

Review Article

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## Production Potential of Finger Millet (*Eleusine coracana* L. Gaertn) as Affected by Integrated Nutrient Management Practices: A Review

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### ABSTRACT

This article comprises of the background information resulting from the previous work done by various scientists of India and Abroad on the effect of Integrated Nutrient Management (INM) on various growth and yield attributes of finger millet crop and its nutrient uptake rate by influencing the nutrient status in soil system. Sustainable agricultural productivity might be achieved through a wise and balanced use of fertilizers. Integrated nutrient management (INM) is a judicious use of organic and inorganic sources of nutrient to crop fields for sustaining and maintaining soil productivity. It is the only possible approach in enhancing the soil productivity through a balanced use of mineral fertilizers combined with organic and biological sources of plant nutrients. It plays a vital role in improving the stock of plant nutrients in soil by increasing the efficiency of plant nutrients, thus limiting losses to the environment. It optimizes the function of the soil biosphere and ultimately sustaining the physical, chemical and biological properties of the soil etc.

#### Keywords

INM, FYM, *Azospirillum* and Biofertilizers

#### Article Info

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### Introduction

Finger millet (*Eleusine coracana*) is an important small millet crop grown in India and has the pride of place in having highest productivity among millets. It is grown on an area of 1.19 million hectare in India with a total production of 1.98 million tonnes and productivity of 1661 kg ha<sup>-1</sup> (Anonymous, 2013). It is a nutritive food for different age

groups. Straw makes valuable fodder for both draught and milch animals. The production and productivity of finger millet is low because of inefficient nutrient management, heavy weed infestation, incidence of blast disease etc.

Despite the continued development of new and improved modern varieties and greater use of chemical fertilizers, yield growth began

to slow in the latter part of the 20th century (Gruhn *et al.*, 2000). Continuous use of chemical fertilizers alone has some deleterious effects on physical, chemical and biological properties of soil which in turn reflects on yield levels and soil health. Concern has also grown in recent years that the use of fertilizers, particularly inorganic fertilizers, can lead to serious environmental consequences. On account of this, balanced use of organic and inorganic fertilizer along with biofertilizer is important not only for increasing growth and yield but also for sustaining soil health (Pullicino *et al.*, 2009). However, since organic manure cannot meet the total nutrient needs of modern agriculture, since their availability is limited hence integrated use of nutrients from fertilizers and organic sources is highly essential in supplying the plant requirements and maintaining the soil health (Singh *et al.*, 1997).

Use of biofertilizers such as biological nitrogen fixing and phosphate solubilizing micro-organisms is also gaining importance since bio-fertilizers are cost effective, eco-friendly and renewable source of plant nutrient to supplement chemical fertilizers. Integrating inorganic, organic and bio-fertilizers are essential in realizing the higher yield and reducing cost of production was reported by Shekhawat *et al.*, (2005). The work of various research workers discussed below indicated that integrated nutrient management practice may play significant role to promote growth and productivity of finger millet in a sustainable basis as well as soil health.

### **Growth parameters of finger millet as affected by INM**

The results of the experiment carried out by Kumar *et al.*, (2003) at GKVK, Bangalore on red sandy loams indicated that application of

100 per cent NPK fertilizers in conjunction with compost @ 7.5 t/ha increased plant height significantly in finger millet compared to that of 50 per cent NPK fertilizers + compost @ 5 t/ha and individual applications of compost and NPK fertilizers, however it was on par with 75 per cent of NPK fertilizers + compost @ 7.5 t/ha.

Basavarajappa *et al.*, (2003) observed that significant increase in plant height of foxtail millet with enriched FYM + *Azospirillum* @ 10 kg/ha (86.35 cm) over individual application of enriched FYM (84.16 cm) and glycidia GLM (81.93 cm) in shallow Alfisols of Hanumanamathi, Dharwad.

Another field study was conducted by Rathore and Gautam (2003) at New Delhi on nutrient management in pearl millet with varying levels of nitrogen and phosphorus along with biofertilizers (*Azotobacter* + VAM) and they observed that higher number of tillers and other growth parameters was recorded with the application of 40 kg N + 30 kg P<sub>2</sub>O<sub>5</sub>/ha along with biofertilizers (*Azotobacter* + VAM).

Kumara *et al.*, (2007) reported significantly higher dry matter of 44.3 g/plant with conjunctive use of RDF (100:50:50 kg NPK/ha + 7.5 t FYM/ha) followed by 37.3 g/plant of dry matter of finger millet with 100% RDF.

Neelam *et al.*, (2009) conducted a study during kharif season at CCSHAU, Hisar on sandy loam soil and concluded that plant growth characteristics viz., plant height (212.7 cm), total number of tillers/plant (4.71), dry matter accumulation/plant (107.36 g) and leaf area/plant (944.9 cm<sup>2</sup>) at harvest were found maximum with 60 kg N + 40 kg P<sub>2</sub>O<sub>5</sub>/ha but was at par with 40 kg N/ha + 30 kg P<sub>2</sub>O<sub>5</sub>/ha + Biomix (*Azotobacter* + *Azospirillum* + PSB).

