International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(6): 1211-1216

Received: 15-09-2017
Accepted: 17-10-2017

Sandhya Rani Y
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, A.P, India

Triveni U
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, A.P, India

Patro TSSK
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, A.P, India

Anuradha N
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, A.P, India

Correspondence
Sandhya Rani Y
Acharya N.G. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, A.P, India

Effect of nutrient management on yield and quality of finger millet (*Eleusine coracana* (L.) Gaertn)

Sandhya Rani Y, Triveni U, Patro TSSK and Anuradha N

Abstract
Finger millet (*Eleusine coracana* (L.) Gaertn) is a staple food crop grown by subsistence farmers in red sandy loam soils of North Coastal Zone and scarce rainfall zone of Andhra Pradesh. It is commonly known as "Nutricereals" and is nutritionally superior to many cereals providing proteins, minerals, calcium and vitamins in abundance and is highly valued by traditional farmers as it is nutritious, drought tolerant, short duration and requires low inputs. High yielding varieties of finger millet require comparatively large quantities of both macro and micronutrients and are expected to respond favourably to their application. In view of this finger millet widely grown and commonly consumed in India was explored as a vehicle for fortification with zinc and iron. A field experiment was conducted to study the yield responses of finger millet pre released variety VR 900 to graded doses of inorganic fertilizers (macronutrients and micronutrients) which has been shown to be important for early establishment of finger millet. The experimental results indicated that significantly higher grain and straw yields of finger millet were recorded in the treatment with 150% RDF+$ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray (78.1q/ha and 33.7q/ha respectively). The highest available soil macronutrients and uptake of plant macronutrients was also found in the same treatment. Whereas the highest available Zn in the soil was found in the treatment 150% RDF+$ZnSO_4$ soil application + $FeSO_4$ 0.2% foliar spray (3.32ppm), and the highest available Fe in the treatment 150% RDF+ $FeSO_4$ 0.2% foliar spray (17.63ppm).

Keywords: Finger millet, Nutrient Management, Zinc, Iron, Soil available nutrients, Plant uptake

1. Introduction
Finger millet (*Eleusine coracana* L. Gaertn) is an important small millet crop grown in India and has the pride of place in having highest productivity among millets. It is also known as ragi, African millet and bird's foot millet and an important staple food crop in part of eastern and central Africa and India. Grain is higher in protein, fat and minerals than rice, corn or sorghum. Ragi is commonly known as "Nutritious millet" as the grain is nutritionally superior to many cereals providing proteins, minerals, calcium and vitamins in abundance to the people. When consumed as food it provides a sustaining diet, especially for people doing hard work. Straw makes valuable fodder for both working and milking animals. Finger millet is considered an especially wholesome food for diabetics. Grain may also be malted and a flour of the malted grain used as cakes or porridge and a nourishing food for infants and invalids.
Malnutrition and under nourishment are the major problems of Indian population due to which millets are becoming alternative sources of human food globally as well as in India. Finger millet (Popularly called as 'Ragi' in A.P.) is an important staple food in the Eastern and Central Africa as well as some parts of India (Majumder *et al*., 2006) [15] being one of the important sources for value added products, besides being a staple food especially in South India.. It is rich in protein, iron, calcium, phosphorus, fibre and vitamin content. The calcium content in this crop is higher than all cereals while the iodine content is said to be highest among all the food grains. Moreover, antioxidant properties, and phytochemicals which makes it easily and slowly digestible and helps to control blood glucose levels in diabetes patients very efficiently. Ragi has best quality protein along with the presence of essential amino acid, vitamin A, vitamin B and phosphorus (Gopalan *et al*., 2004) [9]. Besides this, the importance of micronutrients such as zinc and iron in improving the quality of food or value addition also needs to be evaluated to overcome the imbalance of nutrients in the produce.
The bulkiness of the fibres and the slower digestion rate makes a person feel full after consumption with fewer calories and therefore, may help to prevent from eating excess calories.

Therefore, ragi is considered to be an ideal food for diabetic individuals due to its low sugar content and slow release of glucose/sugar in the body (Lakshmi and Sumathi, 2002 and Kang *et al*., 2008) [13, 12].

The protein of finger millet has been reported to possess a fairly high biological value, which is needed for the maintenance of nitrogen equilibrium of the body. The higher fibre content of finger millet helps in many ways as it prevents constipation, high cholesterol formation and intestinal cancer. Hence, people suffering from diabetes are advised to eat finger millet

Finger millet is usually used for preparation of flour, pudding, porridge and *roti* (Chaturvedi and Srivastava, 2008) [5]. With the changes in scenario of utilization of processed products and awareness of the consumers about the health benefits, finger millet has gained importance because of its functional components, such as slowly digestible starch and resistant starch (Wadikar *et al*., 2007) [29]. It is reported that during malting process, Calcium and Phosphorus content increase whereas iron content decreases (Sangita and Sarita, 2000) [22].

