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Growth, Yield and Quality of Finger Millet (*Eleusine coracana* L. Gaertn) as Influenced by Integrated Nutrient Management

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ABSTRACT

Finger millet (*Eleusine coracana* L. Gaertn) responds well to added nutrients and technocrats suggest to adopt integrated nutrient management with a suitable combination of all possible sources. Though finger millet is a traditional crop of south Odisha, there is lack of sufficient information on nutrient management in finger millet. Hence the present experiment was conducted during *kharif* season of 2018 at Bagusala Farm of M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi,Gajapati, Odisha to study the effect of integrated nutrient management in finger millet (*Eleusine coracana* L. Gaertn) on growth, yield and quality under south Odisha conditions. The soil of the experimental field was sandy loam in texture, slightly acidic in reaction, medium in organic carbon, and low in available nitrogen, medium in phosphorous and medium in potassium. The experiment was laid out in randomized complete block design having ten treatments, replicated thrice. The treatments were: T_1: control, T_2: FYM @4 t ha^{-1}, T_3: FYM @8 t ha^{-1}, T_4 : 100% RDF (40:20:20 - N: P_2O_5: K_2O kg ha^{-1}), T_5: 50% RDF + 4 t FYM, T_6: 75% RDF + 2 t FYM, T_7: FYM 4 t ha^{-1}+ *Azospirillum* @ 5 kg ha^{-1}, T_8: FYM 8 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1}, T_9: 50% RDF + 4 t FYM + *Azospirillum* @ 5 kg ha^{-1}, T_{10}: 75% RDF + 2 t FYM + *Azospirillum* @ 5 kg ha^{-1}. Application of 100% RDF resulted the highest growth attributes such as plant height, number of tillersplant^{-1}, dry matter accumulation and leaf area index at different stages. Similar trend was noted in grain and straw yield of finger millet with 100% RDF which was followed by application of 75% RDF + 2 t FYM + *Azospirillum* (T_{10}) and 75% RDF + 2 t FYM (T_6). However, there was no significant difference among treatments in expression of N, P and K content of finger millet. The results suggest that finger millet may be grown in south Odisha conditions during *kharif* season with 100% recommended dose of fertilizers. However, considering the long-term productivity and improvement of soil fertility, the crop may be cultivated with 75% RDF + 2 t FYM + *Azospirillum* @ 5 kg ha^{-1}.

Keywords: Finger millet, integrated nutrient management, growth, yield, quality

Millets are very high in their nutrition content in terms of proteins, minerals and vitamins and so these are termed as 'Nutri-cereals' instead of coarse cereals. Amongst different small millets, finger millet is having the highest productivity and it is widely grown as a cereal crop in the arid and semiarid areas in Africa and Asia. In India, finger millet is cultivated mainly in the states like Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, Jharkhand, Uttaranchal, Maharashtra, and Gujarat. In India, finger millet is cultivated over an area of 1.27 million hectares with a production of 2.61 million tonne giving an average productivity of 1489 kg ha^{-1} (Agriculture Statistics at a Glance, 2017). The coverage of finger millet in Odisha is 1.58 lakh ha with a production and yield of 1.37 lakh tonne and 868 kg ha^{-1} respectively (Odisha Agriculture at a Glance, 2015). The average productivity of finger millet in Odisha is far below the national average. Actually, the crop is cultivated in resource poor and fragile ecological conditions in the state. Most of the soils where finger millet is grown,

are deficient in major and micronutrients (Maitra *et al*. 1998). Therefore, it is important to optimize nutrient management practices and other related factors affecting finger millet cultivation in order to attain better yields from the potential varieties developed. Unfortunately, the situation and region-specific recommendations available for nutrient management in finger millet are scarce. There is no doubt that fertilizer application is imperative for boosting the growth and productivity of finger millet. In case of nutrient management, scientists suggest for adopting integration of all possible sources of nutrients and hence, the concept of integrated nutrient management has been popularized. Keeping all the above points in view, the present experiment was conducted on integrated nutrient management in finger millet on growth, productivity and quality of grains under south Odisha conditions.

