

## SUSTAINING QUALITY, NUTRIENT UPTAKE AND SOIL FERTILITY THROUGH INTEGRATED NUTRIENT MANAGEMENT IN FOOD – FORAGE CROPPING SYSTEM

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### SUMMARY

A field experiment was carried out at Punjab Agricultural University, Ludhiana for five consecutive years (2005-06 to 2009-10) to find out the effect of integrated nutrient management (INM) on quality, nutrient uptake and soil fertility in mung (*Phaseolus aureus*)-oats (*Avena sativa*) fodder-bajra (*Pennisetum glaucum*)+cowpea (*Vigna unguiculata*) fodder cropping system. The highest crude protein (28.3 q/ha) and lowest crude fiber (78.4 q/ha) were observed with 100 per cent RDF in all the crops. The highest total N uptake (466.4 kg/ha) of the cropping system was also recorded with 75 per cent RDF+25 per cent N through FYM as compared to 453.4 kg/ha with 50 per cent RDF+50 per cent N through FYM and 438.5 kg/ha with 100 per cent RDF. At the end of two years' cropping system, the soil organic carbon, available N, P and K decreased in control, maintained in inorganic fertilizer treatments and improved in INM treatments. The highest values were observed with 50 per cent RDF+50 per cent FYM closely followed by 75 per cent RDF+25 per cent FYM.

**Key words :** Integrated, green fodder, dry matter, crude protein, crude fibre, nitrogen uptake

Pearl millet is an important **kharif** fodder crop of Punjab grown in 1.43 lac ha area (28% of **kharif** fodders). To provide balanced nutrients to the animals and to improve the soil health, it is commonly intercropped with cowpea. During winter, oat is the predominant fodder crop covering an area of 0.97 lac ha (28% of **rabi** fodders). Being cereals, both these crops require heavy amount of nitrogen fertilizers. The stability of soil health for sustained production at high levels depends greatly on the balanced fertilizer use. The close monitoring of the effect of such intensive cropping on soil productivity on long term basis is imperative. Inclusive of crops like oilseed, pulses and vegetables will improve the economic condition of farmers owing to higher price and higher volume of their main and by-products. Kumawat (2001) also reported beneficial effect of inclusion of pulses in the system than cereals after cereals. In addition legumes have favourable impact on the soil fertility and help in increasing the yield of the succeeding rice crop (Kharub *et al.*, 2003). Sexena *et al.* (1997) observed superiority of cluster bean-pearl millet cropping system to continuous pearl millet cropping system due to the maintenance of higher organic matter in the soil.

### MATERIALS AND METHODS

A field experiment was carried out at Forage Research Farm, Punjab Agricultural University, Ludhiana during **kharif**, **rabi** and **zaid** for five consecutive years (2005-06 through 2009-10) to find out the effect of integrated nutrient management (INM) on quality, nutrient uptake and soil fertility in mung (*Phaseolus aureus*)-oats (*Avena sativa*) fodder-bajra (*Pennisetum glaucum*)+cowpea (*Vigna unguiculata*) fodder cropping system. The experiment was laid out in randomized block design with seven fertilizer treatments viz., 100 per cent recommended dose of fertilizer (RDF), 75 per cent RDF+25 per cent N through farm yard manure (FYM), 75 per cent RDF+bio-fertilizer, 50 per cent RDF+50 per cent N through FYM, 50 per cent RDF+25 per cent N through FYM+bio-fertilizer, 50 per cent RDF+bio-fertilizer and control replicated thrice. The soil of the experimental site was sandy loam in texture, low in organic carbon (0.38%) and available N (162 kg/ha) and medium in available P (17.5 kg/ha) and K (157 kg/ha) with a pH of 7.9. FYM was mixed in the soil before sowing the crops. Biofertilizer, *Azotobacter* was

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applied to oats and bajra seeds and *Rhizobium* culture to mung seeds at the time of sowing. The recommended fertilizer to mung (12.5 kg N+40 kg P<sub>2</sub>O<sub>5</sub>/ha), oats (75 kg N+20 kg P<sub>2</sub>O<sub>5</sub>/ha), bajra (12.5 kg N+40 kg P<sub>2</sub>O<sub>5</sub>/ha) and cowpea ((20 kg N+55 kg P<sub>2</sub>O<sub>5</sub>/ha) were applied in the form of urea and single superphosphate as per the treatments. The varieties of mung, oats, bajra and cowpea were ML-668, OL-9, FBC-16 and CL-367, respectively. The crop was sown in a plot size of 5.0 x 4.0 m<sup>2</sup> during all the years of study. The mung crop was harvested when 80 per cent of the crops matured and fodder crops were harvested at 50 per cent flowering. The all other cultural practices were applied uniformly to all the treatments. The samples from each treatment were dried in the sun followed by hot air oven at 60°C. The dried samples were grinded through 1 mm sieve and were processed for the estimation of crude protein and crude fibre contents by the methods as given by A. O. A. C. (1990).