Giribabu *et al.*, (2010) in a study conducted at Bapatla, observed that application of 100% RDF (60:30:20 kg NPK/ha) + FYM 3 t/ha significantly increased plant height (93.9 cm) of finger millet over 75% RDF + FYM 3 t/ha (88.8 cm), over individual application of FYM (84.3 cm) and 100% RDF (88.5 cm).

Saravanane *et al.*, (2011) found that dry matter and LAI of finger millet increased with application of 100% N as FYM (125:100:125 kg NPK/ha) to the preceding potato crop which was on par with integration 50% N as Lantana (54.42 g/plant) and *Parthenium spp.* (52.76 g/plant) each with 50% N as inorganic individually in Indaf 9 variety of finger millet.

### **Yield and yield attributes of finger millet as affected by INM**

Ramamoorthy and Lourduraj (2002) stated that application of 50% RDF + 50% FYM + biofertilizer inoculation of *Azospirillum* and *Aspergillus* @ 25 g/kg seed was found on par with biofertilizer + 100% RDF (60:30:30 kg NPK/ha) regarding finger length of 11.5 and 10.8 cm in finger millet respectively.

Significantly higher finger length of 15.84 cm, grain weight/panicle (4.84 g) of foxtail millet was found with application of enriched FYM + *Azospirillum* followed by glyricidia GLM (14.12 cm), enriched FYM (13.60 cm) and control (11.89 cm). Harvest index was found non-significant with enriched FYM + *Azospirillum*, enriched FYM, glyricidia GLM respectively (Basavarajappa *et al.*, 2003).

Sapthagiri variety of finger millet grown on sandy loams of Tirupati produced on par fingers/earhead of 9.90, 9.71 and 9.58 and grain weight/ear of 6.19, 6.16 and 6.12 g with 100% RDF, 75% RDF + 25% N through FYM and 75% RDF + 25% N through glyricidia GLM respectively (Sunitha *et al.*, 2004).

Patil *et al.*, (2006) studied various nutrient management systems at College of Agriculture, Phule found that application of 50% RDF (50 kg N/ha + 25 kg P<sub>2</sub>O<sub>5</sub>/ha) + FYM @ 2.5 t/ha + biofertilizer as seed treatment was significant in increasing the grain (20.11 q/ha) and fodder yield (28.17 q/ha) in finger millet.

Conjunctive use of RDF (100:50:50 kg N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O/ha) + 7.5 t FYM/ha improved the 1000 grain weight (2.83 g) over 100% RDF alone (2.62 g) in finger millet (Kumara *et al.*, 2007).

The PSB and plant growth promoting rhizobacteria (PGPR) together reduce P fertilizer application by 50 per cent without any significant reduction of crop yield (Jilani *et al.*, 2007)

Tyagi and Ramamoorthy (2007) investigated that there was increase in number of fingers/ear (6.93), increased test weight with application of 12.5 t FYM/ha in finger millet + pigeon pea in 6:2 ratio which was on par with application of 40:20:20 kg NPK/ha (6.80) and FYM @ 12 t FYM/ha (6.60) individually in finger millet alone on clay loams.

Integrated use of RDF (100:50:50 kg N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O/ha) + 7.5 t FYM/ha significantly improved the finger length by 10.5 per cent and maximum number of fingers/earhead (5.1) over 100 per cent RDF alone in HR 911 variety in finger millet (Kumara *et al.*, 2007).

Significantly higher grain yield of 2038 and 2127 kg/ha and straw yield of 3191 and 3016 kg/ha was resulted from 50% N through FYM + 50% RDF and 50% N through vermicompost + 50% RDF respectively in GPU-28 variety of finger millet (Basavaraju and Purushotham, 2009).

Among four levels of nutrient management systems tried the application of 100% RDF (60:30:20 kg NPK/ha) + 3 t FYM/ha produced on par fingers/earhead in finger millet. Significantly increased the productive tillers/m<sup>2</sup> (178.9) over 75% RDF + 3 t FYM/ha (167.5) over individual application of 100% RDF (163.5) and FYM (155.5) in finger millet (Giribabu *et al.*, 2010).

Jagathjothi *et al.*, (2010) reported higher number of productive tillers/m<sup>2</sup> (176), increased finger length of 7.15 and 7.01 cm with band placement of 2 t enriched FYM/ha + 64:55.5 kg NK/ha in CO14 variety of finger millet compared to other combinations of inorganic with organic nitrogen sources. Increased straw yields of 5908 and 5706 kg/ha in finger millet was recorded with band placement of 2 t enriched FYM/ha + 64:55.5 kg NK/ha and broadcasting with 4t enriched FYM/ha + 64:55.5 kg NK/ha over other treatments.