Since the introduction of green revolution in Asia, cultivation of high yielding genotypes, improved agricultural mechanization and production of macronutrient fertilizers with low impurities of trace elements has resulted in higher crop production per unit area with greater depletion of plant available micronutrients. Deficiencies of vitamin A, iron and iodine are widespread in developing countries including India, the deficiency of zinc is also gaining attention. Zinc deficiency is now recognized as one of the most widespread mineral deficiencies in global human nutrition. Zinc is required for the structural and functional integrity of about 2800 proteins, contributes to protein biosynthesis and is a key defense factor in detoxification of highly toxic oxygen free radicals (Andreini *et al.,* 2009) [1]. Cakmak (2008) [3], showed that foliar or combined soil and foliar application of zinc fertilizer under field conditions are highly effective and very practical way to maximize uptake and accumulation of zinc in whole wheat grain. Finger millet flour fortified with either zinc oxide was specifically examined for the bio accessibility of the fortified mineral, as measured by *in vitro*, stimulated gastrointestinal digestion procedure and storage stability (Bhumika and Kalpana, 2010) [2].

Hence, the present investigation was conducted with the objective to find out the best nutrient requirement of both macronutrients and micronutrients of finger millet crop.

Material and Methods

The field experiment was conducted during *Kharif* 2015-16 and 2016-17 at Agricultural Research Station, Vizianagaram. The soil was sandy loam in texture, low in Organic Carbon, available Nitrogen, high in available Phosphorus and medium in available Potassium. The experiment was laid down in Randomised Block Design with twelve treatments replicated thrice. Uniform cultural practices were carried out in all the experimental plots of 3 X 3 m and healthy seeds of both the varieties were sown with a spacing of 30X10cm in all the plots. Required population of finger millet crop of pre released variety VR 900 was maintained by thinning and gap filling whenever required.

Different treatments taken are

T1 : R.D.F (60-40-30 kg ha^{-1} of N, P_2O_5 and K_2O)
T2 : 150% R.D.F
T3 : T1+ $ZnSO_4$@ 50 kg ha^{-1} as soil application
T4 : T1+ $ZnSO_4$0.5% foliar spray
T5 : T1+ $FeSO_4$0.2% foliar spray
T6 : T1+ $ZnSO_4$soil application + $FeSO_4$ 0.2% foliar spray
T7 : T1+ $ZnSO_4$0.5% foliar spray + $FeSO_4$ 0.2% foliar spray
T8 : T2+ $ZnSO_4$@ 50 kg ha^{-1} as soil application
T9 : T2+ $ZnSO_4$0.5% foliar spray
T10 : T2+ $FeSO_4$ 0.2% foliar spray
T11 : T2+ $ZnSO_4$ soil application + $FeSO_4$ 0.2% foliar spray
T12 : T2 + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray

The recommended dose of nutrients (R.D.F.) was 60 kg N, 40 kg P_2O_5 and 30 kg K_2O ha^{-1} which was applied in the form of urea, DAP and muriate of potash. Fertilizer nitrogen was applied as per treatments in two equal splits - half at transplanting and half at 30 days after transplanting (DAT). Phosphorus and potash were applied basally, at transplanting as per the treatments. Foliar spray of nutrients *viz*. zinc sulphate (0.5%) and ferrous sulphate (0.2%) was done twice at 30 and 45 days after transplanting while soil application of zinc sulphate @50 kg ha^{-1} was done as per the treatments at the time of transplanting.

Growth parameters *viz*., plant height, No. of productive tillers, leaf length, leaf width, ear head length, No. of fingers/ear, straw and grain yields were recorded at the time of harvest. The initial soil samples before sowing of the crop and final soil samples after harvest of the crop was analysed for pH, EC, available N, P_2O_5, K_2O and available micronutrients *viz*., Zn, Fe, Cu and Mn as per the standard procedures. The plant samples of both the grain and straw of both the varieties of little millet were prepared and analysed for both macro and micronutrient uptake.