## RESULTS AND DISCUSSION

### Quality

The quality of all the crops in sequence was improved with all the fertilizer treatments over control. The highest crude protein (28.3 q/ha) and lowest crude fibre (78.4 q/ha) were observed with 100 per cent RDF in all the crops. Similar results were also obtained by Puri and Tiwana (2007) in maize fodder.

The crude protein content was highest with 100 per cent RDF in all the crops in sequence. But the significantly higher crude protein production was

obtained with 75 per cent RDF+25 per cent N through FYM closely followed by 50 per cent RDF+50 per cent N through FYM in all the crops. All the fertilizer treatments including INM increased the uptake of N over control in all the crops but the highest uptake of N in all the crops was observed with 75 per cent RDF+25 per cent N through FYM closely followed by 50 per cent RDF+50 per cent N through FYM and 100 per cent RDF. Joshi and Kewalanand (2011) also reported that the application of 50 per cent N through FYM and 50 per cent through inorganic fertilizers was found best in terms of crude protein yield.

### Nutrient Uptake

The highest total N uptake (466.4 kg/ha) of the cropping system was also recorded with 75 per cent RDF+25 per cent N through FYM as compared to 453.4 kg/ha with 50 per cent RDF+50 per cent N through FYM and 438.5 kg/ha with 100 per cent RDF. The increase in N uptake could be mainly attributed to the production of higher yield due to favourable effect of different nutrient management treatments (Singh *et al.*, 2008). Higher N uptake by rice, cabbage and greengram in sequence was also recorded by Acharya and Mondal (2010) when the crops were applied 75 per cent RDF+25 per cent N through organic sources of nutrients which might be due to increased efficiency of fertilizers in presence of FYM resulting in increased uptake of nutrients. Joshi and Kewalanand (2011) observed higher N uptake with 50 per cent N through FYM and 50 per cent through inorganic fertilizer source in rice-berseem-maize+cowpea cropping system.

TABLE 1  
Effect of INM on crude protein and crude fibre content in mung-oats-bajra+cowpea cropping system

| Treatment  | N content (%) |       |      |        | Crude protein content (%) |       |      |        | Crude fibre content (%) |      |        |
|--|---------------|-------|------|--------|---------------------------|-------|------|--------|-------------------------|------|--------|
|  | Mung          |       | Oats | Bajra+ | Mung                      |       | Oats | Bajra+ | Mung                    | Oats | Bajra+ |
|  | Grain         | Straw |      | cowpea | Grain                     | Straw |      | cowpea |                         |      | cowpea |
| T <sub>1</sub> -Control  | 3.78          | 1.56  | 1.25 | 1.46   | 23.6                      | 9.73  | 7.80 | 9.12   | 26.8                    | 32.8 | 26.0   |
| T <sub>2</sub> -100% of NPK through inorganic fertilizer                     | 4.27          | 2.17  | 1.46 | 1.81   | 26.7                      | 13.26 | 9.12 | 11.32  | 22.6                    | 28.2 | 24.4   |
| T <sub>3</sub> -FYM 25% N+75% NPK through inorganic fertilizer               | 4.22          | 2.08  | 1.42 | 1.77   | 26.4                      | 12.98 | 8.90 | 11.06  | 23.5                    | 29.1 | 25.8   |
| T <sub>4</sub> -FYM 50% N+50% NPK through inorganic fertilizer               | 4.14          | 2.05  | 1.41 | 1.74   | 25.9                      | 12.82 | 8.79 | 10.88  | 23.8                    | 28.8 | 25.4   |
| T <sub>5</sub> -50% NPK through inorganic fertilizer+biofertilizer           | 3.86          | 1.69  | 1.35 | 1.58   | 24.1                      | 10.56 | 8.46 | 9.88   | 25.9                    | 31.4 | 24.8   |
| T <sub>6</sub> -FYM 25% N+50% NPK through inorganic fertilizer+Biofertilizer | 4.03          | 1.79  | 1.37 | 1.74   | 25.2                      | 11.21 | 8.56 | 10.88  | 25.0                    | 31.0 | 25.0   |
| T <sub>7</sub> -75% NPK through inorganic fertilizer+biofertilizer           | 4.06          | 1.84  | 1.39 | 1.64   | 25.4                      | 11.47 | 8.68 | 10.26  | 24.2                    | 30.7 | 24.2   |
| S. Em±   | 0.13          | 0.067 | 0.47 | 0.52   | 0.95                      | 0.41  | 0.31 | 0.34   | 0.85                    | 0.99 | 0.88   |
| C. D. (P=0.05)   | 0.41          | 0.21  | NS   | NS     | 2.94                      | 1.25  | 0.96 | 1.05   | 2.61                    | 3.06 | NS     |