MATERIALS AND METHODS

The investigation was conducted at Bagusala Farm, of M.S. Swaminathan School of Agriculture, Centurion University of Technology Management, Paralakhemundi, Gajapati, Odisha, which is geographically located at 23°39' N latitude and 87°42' E longitude under tropical climatic conditions. Sowing of finger millet crop coincided with sufficient rain (1047.6 mm) occurred during the year 2018. During the crop period the mean maximum temperature varied between 30.1° C to 45.8° C with an average of 34.6° C, whereas the weekly mean minimum temperature during this crop period ranged from 21.4° C to 27.5° C which an average of 25.6° C. The experimental soil was sandy loam in texture, neutral in soil reaction (pH 6.5), medium in organic carbon (0.50%), low in available nitrogen (104 kg ha^{-1}), medium in available phosphorus (23 kg ha^{-1}) and medium in available potassium (196 kg ha^{-1}). The experiment was laid out in a randomized complete block design (RCBD) with ten treatments and three replications. The spacing row to row and plant to plant distance 20 cm × 20 cm adopting square planting method and the plot size was 4 m x 3 m. The treatments were: T_1: control, T_2: FYM @ 4 t ha^{-1},T_3: FYM @ 8 t ha^{-1}, T_4: 100% RDF (40:20:20 kg ha^{-1} of N: P_2O_5 : K_2O), T_5: 50% RDF + 4 t FYM ha^{-1}, T_6: 75% RDF + 2 t FYM ha^{-1}, T_7: FYM 4 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}, T_8: FYM 8 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1}, T_9: 50% RDF + 4 t FYM ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}, T_{10}: 75% RDF + 2 t FYM ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}. The entire quantity of phosphorus and potassium and half of the nitrogen were applied as basal at the time of transplanting. The remaining quantity of nitrogen was applied as top dressing at 21 days after transplanting. The *Azospirillium* slurry was prepared and the seedlings for the respective treatments were treated by root dipping for 30 minutes prior to transplanting. Though it was a rainfed crop, two life-saving irrigations were given on 17 and 42 DAT. Nitrogen content in grain and straw were estimated by modified micro-Kjeldahl method (AOAC, 1960). The Percent nitrogen is multiplied with 6.25 and per cent protein in crop was calculated (Williams, 1974). The data recorded on various parameters of crop were subjected to statistical scrutiny by the method of analysis of variance as outlined by Panse and Sukhatme (1985).

RESULT AND DISCUSSION

Growth attributes

Different growth attributes like plant height, dry matter accumulation and leaf area index of finger millet recorded at 25, 50 and 75 days after transplanting (DAT) and at harvest stage differed significantly due to nutrient management treatments studied (Table 1 and Fig. 1 & 2). There was a gradual progression in plant height towards maturity and at harvest stage the crop registered the highest value. Like other growth stages, at harvest stage application of T_4 (100% RDF) expressed the highest value of plant height (96.8 cm) and it was of lowest value with control (79.2 cm) and the latter remained significantly inferior to T_4. However, the treatments T_9 (50% RDF + 4 t FYM + *Azospirillum* @ 5 kg ha^{-1}) and T_{10} (75% RDF + 2 t FYM + *Azospirillum* @ 5 kg ha^{-1}) showed at par values with the treatment T_4 (100 % RDF). Supply of inorganic nutrient with 100% recommended dose fulfilled the requirement of the crops during the growing period. Similar results were obtained by Patil *et al*. (2015) and Sandhya Rani *et al*. (2017).