Results and Discussion

The growth characters, yield attributes, soil and plant quality were significantly influenced with different nutrient management practices. The plant height (Table 1) was found highest with the treatment with 150% RDF + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray (T_{12}) which was however on par with150% RDF + $ZnSO_4$soil application +$FeSO_4$ 0.2% foliar spray (T_{11}) as well as 150% RDF (T_2) and these were significantly better compared to all the other treatments whereas the lowest was recorded with the treatment 100% RDF + $ZnSO_4$@ 50 kg ha^{-1}. The leaf length (Table 1) has no significant difference between the treatments. Increase in plant height with increasing levels of nitrogen was reported by Gupta *et al.,* 2012 [10], while Tenywa *et al*., 1999 found that application of P fertilizer (20–40 kg P_2O_5 ha^{-1}) increased the growth and yield of finger millet compared to the no fertilizer control under row planting conditions. The No. of productive tillers per plant (Table 1) was recorded highest with the treatment with 150% RDF + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray (T_{12}) which was significantly higher than all the other treatments. The earhead length and fingers/ear were also found highest with treatment T_{12} which was found on par with T_{10} and T_{11} and significantly higher than all the other treatments. Similar results were recorded by Sankar *et al*., (2011) [21] and Chavan *et al.* (1995) [6] obtained the highest number of effective tillers with 120 kg N ha^{-1}. While Sunitha *et al.* (2006) [26] recorded on par values of number of tillers m^{-2} with 100% N through fertilizers and 75% N through fertilizer + 25% through green leaf manure while Giribabu *et al.* (2010) [8] observed that the

number of effective tillers m^{-2} significantly increased with application of 100% R.D.F + 3 t FYM ha^{-1}.

The highest grain yield (33.7q ha^{-1}) (Table 3) was obtained with 150% R.D.F + $ZnSO_4$ 0.5% foliar spray+ $FeSO_4$ 0.2% foliar spray (T_{12}) followed by 150% R.D.F+ $FeSO_4$ 0.2% foliar spray (T_{10}),150% R.D.F (T_2), 150% R.D.F + 50 kg ha^{-1} $ZnSO_4$ soil application + $FeSO_4$ 0.2% foliar spray (T_{11}), 150% R.D.F + $ZnSO_4$ 0.5% foliar spray (T_9), 150% R.D.F + $ZnSO_4$ @ 50 kg ha^{-1} soil application (T_8), 100% R.D.F + $ZnSO_4$ 0.5% foliar spray (T_4), 100% R.D.F + $FeSO_4$ 0.2% foliar spray (T_5), while lowest was recorded by 100% R.D.F (T_1) followed by 100% RDF + 50 kg ha^{-1} $ZnSO_4$ soil application (T3). Increased grain yield due to varying levels of nutrients have also been reported by Dubey and Shrivas, 1999 [7] (40 kg N), Chakraborty *et al*., 2002 [4] (80 kg N) and Tetarwal and Rana, 2006 (80 kg N + 40 kg P_2O_5).

Maximum straw yield (78.1q ha^{-1}) (Table 3) was recorded with 150% R.D.F + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray (T_{12})closely followed by 150% R.D.F +$FeSO_4$ 0.2% foliar spray (T_{10}), both of which were at par and succeeded by 150% R.D.F + $ZnSO_4$@ 50 kg ha^{-1} as soil application + $FeSO_4$0.2% foliar spray (T_{11}), 150% R.D.F + $ZnSO_4$ 0.5% foliar spray (T_9), 150% R.D.F (T_2), 150% R.D.F + $ZnSO_4$ @ 50 kg ha^{-1} as soil application (T_8), 100% R.D.F +$FeSO_4$ 0.2% foliar spray (T_5). Varied responses in straw yield due to varied levels of nutrients have also been reported by Pilane *et al*., 1997 (50 kg N +25 kg P_2O_5), Singh, 1999 (75% of 50-40-25 kg N, P, K ha^{-1}), Sunitha *et al*., 2006 [26] (100% N through fertilizer) and Chavan *et al*., 1995 [6] (120 kg N).

The physicochemical properties (pH and E.C) showed no significant influence with the application of different nutrient management practices (Table 4). The Organic Carbon percentage of the soil was also not significantly influenced by various treatments (Table 4).