NS-Not Significant.

TABLE 2  
Effect of INM on crude protein and crude fibre yield in mung-oats-bajra+cowpea cropping system (Pooled over five years)

| Treatments   | Crude protein yield (q/ha) |       |                  |                    | Crude fibre yield (q/ha) |      |                  |                    |
|--|----------------------------|-------|------------------|--------------------|--------------------------|------|------------------|--------------------|
|  | Mung<br>(grain+straw)      | Oats  | Bajra+<br>cowpea | Total of<br>system | Mung<br>straw            | Oats | Bajra+<br>cowpea | Total of<br>system |
| T <sub>1</sub> -Control  | 2.42                       | 6.44  | 6.82             | 15.68              | 4.5                      | 31.0 | 28.5             | 64.0               |
| T <sub>2</sub> -100% of NPK through inorganic fertilizer                         | 4.80                       | 11.82 | 9.11             | 25.73              | 5.8                      | 38.6 | 33.4             | 77.8               |
| T <sub>3</sub> -FYM 25% N+75% NPK through inorganic fertilizer                   | 4.58                       | 11.23 | 11.34            | 27.15              | 6.0                      | 39.0 | 35.2             | 80.2               |
| T <sub>4</sub> -FYM 50% N+50% NPK through inorganic fertilizer                   | 4.35                       | 10.59 | 10.69            | 25.63              | 5.8                      | 38.7 | 34.4             | 78.9               |
| T <sub>5</sub> -50% NPK through inorganic fertilizer+biofertilizer               | 3.20                       | 8.27  | 8.44             | 19.91              | 5.0                      | 35.7 | 31.3             | 72.0               |
| T <sub>6</sub> -FYM 25% N+50% NPK through inorganic fertilizer+<br>Biofertilizer | 3.61                       | 9.46  | 9.34             | 22.41              | 5.4                      | 38.6 | 33.2             | 77.2               |
| T <sub>7</sub> -75% NPK through inorganic fertilizer+Biofertilizer               | 3.82                       | 9.50  | 9.32             | 22.64              | 5.5                      | 38.1 | 31.5             | 75.1               |
| S. Em±   | 0.14                       | 0.30  | 0.37             | 0.95               | 0.18                     | 1.49 | 1.23             | 3.06               |
| C. D. (P=0.05)   | 0.43                       | 0.93  | 1.13             | 2.91               | 0.54                     | 4.58 | 3.79             | 9.42               |

TABLE 3  
Effect of INM on NPK uptake (kg/ha) in mung-oats-bajra+cowpea cropping system (Pooled over five years)