Dry matter accumulation of finger millet (g m^{-2}) was recorded periodically (25, 50, 75 DAT and at harvest), analysed statistically and presented (Table 1 and Fig. 2). The highest dry matter accumulation

Table 1: Effect of integrated nutrient management on plant height (cm) of finger millet at different growth stages

Treatments	Plant height (cm)				Dry matter accumulation (g m^{-2})				Tillers m^{-2}
	25 DAT	50 DAT	75 DAT	Harvest	25 DAT	50 DAT	75 DAT	Harvest	
T_1 Control (no fertilizer)	32.6	62.8	76.3	79.2	58.6	156.3	212.6	287.8	31.1
T_2 FYM 4 t ha^{-1}	33.6	64.8	78.4	81.7	61.7	162.7	218.3	291.6	37.2
T_3 FYM 8 t ha^{-1}	33.7	65.5	79.6	82.1	64.2	166.1	221.6	298.3	38.0
T_4 100% RDF	39.8	76.1	91.6	96.8	75.8	250.4	421.3	601.3	56.3
T_5 50% RDF + 4 t FYM	37.5	72.1	84.1	86.3	70.2	222.5	356.5	418.4	49.3
T_6 75% RDF + 2 t FYM	37.2	75.1	85.2	87.6	71.0	232.6	371.4	520.1	49.8
T_7 FYM 4 t ha^{-1} + *Azospirillum*	37.0	69.7	80.0	83.0	62.5	202.7	228.1	316.1	48.1
T_8 FYM 8 t ha^{-1} + *Azospirillum*	37.8	71.6	83.1	83.9	69.4	218.5	231.2	312.1	48.9
T_9 50% RDF + 4 t FYM + *Azospirillum*	38.5	75.1	89.7	94.3	72.7	237.2	351.6	417.1	52.6
T_{10} 75% RDF + 2 t FYM + *Azospirillum*	38.7	75.3	91.0	95.3	73.1	240.6	398.4	501.9	54.2
SEm ±	1.33	1.71	2.34	2.35	2.46	4.93	9.61	16.5	1.30
CD (P= 0.05)	3.95	5.09	6.95	7.00	7.31	14.6	28.5	49.2	3.88
CV (%)	10.9	7.3	8.4	8.1	10.8	7.1	9.6	12.5	8.4

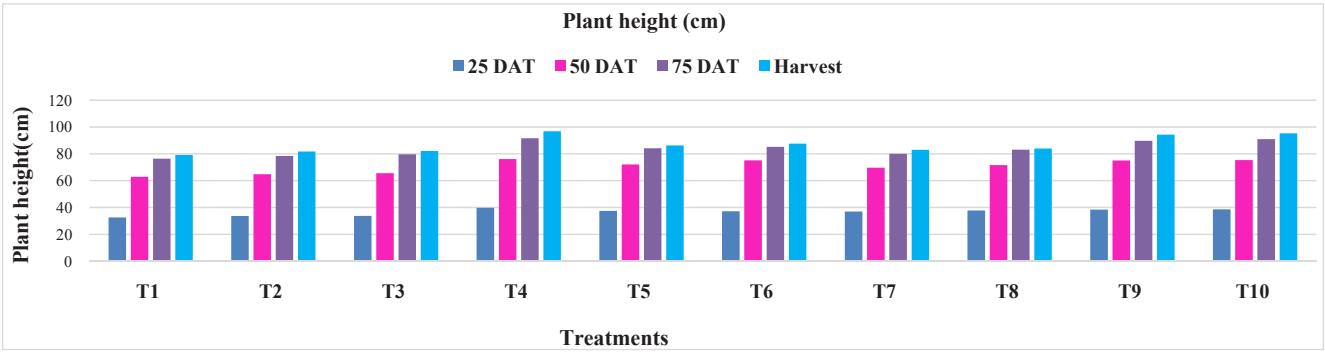

Fig. 1: Effect of integrated nutrient management on plant height (cm) of finger millet at different growth stages