The soil available Nitrogen, Phosphorus and Potassium (Table 5) were significantly influenced by different nutrient management practices. The maximum soil available nitrogen and phosphorus after harvest of the crop was recorded with 150% RDF + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray (T_{12}) followed by 150% RDF + $FeSO_4$ 0.2% foliar spray (T_{10}), 150% RDF + $ZnSO_4$ @ 50 kg ha^{-1} as soil application + $FeSO_4$ 0.2% foliar spray (T_{11}) and 150% RDF + $ZnSO_4$ 0.5% foliar spray (T_9) and 150% R.D.F + $ZnSO_4$ @ 50 kg ha^{-1} as soil application (T_8) which were on par with each other and significantly different from all the other treatments. The least soil available nitrogen was recorded with 100% RDF + $ZnSO_4$ @ 50 kg ha^{-1} as soil application (T_3) and phosphorus was recorded in T_5 which, was significantly inferior to all other treatments. Similar results were recorded by Rurinda *et al*., 2014 [20].

Maximum value of available potassium (Table 5)was observed with 150% RDF + $ZnSO_4$ @ 50 kg ha^{-1} as soil application + $FeSO_4$ 0.2% foliar spray (T_{11}) which, however, was on par with 150% RDF + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray (T_{12}). The lowest soil available potassium status resulted with 100% RDF + $ZnSO_4$soil application + $FeSO_4$ 0.2% foliar spray (T_6). Similar results were recorded by Hemalatha and Chellamuthu, 2013.

In the soil available micronutrients (Table 5), available Zn and Fe were significantly influenced by various treatments of nutrient management. The highest quantity of available zinc in soil was observed with 150%RDF+$ZnSO_4$@ 50 kg ha^{-1} as soil application+$FeSO_4$ 0.2% foliar spray (T_{11}) which is significantly different from all the other treatments. Significantly least quantity of available zinc was recorded with 150% RDF (T_2). Maximum available Fe status in soil was recorded with 150% RDF + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray (T_{12}) which, however, was on a par with 150% R.D.F +$FeSO_4$ 0.2% foliar spray (T_{10}) and150% RDF + $ZnSO_4$ @ 50 kg ha^{-1} as soil application + $FeSO_4$ 0.2% foliar spray (T_{11}) and these treatments were significantly superior to rest of the treatments. Significantly, lowest quantity of available Fe in soil was noticed with 150% RDF (T_2). Similar results were reported by Rangaraj *et al*., 2007 [18].

The uptake of macronutrients(N, P and K) (Table 6)was found highest in the treatment 150% RDF + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray (T_{12}) which was found on par with 150% RDF+ $FeSO_4$ 0.2% foliar spray (T_{10}), 150% RDF (T2) and 150% RDF + $ZnSO_4$ soil application + $FeSO_4$ 0.2% foliar spray (T_{11}). Increased uptake of N with increased levels of N application has been reported by Sudhakara Rao *et al.,* (1991) [25] while increase in N uptake by grain and straw of pearl millet due to increased levels of nitrogen has been reported by Tetarwal and Rana (2006).The uptake of micronutrients (Zn and Fe) (Table 6) was found highest with the treatment 150% RDF + $ZnSO_4$ 0.5% foliar spray + $FeSO_4$ 0.2% foliar spray (T_{12}) which was found on par with the treatments 150% RDF + $ZnSO_4$ 0.5% foliar spray (T_9) and 150% RDF + $ZnSO_4$ soil application + $FeSO_4$ 0.2% foliar spray (T_{11}). The lowest uptake of micronutrients was recorded with 100% RDF (T1). Similar results were recorded by Rao *et al*., 2012 [19], Srinivasarao *et al*., 2008 [24] and Ramachandrappa *et al*., 2014 [17]. The grain Zinc content (Table 7) was found highest with the treatment T_{12} compared to all the other treatments. The grain Fe content was found highest with the treatment T_{12} which was on par with T_{10}.Whereas the grain N content and protein content were found non-significant between the treatments.

Table 1: Plant growth parameters of finger millet as influenced by nutrient management practices

Treatment	Plant height (cm)			Leaf length (cm)		
	2015	2016	Mean	2015	2016	Mean
T1: 100% R.D.F (60-40-30 kg ha^{-1} of N, P_2O_5 and K_2O)	110.1	113.7	111.9	26.6	30.2	28.4
T2 : 150% R.D.F	119.9	120.7	120.3	25.8	32.4	29.1
T3 : T1+ $ZnSO_4$@ 50 kg ha^{-1} as soil application	104.5	115.7	110.1	26.0	32.1	29.1
T4 : T1+ $ZnSO_4$0.5% foliar spray	107.8	120.8	114.3	27.3	32.4	29.9
T5 : T1+ $FeSO_4$0.2% foliar spray	112.5	119.3	115.9	26.6	33.1	29.9
T6 : T1+ $ZnSO_4$soil application + $FeSO_4$0.2% foliar spray	110.2	119.7	115.0	26.9	34.5	30.7
T7: T1+ $ZnSO_4$0.5% foliar spray + $FeSO_4$0.2% foliar spray	111.3	119.0	115.2	25.1	34.6	29.9
T8: T2+ $ZnSO_4$@ 50 kg ha^{-1} as soil application	114.9	118.3	116.6	29.6	33.3	31.5
T9 : T2 + $ZnSO_4$0.5% foliar spray	116.2	120.9	118.5	29.0	34.2	31.6
T10 :T2+ $FeSO_4$0.2% foliar spray	120.5	118.6	119.6	28.5	34.5	31.5