### **Nutrient uptake of finger millet as affected by INM**

Nitrogen fixation is the prime mechanism of action suggested for the enhancement of plant growth by *Azospirillum*. Incorporation of atmospheric nitrogen into the host plant by *Azospirillum* was evaluated mainly by the indirect assay i.e., acetylene reduction (Dobereiner, 1977). Nitrogen fixation by *Azospirillum* has been confirmed by several workers, using not only conventional micro Kjeldhal assay but also by the more definite method of isotopic enrichment involving <sup>15</sup>N<sub>2</sub> (Wong and Sternberg, 1979).

Several experiments conducted on sorghum, pearl millet, finger millet and rice at different locations in India under All India Coordinated Research Project on Biological Nitrogen Fixation have indicated the positive response of the cultivars to *Azospirillum* inoculation (SubbaRao, 1981).

Kalibhavi *et al.*, (2003) reported that application of FYM (5 t/ha) + vermicompost (1.5 t/ha) + *Azospirillum brasiliense* as soil application (10 kg/ha) + 100% recommended dose of fertilizers significantly increased N (254.49 kg/ha), P (27.07 kg/ha) and K (165.70 kg/ha) uptake in sorghum as compared to their individual application.

Significant increase in NPK uptake by grain as well as straw in finger millet was observed with combined application of 100% NPK fertilizer and 7.5 t compost/ha over individual applications of organic and inorganic fertilizers on sandy loam soils of Bangalore (Kumar *et al.*, 2003).

Raman and Krishnaprabu (2004) reported that in finger millet NPK uptake was significantly increased with application of 100% recommended NPK fertilizers in conjunction with FYM @ 12.5 t/ha over 100% recommended NPK fertilizers alone.

Duryodhana *et al.*, (2004) observed that the significant improvement in NPK uptake by grain and straw in finger millet was with application of 100% NPK fertilizers in conjunction with 7.5 t/ha compared to that of individual application of organic and inorganic fertilizers on sandy loam soils of Bangalore.

Meena and Gautam (2005) studied the effect of chemical fertilizers and biofertilizers on pearl millet which indicated that combined application of *Azospirillum* + PSB with 20 kg N/ha + 15 kg P<sub>2</sub>O<sub>5</sub>/ha recorded the highest N, P and K uptake and was at par with 40kg N/ha + 30 kg P<sub>2</sub>O<sub>5</sub>/ha.

Rathore *et al.*, (2006) recorded higher uptake of nitrogen and phosphorus by pearl millet with the application of 50% RDF + *Azospirillum* + PSB in comparison to 50% RDF, 50% RDF + *Azospirillum* and 50% RDF + PSB.

Choudhary and Gautam (2007) conducted a field experiment at IARI, New Delhi on pearl millet and reported that application of 60 kg nitrogen + 40 kg phosphorus/ha along with 10 t FYM/ha and biofertilizers gave significantly higher N and P uptake over control and FYM (5 and 10 t/ha) + biofertilizers.

### **Economics of finger millet as affected by INM**

Purushotham *et al.*, (1994) conducted field trial during *kharif*, finger millet cultivar Indaf B was given 0-90 kg N + 0-60 kg P + 0-50 kg K/ha in various combinations and 25 kg ZnSO<sub>4</sub> with 90 kg N + 60 kg P + 50 kg K + ZnSO<sub>4</sub>. Application of 60 kg N/ha + 60 kg P/ha + 30 kg K/ha gave the highest benefit: cost ratio.

In a study on nutrient management systems, Rathore *et al.*, (2005) observed that gross returns (₹ 35,661 /ha), cost of cultivation (₹ 10,933/ha) and net return (₹ 24,728/ha) was highest with 125 per cent RD N, whereas benefit: cost ratio (2.26) for 125 per cent RD N was at par with 100 per cent RDN + biofertilizer.

Patil *et al.*, (2006) studied various nutrient management systems at College of Agriculture, Phule and concluded that application of 50% RDF + FYM @ 2.5 t/ha + biofertilizer as seed treatment was significant in increasing the gross monetary return (₹ 12,911.10/ha) over the others. The net monetary return (₹ 8867.75/ha) and B:C ratio (3.14) was also highest with this treatment.

Kumar *et al.*, (2006) conducted an field trial on pearl millet at Hisar and reported that use of biofertilizers and biomix with 75 and 100 per cent RD N improved the economics of system in terms of gross return, net return and benefit: cost ratio over absolute control, 75 and 100 per cent RD N.

Sonawane *et al.*, (2007) observed that among various fertilizer levels, 60 kg N/ha + 40 kg P<sub>2</sub>O<sub>5</sub>/ha recorded highest net return (₹ 17,740/ha) over other treatments and being at par with 40 kg N/ha + 30 kg P<sub>2</sub>O<sub>5</sub>/ha + biofertilizers (₹ 17,599/ha). The benefit: cost ratio was highest with 40 kg N + 30 kg P<sub>2</sub>O<sub>5</sub>/ha + biofertilizers (2.38).

In conclusion, these reviews clearly suggest that integrating inorganic, organic and bio-fertilizers are essential in realizing the higher growth, yield and yield attributes of finger millet and reducing cost of cultivation by practicing integrated manner. The practices not only improve yield but also improves the soil physical, chemical, biological properties and nutrient availability.

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