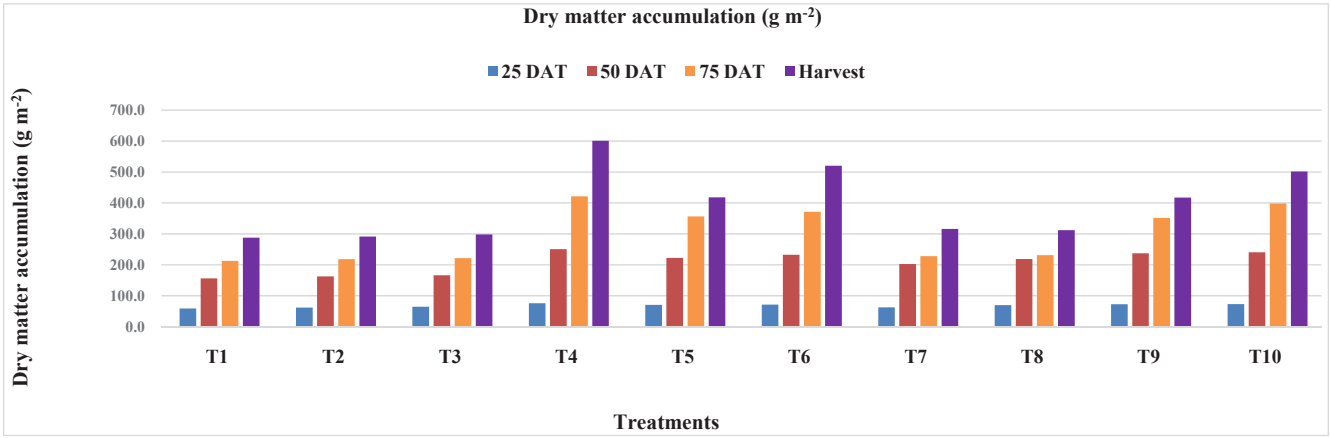

Fig. 2: Effect of integrated nutrient management on dry matter accumulation (g m^{-2}) of finger millet at different growth stages

produced with 100% RDF (T_4). However, remaining all other treatments like T_1(control), T_2 (FYM 4t ha^{-1}), T_3 (FYM 8t ha^{-1}), T_5 (50% RDF + 4 t FYM), T_6 (75% RDF + 2 t FYM), T_7 (FYM 4 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}), T_8 (FYM 8 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1}), T_9 (50% RDF + 4 t FYM + *Azospirillum* @ 5 kg ha^{-1}) and T_{10} (75% RDF + 2 t FYM + *Azospirillum* @ 5 kg ha^{-1}) were significantly inferior to the treatment T_4 (100% RDF). Similar observations were also made by earlier workers (Abdullahi *et al*. 2014; Ramakrishnan and Bhuvaneswari, 2014). Total number of tillers m^{-2} in finger millet recorded at harvest were significantly

Table 2: Effect of integrated nutrient management on Leaf area index and yield of finger millet

Treatments	Leaf area index				Yield	
	25 DAT	50 DAT	75 DAT	Harvest	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1Control (no fertilizer)	0.25	2.13	3.17	2.96	637	2267
T_2FYM 4 t ha^{-1}	0.36	2.28	3.36	3.17	648	2280
T_3FYM 8 t ha^{-1}	0.39	2.35	3.43	3.20	661	2320
$T_4$100% RDF	0.78	2.97	4.87	4.61	1412	4532
$T_5$50% RDF + 4 t FYM	0.57	2.67	4.53	4.31	932	3178
$T_6$75% RDF + 2 t FYM	0.61	2.70	4.60	4.35	1176	3951
T_7FYM 4 t ha^{-1} + *Azospirillum*	0.51	2.51	4.50	4.26	702	2450
T_8FYM 8 t ha^{-1} + *Azospirillum*	0.56	2.59	4.53	4.29	731	2536
$T_9$50% RDF + 4 t FYM + *Azospirillum*	0.70	2.83	4.81	4.50	948	3204
T_{10}75% RDF + 2 t FYM + *Azospirillum*	0.71	2.78	4.76	4.48	1191	3882
SEm ±	0.01	0.09	0.16	0.09	26	55
CD (P= 0.05)	0.04	0.27	0.48	0.28	78	162
CV (%)	8.5	10.8	11.5	7.1	8.8	5.4