T11:T2+ $ZnSO_4$ soil application + $FeSO_4$0.2% foliar spray	114.2	**128.0**	121.1	29.3	34.5	31.9
T12 : T2 + $ZnSO_4$0.5% foliar spray+ $FeSO_4$0.2% foliar spray	**121.8**	124.7	123.3	29.5	35.7	32.6
SEm±	5.19	2.256	2.98	1.61	1.082	0.881
CD (0.05)	15.23	6.62	8.77	NS	NS	2.59
CV%	7.91	3.26	4.43	10.16	5.60	5.01

Table 2: Yield attributes of finger millet as influenced by nutrient management practices

Treatment	No. of productive tillers/plant			Ear head length (cm)			Fingers/ear		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
T1: 100% R.D.F (60-40-30 kg ha^{-1} of N, P_2O_5 and K_2O)	2.5	2.73	2.6	8.4	8.17	8.3	8.5	8.07	8.3
T2 : 150% R.D.F	2.7	3.40	3.0	9.0	9.00	9.0	9.0	8.47	8.7
T3 : T1+ $ZnSO_4$@ 50 kg ha^{-1} as soil application	2.1	3.13	2.6	8.0	8.47	8.2	8.4	8.27	8.3
T4 : T1+ $ZnSO_4$0.5% foliar spray	2.3	3.20	2.7	8.2	8.53	8.4	8.5	8.13	8.3
T5 : T1+ $FeSO_4$0.2% foliar spray	2.5	2.87	2.7	8.4	8.37	8.4	9.1	8.20	8.7
T6 : T1+ $ZnSO_4$soil application + $FeSO_4$0.2% foliar spray	2.7	3.07	2.9	8.3	8.67	8.5	8.4	8.40	8.4
T7: T1+ $ZnSO_4$0.5% foliar spray + $FeSO_4$0.2% foliar spray	2.6	3.13	2.9	8.4	8.50	8.5	8.7	8.73	8.7
T8: T2+ $ZnSO_4$@ 50 kg ha^{-1} as soil application	2.3	3.13	2.7	8.5	8.93	8.7	8.8	8.87	8.8
T9 : T2 + $ZnSO_4$0.5% foliar spray	2.9	3.20	3.0	8.6	8.60	8.6	9.0	9.00	9.0
T10 :T2+ $FeSO_4$0.2% foliar spray	2.8	3.33	3.1	9.1	8.80	9.0	9.2	8.93	9.1
T11:T2+ $ZnSO_4$ soil application + $FeSO_4$0.2% foliar spray	2.9	3.60	3.2	8.9	9.97	9.4	9.2	9.47	9.3
T12 : T2 + $ZnSO_4$0.5% foliar spray+ $FeSO_4$0.2% foliar spray	3.5	4.13	3.8	9.4	10.00	9.7	9.9	9.93	9.9
SEm±	0.29	0.224	0.184	0.33	0.35	0.243	0.37	0.374	0.246
CD (0.05)	0.84	0.66	2.59	0.97	1.03	0.72	1.09	1.10	0.72
CV%	18.85	11.67	5.01	6.63	6.89	4.84	7.26	7.44	4.85

Table 3: Straw and grain yield of finger millet as influenced by nutrient management practices

