manuring with 100% RDN, T<sub>11</sub>: maize + cowpea (1:2) green manuring with 75% RDN, T<sub>12</sub>: maize + cowpea (1:2) green manuring with 50% RDN and T<sub>13</sub>: sole maize (no green manuring) with 100% RDN.

**Table 2:** Yield and economics of maize as influenced by green manuring practices and nitrogen levels in maize

| Treatment          | Grain weight per cob (g cob <sup>-1</sup> ) | Grain number per cob | No of rows cob <sup>-1</sup> | Test weight (g) | Grain yield (kg ha <sup>-1</sup> ) | Stover yield (t ha <sup>-1</sup> ) | Harvest index | Gross return (₹ ha <sup>-1</sup> ) | Net return (₹ ha <sup>-1</sup> ) | B:C ratio |
|--------------------|---|----------------------|------------------------------|-----------------|------------------------------------|------------------------------------|---------------|------------------------------------|----------------------------------|-----------|
| T <sub>1</sub>     | 118.8                                       | 470.9                | 15.5                         | 29.1            | 5209                               | 7.79                               | 0.40          | 77,607                             | 41,487                           | 2.15      |
| T <sub>2</sub>     | 112.5                                       | 422.2                | 15.1                         | 29.5            | 4883                               | 7.53                               | 0.39          | 72,878                             | 37,085                           | 2.04      |
| T <sub>3</sub>     | 111.3                                       | 415.3                | 15.0                         | 28.8            | 4699                               | 7.51                               | 0.38          | 70295                              | 34,827                           | 1.98      |
| T <sub>4</sub>     | 128.4                                       | 562.4                | 17.2                         | 33.1            | 5758                               | 8.78                               | 0.40          | 85,883                             | 49,763                           | 2.38      |
| T <sub>5</sub>     | 126.5                                       | 557.4                | 16.0                         | 33.0            | 5624                               | 8.71                               | 0.39          | 83,964                             | 48,171                           | 2.35      |
| T <sub>6</sub>     | 119.6                                       | 480.7                | 15.1                         | 30.0            | 5192                               | 8.30                               | 0.38          | 77,673                             | 42,605                           | 2.21      |
| T <sub>7</sub>     | 111.1                                       | 469.5                | 14.9                         | 29.7            | 5024                               | 7.73                               | 0.40          | 74,972                             | 39,252                           | 2.10      |
| T <sub>8</sub>     | 113.8                                       | 467.1                | 14.7                         | 30.3            | 4692                               | 7.66                               | 0.38          | 70,281                             | 34,488                           | 1.96      |
| T <sub>9</sub>     | 109.2                                       | 413.6                | 14.5                         | 27.4            | 4458                               | 7.49                               | 0.37          | 66,903                             | 31,436                           | 1.89      |
| T <sub>10</sub>    | 120.4                                       | 550.0                | 15.9                         | 32.0            | 5269                               | 8.24                               | 0.39          | 78,713                             | 42,593                           | 2.18      |
| T <sub>11</sub>    | 120.9                                       | 488.5                | 15.6                         | 31.0            | 5276                               | 8.22                               | 0.39          | 78,789                             | 42,996                           | 2.20      |
| T <sub>12</sub>    | 119.9                                       | 469.6                | 15.0                         | 31.0            | 5056                               | 8.18                               | 0.38          | 75,697                             | 40,229                           | 2.13      |
| T <sub>13</sub>    | 119.2                                       | 470.6                | 15.0                         | 31.2            | 5047                               | 8.15                               | 0.38          | 75,543                             | 44,000                           | 2.39      |
| S.Em. <sub>±</sub> | 3.58  | 30.19                | 0.92                         | 1.42            | 232.65                             | 0.30                               | 0.02          | 3232                               | 3232                             | 0.09      |
| C.D. at 5%         | 11.05                                       | 93.22                | NS                           | NS              | 718.36                             | 0.91                               | NS            | 9979                               | 9979                             | 0.28      |

T<sub>1</sub>: Maize + sunnhemp (1:2) brown manuring with 100% RDN, T<sub>2</sub>: maize + sunnhemp (1:2) brown manuring with 75% RDN, T<sub>3</sub>: maize + sunnhemp (1:2) brown manuring with 50% RDN, T<sub>4</sub>: maize + sunnhemp (1:2) green manuring with 100% RDN, T<sub>5</sub>: maize + sunnhemp (1:2) green manuring with 75% RDN, T<sub>6</sub>: maize + sunnhemp (1:2) green manuring with 50% RDN, T<sub>7</sub>: maize + cowpea (1:2) brown manuring with 100% RDN, T<sub>8</sub>: maize + cowpea (1:2) brown manuring with 75% RDN, T<sub>9</sub>: maize + cowpea (1:2) brown manuring with 50% RDN, T<sub>10</sub>: maize + cowpea (1:2) green manuring with 100% RDN, T<sub>11</sub>: maize + cowpea (1:2) green manuring with 75% RDN, T<sub>12</sub>: maize + cowpea (1:2) green manuring with 50% RDN and T<sub>13</sub>: sole maize (no green manuring) with 100% RDN.

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