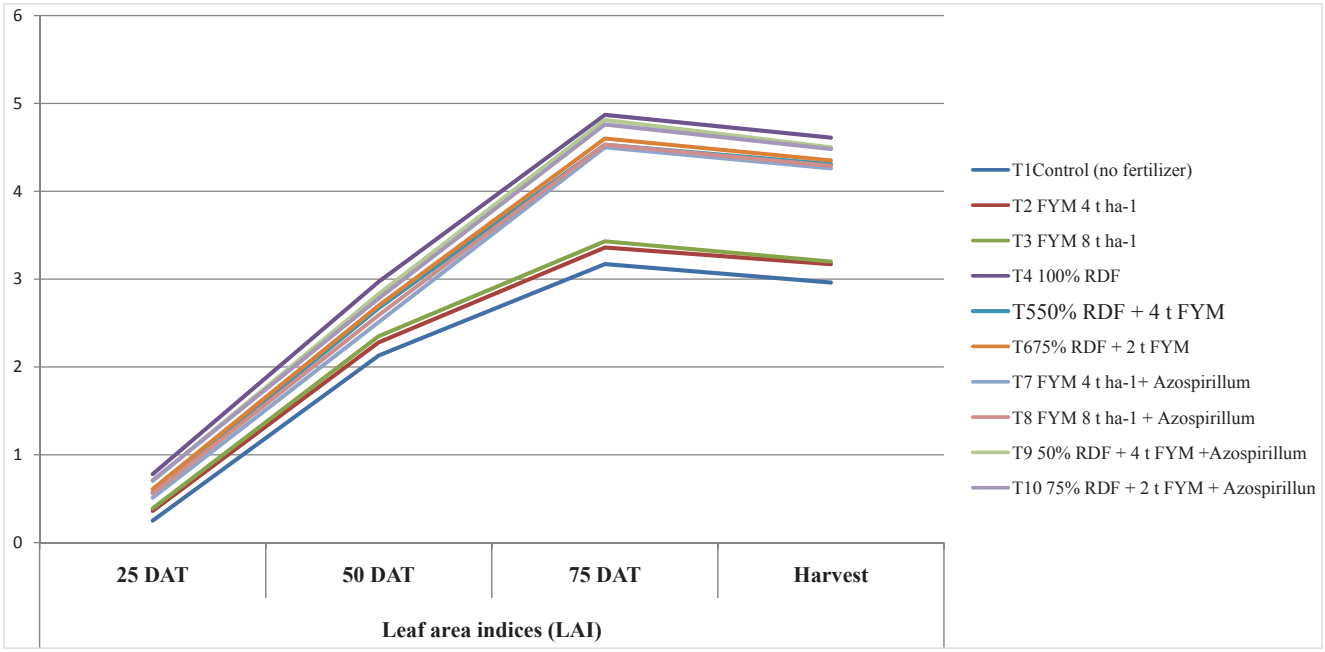

Fig. 3: Effect of integrated nutrient management on leaf area index of finger millet at different growth stages

influenced by integrated nutrient management (Table 1). Like other growth parameters, number of tillers m^{-2} also showed its superiority with the treatment T_4 (100% RDF) over others. Enhanced number of tillers m^{-2} with inorganic sources, as evidenced in this investigation corroborates with the findings of Nigade *et al*. (2014).

The Leaf area indices of finger millet at different crop growth stages as influenced by integrated nutrient management are presented in table 2 and Fig. 3. The leaf area index increased steadily up to 75 DAT and there after it decreased sharply due to rapid senescence of the older leaves as the crop progressed towards maturity. At all the growth stage T_4 (100% RDF) recorded superior to all other the treatment. whereas at 75 DAT the maximum leaf area index (4.87) was observed maximum in treatment T_4 (100% RDF), which was significantly more than T_1 (control), T_2 (FYM 4t ha^{-1}) and T_3 (FYM 8tha^{-1}). But the treatments like T_5 (50% RDF + 4 t FYM), T_6 (75% RDF + 2 t FYM), T_7 (FYM 4 t ha^{-1}+*Azospirillum* @ 5 kg ha^{-1}), T_8 (FYM 8 t ha^{-}

Table 3: Effect of integrated nutrient management on nutrient content (%) and protein content of finger millet grain