Treatment	Straw Yield (q/ha)			Grain yield (q/ha)			B:C		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
T1: 100% R.D.F (60-40-30 kg ha^{-1} of N, P_2O_5 and K_2O)	52.4	55.89	52.6	21.7	26.88	24.3	2.59	2.29	2.44
T2 : 150% R.D.F	68.1	64.82	66.5	29.8	34.41	32.1	2.52	2.76	2.64
T3 : T1+ $ZnSO_4$@ 50 kg ha^{-1} as soil application	53.1	60.60	56.9	19.2	32.22	25.7	2.20	2.72	2.46
T4 : T1+ $ZnSO_4$0.5% foliar spray	54.7	59.31	57.0	24.9	29.42	27.2	2.18	2.48	2.33
T5 : T1+ $FeSO_4$0.2% foliar spray	60.6	57.42	59.0	23.6	29.67	26.6	2.36	2.43	2.395
T6 : T1+ $ZnSO_4$soil application + $FeSO_4$0.2% foliar spray	54.4	64.68	59.5	20.1	32.12	26.1	2.43	2.52	2.475
T7: T1+ $ZnSO_4$0.5% foliar spray + $FeSO_4$0.2% foliar spray	57.7	63.04	60.4	19.8	31.88	25.8	2.11	2.66	2.385
T8: T2+ $ZnSO_4$@ 50 kg ha^{-1} as soil application	65.6	70.10	67.9	26.3	33.83	30.1	2.35	2.53	2.44
T9 : T2 + $ZnSO_4$0.5% foliar spray	68.7	63.41	66.0	28.0	30.88	29.5	2.31	2.29	2.3
T10 :T2+ $FeSO_4$0.2% foliar spray	71.9	77.44	74.7	29.6	34.60	32.1	2.49	2.63	2.56
T11:T2+ $ZnSO_4$ soil application + $FeSO_4$0.2% foliar spray	69.5	74.15	71.8	27.0	35.85	31.4	2.18	2.56	2.37
T12 : T2 + $ZnSO_4$0.5% foliar spray+ $FeSO_4$0.2% foliar spray	73.2	82.96	78.1	30.2	37.28	33.7	2.71	2.89	2.8
SEm±	5.18	3.95	2.93	2.39	1.66	1.44			
CD (0.05)	15.18	11.59	8.60	7.01	4.88	4.23			
CV%	14.41	10.35	7.91	16.56	8.89	8.70			

Table 4: Physico chemical properties and O.C% as influenced by nutrient management practices

Treatment	pH			EC			OC%		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
T1: 100% R.D.F (60-40-30 kg ha^{-1} of N, P_2O_5 and K_2O)	6.53	7.36	6.95	0.100	0.20	0.15	0.46	0.45	0.46
T2 : 150% R.D.F	6.54	7.38	6.96	0.097	0.23	0.16	0.45	0.44	0.45
T3 : T1+ $ZnSO_4$@ 50 kg ha^{-1} as soil application	6.71	7.46	7.08	0.100	0.18	0.14	0.47	0.48	0.48
T4 : T1+ $ZnSO_4$0.5% foliar spray	6.61	7.21	6.91	0.107	0.22	0.16	0.46	0.44	0.45
T5 : T1+ $FeSO_4$0.2% foliar spray	6.65	7.19	6.92	0.113	0.21	0.16	0.45	0.41	0.43
T6 : T1+ $ZnSO_4$soil application + $FeSO_4$0.2% foliar spray	6.70	7.17	6.94	0.120	0.18	0.15	0.50	0.47	0.48
T7: T1+ $ZnSO_4$0.5% foliar spray + $FeSO_4$0.2% foliar spray	6.68	7.46	7.07	0.113	0.16	0.14	0.51	0.49	0.51
T8: T2+ $ZnSO_4$@ 50 kg ha^{-1} as soil application	6.63	7.49	7.06	0.113	0.21	0.16	0.49	0.46	0.48
T9 : T2 + $ZnSO_4$0.5% foliar spray	6.59	7.38	6.99	0.123	0.14	0.13	0.52	0.46	0.49
T10 :T2+ $FeSO_4$0.2% foliar spray	6.67	7.24	6.96	0.120	0.17	0.14	0.49	0.50	0.51
T11:T2+ $ZnSO_4$ soil application + $FeSO_4$0.2% foliar spray	6.68	7.41	7.05	0.113	0.20	0.16	0.47	0.49	0.48
T12 : T2 + $ZnSO_4$0.5% foliar spray+ $FeSO_4$0.2% foliar spray	6.67	7.47	7.07	0.113	0.16	0.14	0.52	0.44	0.50
SEm±	0.06	0.084	0.06	0.01	0.018	0.009	0.04	0.027	0.026
CD (0.05)	NS	NS	NS	NS	NS	0.03	NS	NS	NS
CV%	1.50	1.99	1.49	14.67	16.35	10.68	13.45	9.93	9.68
Initial values	6.68	7.67	7.17	0.12	0.22	0.17	0.46	0.48	0.47

Table 5: Soil available macronutrients and micronutrients as influenced by nutrient management practices