| Treatment  | N uptake                  |       |                  | P uptake                  |      |                  | K uptake                  |       |                  | NPK<br>uptake of<br>the system |
|--|---------------------------|-------|------------------|---------------------------|------|------------------|---------------------------|-------|------------------|--------------------------------|
|  | Mung<br>(grain+<br>straw) | Oats  | Bajra+<br>cowpea | Mung<br>(grain+<br>straw) | Oats | Bajra+<br>cowpea | Mung<br>(grain+<br>straw) | Oats  | Bajra+<br>cowpea |                                |
| T <sub>1</sub> -Control  | 38.9                      | 103.1 | 109.2            | 4.1                       | 23.4 | 9.8              | 28.6                      | 66.8  | 80.8             | 474.7                          |
| T <sub>2</sub> -100% of NPK through inorganic fertilizer                         | 76.8                      | 189.4 | 176.8            | 9.6                       | 43.9 | 20.7             | 42.8                      | 119.3 | 122.2            | 801.5                          |
| T <sub>3</sub> -FYM 25% N+75% NPK through inorganic fertilizer                   | 73.3                      | 182.2 | 181.4            | 9.1                       | 42.5 | 20.4             | 42.4                      | 113.4 | 122.3            | 796.0                          |
| T <sub>4</sub> -FYM 50% N+50% NPK through inorganic fertilizer                   | 69.6                      | 169.1 | 171.1            | 8.8                       | 39.7 | 19.4             | 41.6                      | 108.0 | 117.9            | 745.2                          |
| T <sub>5</sub> -50% NPK through inorganic fertilizer+Biofertilizer               | 51.2                      | 132.4 | 135.1            | 5.4                       | 29.6 | 13.1             | 31.8                      | 85.1  | 97.6             | 581.3                          |
| T <sub>6</sub> -FYM 25% N+50% NPK through inorganic fertilizer+<br>Biofertilizer | 57.9                      | 151.5 | 149.6            | 6.9                       | 35.6 | 15.9             | 35.7                      | 95.1  | 109.7            | 657.9                          |
| T <sub>7</sub> -75% NPK through inorganic fertilizer+Biofertilizer               | 61.2                      | 152.0 | 150.9            | 7.7                       | 37.3 | 16.9             | 37.5                      | 94.8  | 107.3            | 665.6                          |
| S. Em±   | 2.61                      | 5.81  | 7.33             | 0.22                      | 1.49 | 0.67             | 1.75                      | 3.73  | 4.42             | 28.08                          |
| C. D. (P=0.05)   | 8.04                      | 17.9  | 22.6             | 0.68                      | 4.58 | 2.06             | 5.49                      | 11.5  | 13.6             | 86.6                           |

TABLE 4  
Soil fertility status in mung-oats-bajra+cowpea cropping system (after the completion of the system i.e. 5 years)

| Treatment  | OC (%) | Available nitrogen | Available phosphorus | Available potassium |
|--|--------|--------------------|----------------------|---------------------|
| T <sub>1</sub> -Control  | 0.40   | 147                | 15.1                 | 150                 |
| T <sub>2</sub> -100% of NPK through inorganic Fertilizer                         | 0.42   | 151                | 17.8                 | 144                 |
| T <sub>3</sub> -FYM 25% N+75% NPK through inorganic fertilizer                   | 0.44   | 171                | 19.1                 | 164                 |
| T <sub>4</sub> -FYM 50% N+50% NPK through inorganic fertilizer                   | 0.46   | 175                | 20.7                 | 169                 |
| T <sub>5</sub> -50% NPK through inorganic fertilizer+Biofertilizer               | 0.40   | 154                | 16.9                 | 153                 |
| T <sub>6</sub> -FYM 25% N+50% NPK through inorganic fertilizer+<br>Biofertilizer | 0.44   | 168                | 19.4                 | 164                 |
| T <sub>7</sub> -75% NPK through inorganic fertilizer+Biofertilizer               | 0.42   | 157                | 17.2                 | 150                 |
| Initial status of the soil   | 0.38   | 162                | 17.5                 | 157                 |

### Soil Fertility

At the end of two years' cropping system, the soil organic carbon, available N, P and K decreased in control, maintained in inorganic fertilizer treatments and improved in INM treatments. The highest values were observed with 50 per cent RDF+50 per cent FYM closely followed by 75 per cent RDF+25 per cent

FYM. This might be due to the improvement of soil health with FYM resulting in higher native nutrient availability (Singh *et al.*, 2008). Chand *et al.* (2007) observed reduction in soil pH, increase in organic carbon and slight reduction in bulk density with the application of FYM.

It may be concluded that the application of 75 per cent RDF+25 per cent N through FYM and 50

per cent RDF+50 per cent N through FYM to all the crops in system recorded highest productivity, net returns, B : C ratio, crude protein and nitrogen uptake closely followed by 100 per cent RDF, whereas the soil fertility was improved with integrated nutrient management treatments.

### CONCLUSION

It may be concluded that quality was improved with 100 per cent RDF through inorganic fertilizers in all the crops, whereas the highest total N uptake of the cropping system was recorded with 75 per cent RDF+25 per cent N through FYM as compared to 50 per cent RDF+50 per cent N through FYM and 100 per cent RDF. The soil fertility status decreased in control, maintained in inorganic fertilizer treatments and improved in INM treatments.

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