Treatments	Nutrient content (%)						Protein content of grain (%)
	Grain			Straw			
	N	P	K	N	P	K	
T_1 Control (no fertilizer)	1.30	0.26	0.32	0.33	0.31	1.35	8.13
T_2 FYM 4 t ha^{-1}	1.30	0.27	0.32	0.33	0.31	1.35	8.13
T_3 FYM 8 t ha^{-1}	1.31	0.27	0.33	0.33	0.32	1.36	8.19
T_4 100% RDF	1.34	0.29	0.36	0.36	0.34	1.38	8.38
T_5 50% RDF + 4 t FYM	1.32	0.28	0.34	0.35	0.33	1.37	8.25
T_6 75% RDF + 2 t FYM	1.32	0.28	0.34	0.36	0.33	1.37	8.25
T_7 FYM 4 t ha^{-1} + *Azospirillum*	1.31	0.27	0.33	0.34	0.32	1.36	8.19
T_8 FYM 8 t ha^{-1} + *Azospirillum*	1.32	0.28	0.33	0.34	0.32	1.37	8.25
T_9 50% RDF + 4 t FYM + *Azospirillum*	1.33	0.29	0.35	0.36	0.34	1.38	8.31
T_{10} 75% RDF + 2 t FYM + *Azospirillum*	1.34	0.29	0.36	0.36	0.34	1.38	8.38
SEm ±	0.023	0.007	0.009	0.007	0.006	0.021	0.13
CD (P= 0.05)	NS	NS	NS	NS	NS	NS	NS
CV (%)	8.4	7.9	8.5	6.7	6.3	8.1	4.6

^{1}+*Azospirillum* @ 5 kg ha^{-1}), T_9 (50% RDF + 4 t FYM + *Azospirillum* @ 5 kg ha^{-1}) and T_{10} (75% RDF + 2 t FYM + *Azospirillum* @ 5 kg ha^{-1}) were statistically at par with treatment T_4 (100% RDF). The results are in conformity with the findings of Pallavi *et al*. (2016).

Yield

Similar trend was also observed in other parameter same result was revealed from the grain and straw yield (Table 2) of finger millet was influenced significantly by different nutrient management treatments. The Application of 100% RDF (T4) resulted in maximum grain yield (1412 kg ha^{-1}) and straw yield (4532 kg ha^{-1}), however, the treatment was significantly superior to all other treatments. Further, it was noted that the treatments with 75% RDF and 50% RDF along with combination of organic manure and biofertilizer recorded grain and straw yield of finger millet significantly higher than the control treatment. The results clearly indicated that the requirement of sufficient nutrients for enhancement of productivity. Application of only organic manure and biofertilizer did not show much influence in terms of grain yield, probably because of organic manures are slow release in nature and might be the entire nutrient would not be released in the crop cycle and it might be benefited to the succeeding crop. The results corroborate the findings of Saraswathi *et al.* (2017) and Roy *et al.* (2018).

NPK and Protein content

The N, P and K content in grain straw did not vary much due to different nutrient management practices adopted in the study (Table 3). The highest nitrogen content of grain and straw content was observed with treatments T_4 (100% RDF) and T_{10} (75% RDF + 2 t FYM + *Azospirillum* @ 5 kg ha^{-1}). The lowest nitrogen content of grain and straw content was recorded with treatments T_1 (control) and T_2 (FYM 4tha^{-1}). The Protein content of grain was not influenced significantly by different nutrient management treatments. Comparatively higher protein content of grain was recorded with 100% RDF (T4) and 75% RDF + 2 t FYM + *Azospirillum* (T_{10}) and it was closely followed by T_9 (50% RDF + 4 t FYM + *Azospirillum* @ 5 kg ha^{-1}). The above data emphasized the point that for improvement of nutrientsupply enhanced N content of grain and the same was reflected in the content of protein in finger millet grain. The results corroborate with the findings of Arnulv Stabursvik (1974). This might be due to increased nutrient availability by supply of nutrients through different sources which probably caused higher meristematic activities of top and roots of the plant, therefore, high absorption of these nutrients. These results were in conformity with findings were reported by Roy *et al*. (2018).