Treatment	AvailableN(kg/ha)			AvailableP_2O_5(kg/ha)			AvailableK_2O (kg/ha)			Available Zn (ppm)			Available Fe (ppm)		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
T1	216	192	204	62	40	51	166	273	219	1.69	0.75	1.22	9.60	16.42	13.01
T2	224	209	216	74	63	69	167	282	224	1.37	0.77	1.07	10.67	14.42	12.54
T3	178	167	172	62	55	59	156	273	215	3.11	0.67	1.89	11.30	17.51	14.40
T4	182	171	177	67	53	60	149	285	217	2.17	1.24	1.71	12.80	17.14	14.97
T5	203	192	197	59	50	55	142	276	209	1.78	1.18	1.48	13.13	14.06	13.59
T6	198	188	193	64	48	56	164	251	208	3.19	2.19	2.69	12.30	14.96	13.63
T7	219	209	214	63	57	60	166	300	233	2.62	1.55	2.08	14.23	15.33	14.78
T8	241	230	236	65	59	63	165	270	218	3.22	1.23	2.23	14.73	12.42	13.57
T9	250	243	247	71	55	63	183	264	224	2.89	1.13	2.01	13.50	15.14	14.32
T10	281	272	276	69	52	61	168	345	257	1.49	1.18	1.34	17.17	16.42	16.79
T11	279	268	274	71	65	68	208	364	286	3.47	3.17	3.32	12.60	19.51	16.05
T12	284	276	280	73	72	73	211	347	279	3.05	1.44	2.24	15.57	19.69	17.63
SEm±	19.01	13.15	15.20	5.08	3.31	3.08	14.67	14.23	9.48	0.21	0.142	0.130	1.23	0.82	0.653
CD (0.05)	55.74	38.58	44.58	NS	9.70	9.06	43.01	41.73	27.81	0.62	0.42	0.38	3.61	2.43	1.92
CV%	14.33	10.45	11.76	13.13	10.26	8.71	14.88	8.39	7.07	14.52	17.95	11.68	16.25	8.92	7.75
Initial values	226	238	232	64	52	58	177	321	249	1.46	1.27	1.37	10.32	12.43	11.38

Table 6: Plant macronutrient and micronutrientuptakeas influenced by nutrient management practices

Treatment	N uptake(kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)			Zn uptake (gm/ha)			Fe uptake(gm/ha)		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
T1	58.3	58.7	58.5	11.0	14.7	12.8	41.7	46.1	44.0	91.4	129.7	110.6	428.5	910.5	669.5
T2	82.9	80.0	81.5	20.3	22.1	21.2	58.1	65.2	61.7	137.3	179.1	158.2	690.1	1109.7	899.9
T3	57.8	67.2	62.5	10.1	13.9	12.0	39.9	54.1	46.8	101.7	218.9	160.3	542.3	968.6	755.4
T4	61.8	63.7	62.7	12.7	15.4	14.1	36.7	54.6	45.5	128.1	254.2	191.2	601.9	1003.2	802.5
T5	65.9	66.5	66.2	15.4	15.8	15.6	54.2	54.5	54.3	108.9	104.8	106.8	1040.4	1261.1	1150.7
T6	59.4	72.8	66.1	8.9	13.1	11.0	44.2	57.7	50.8	116.4	212.2	164.3	924.3	1466.4	1195.3
T7	63.9	82.4	73.1	15.4	19.1	17.3	53.6	66.1	59.9	115.6	282.2	198.9	913.7	1421.4	1167.6
T8	72.7	74.9	73.8	18.2	21.4	19.8	51.2	65.1	58.1	131.1	268.7	199.9	649.3	1165.6	907.5
T9	75.2	78.6	76.9	19.7	18.6	19.1	66.6	62.4	64.3	162.3	341.9	252.1	727.1	1185.1	956.1
T10	86.5	80.9	83.7	21.1	22.7	21.9	70.3	73.8	72.1	114.4	154.5	134.5	1187.2	1901.2	1544.2
T11	78.1	94.1	86.1	21.9	26.5	24.2	67.3	80.4	73.9	141.0	250.9	195.9	1135.2	1468.1	1301.7
T12	90.9	100.4	95.6	22.9	28.6	25.8	73.6	90.0	81.9	181.9	379.4	280.7	1163.6	2133.2	1648.4
SEm±	4.69	4.22	2.82	2.42	1.17	1.527	5.42	4.66	3.74	14.69	13.31	8.69	75.9	86.3	57.6
CD (0.05)	13.7	12.40	8.28	7.10	3.44	4.48	15.90	13.69	10.97	43.09	39.06	26.08	222.6	253.33	172.8
CV%	11.4	9.55	6.62	15.48	10.51	14.97	17.13	12.60	10.90	19.96	9.97	12.56	15.78	11.23	12.45