CONCLUSION

The study revealed that supply of adequate and readily available nutrient assured more assimilate

production and it was reflected in enhancement of different growth parameters, yield and quality of finger millet. Further, it may be concluded from the experimental results that application of 100 % recommended dose of fertilizer (RDF) may be applied to obtain higher productivity of finger millet under south Odisha conditions. Application of only organic manure and biofertilizer did not show much influence in terms of grain yield like 100% RDF, because organic manures are slow release in nature and the entire nutrient is not released from organic manures in single crop cycle. But organic manures and biofertilizer are known to improve the soil physio-chemical and biological properties. Integrated application of inorganic, organic and biofertilizer also performed well in the resource poor soil, therefore, for sustaining long-term productivity this approach may also be considered and present study clearly indicates the scope of long term research on impact of integrated nutrient management.

REFERENCES

Abdullahi, R., Sheriff, H.H. and Buba, A. 2014. Effect of bio-fertilizer and organic manure on growth and nutrients content of pearl millet. *Journal of Agricultural and Biological Sciences*, **9**(10): 351 - 355.

Agricultural Statistics at a Glance. 2017. Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

AOAC, 1960. Official methods of analysis of the association official agricultural chemists. 9th Edition. Washington, 4.D.C.

Arnulv Stabursvik. 1974. Protein content and amino acid spectrum of finger millet [*Eleusine coracana* (L.) Gaertn.] as influenced by nitrogen and sulphur fertilizers. *Plant and Soil*, **41**(3): 549–571.

Maitra, S., Ghosh, D.C., Jana, P.K. and Sounda, G. 1998. Effect of Seed Treatment of Growth and Productivity of Finger Millet under Rainfed Red and Lateritic Belt of West Bengal. *Indian Agriculturist*, **42**(1): 37-43.

Nigade, R.D., Gajbhiye, P.N and More, S.M. 2014. Integrated nutrient management studies in finger millet (*Eleusine coracana* L.). *Crop Research*, **48**(1, 2 & 3): 27-31.

Odisha Agriculture at a Glance, 2015. Department of Agriculture, Government of Odisha.

Pallavi, Ch., Joseph, B., Aariff Khan, M.A. and Hemalatha, S. 2016. Effect of integrated nutrient management on nutrient uptake, soil available nutrients and productivity of rainfed finger millet. *International Journal of Science, Environment and Technology*, **5**: 2798 – 2813.

Panse, V.G. and Sukhatme. 1985. Statistical methods for agricultural workers 3rd edition. *Indian Council of Agricultural Research Publication*, New Delhi, pp. 361.

Patil, S.V., Bhosale, A.S. and Khambal, P.D. 2015. Effect of various levels of fertilizers on growth and yield of finger millet. *IOSR Journal of Agriculture and Veterinary Science*, **8**: 49-52.

Ramakrishnan, K. and Bhuvaneswari, G. 2014. Effect of inoculation of fungi and beneficial microorganisms on growth and nutrient uptake of *Eleusine coracana* L. Gaertn. (Finger millet). *International Letters of Natural Sciences*, **8**(2): 59-69.

Roy, A.K., Ali, N., Lakra, R.K., Alam, P., Mahapatra, P. and Narayan, R.2018. Effect of integrated nutrient management practices on nutrient uptake, yield of finger millet (*Eleusine coracana*L. Gaertn.) and post-harvest nutrient availability under rainfed condition of Jharkhand. *International Journal of Current Microbiology and Applied Sciences*, **7**(8): 339-347.

Sandhya Rani, Y., Triveni, U., Patro, T.S.S.K. and Anuradha, N. 2017. Effect of nutrient management on yield and quality of finger millet (*Eleusine coracana* L. Gaertn). *International Journal of Chemical Studies*, **5**(6): 1211-1216.

Saraswathi, Y., Vishawanath Shetty, M., Dinesh Kumar, and Ashwini M. 2017. Effect of NPK application through different approaches on yield and major nutrient uptake by finger millet (*Eleusine coracana* L. Gaertn) under rainfed conditions. *Hind Agricultural Research and Training Institute.* 12.

Williams, P.C. 1974. Errors in protein testing and their consequences. *Cereal Sci. Today*, **19**: 280-282, 286.