Table 7: Grain quality parameters of finger millet as influenced by nutrient management Practices

Treatments Treatment	N content (%)			Protein Content (%)			Zn Content (ppm)			Fe Content (ppm)		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
T1	1.20	1.14	1.17	7.53	7.12	7.32	24.5	17.02	20.8	123.8	105.5	114.6
T2	1.32	1.29	1.30	8.23	8.05	8.14	26.7	22.10	24.4	118.2	107.5	112.8
T3	1.08	1.04	1.06	6.77	6.48	6.62	29.4	22.30	25.8	107.4	100.0	103.7
T4	1.04	0.99	1.01	6.48	6.18	6.33	28.7	30.85	29.8	112.8	109.3	111.0
T5	1.03	0.99	1.01	6.42	6.18	6.30	25.8	15.30	20.6	164.7	140.6	152.7
T6	1.00	0.93	0.97	6.24	5.83	6.04	33.2	24.50	28.8	161.1	147.3	154.2
T7	1.18	1.13	1.15	7.35	7.06	7.20	34.0	27.40	30.7	158.9	145.6	152.3
T8	1.00	1.00	1.00	6.24	6.24	6.24	27.4	26.95	27.2	128.1	107.5	117.8
T9	1.05	1.19	1.12	6.59	7.47	7.03	34.1	36.75	35.4	137.7	121.1	129.4
T10	1.22	0.84	1.03	7.64	5.25	6.45	24.8	16.77	20.8	172.8	159.9	166.4
T11	1.18	1.26	1.22	7.35	7.88	7.61	30.7	25.60	28.1	154.5	129.1	141.8
T12	1.37	1.42	1.40	8.58	8.87	8.72	34.8	33.80	34.3	178.2	168.1	173.2
SEm±	0.107	0.089	0.09	0.67	0.56	0.563	1.29	1.39	0.934	9.87	4.56	5.398
CD (0.05)	0.31	0.26	NS	1.69	1.64	NS	3.79	4.10	2.74	28.95	13.40	15.82
CV%	16.29	14.08	13.94	16.3	14.08	13.94	8.59	9.72	5.94	11.94	6.16	6.88

Conclusion

Keeping in close view of the above options the following broar conclusion could that, for realizing higher and economic production with good quality grain, the finger millet pre released variety VR- 900 has to be supplied with 90 N + 60 P_2O_5 + 45 K_2O kg/ha along with Zinc either as soil application or foliar application along with Iron (0.2% foliar spray).

References

1. Andreini Bertini I, Rosato A. Metalloproteomes: a bioinformatic approach. Accounts of Chemical Research. 2009; 42:1471-1479.
2. Bhumika Tripathi, Kalpana Patel. Finger millet flour as a vehicle for fortification with Zinc. Journal of Trace Elements in Medicine and Biology. 2010; 24(1):46-51.

3. Cakmak I. Enrichment of cereal grains with Zinc Agronomic or genetic bio fortification. Plant and Soil. 2008; 302(1-2):1-17.
4. Chakraborty T, Roy DK, Sounda G. Effect of fertilizer, rock phosphate and *Azospirillium* on growth and yield of finger millet (*Eleusinecorocana* L. Gaertn). Indian Journal of Agricultural Research. 2002; 36(3):192-195.
5. Chaturvedi R, Srivastava S. Genotype variations in physical, nutritional and sensory quality of popped grains of amber and dark genotype of finger millet. Journal of Food Science Technology. 2008; 45(5):443-446.
6. Chavan AP, Chavan SA, Khanvilkar SA. Response of finger millet to nitrogen, methods of fertilizer application and age of seedlings at transplanting. Journal of Maharashtra Agricultural University. 1995; 20(3):466 - 467.
7. Dubey OP, Shrivas DN. Response of finger millet (*Eleusine coracana*) genotypes to nitrogen. Indian Journal of Agronomy. 1999; 44(3):564-566.
8. GiriBabu B, Martin Luther M, Chandra Sekhar K, Sankara Rao V. Effect of nutrient management system on productivity of finger millet (*Eleusine coracana* (L.)Gaertn.) Cultivars under sandy soils. The Andhra Agricultural Journal. 2010; 57(1):4-6.
9. Gopalan C, Ramasastri BV, Balasubramanian SC. Nutritive value of Indian Foods. National Institute of Nutrition (NIN). Indian Council of Medical Research, Hyderabad. 2004, 59-67.
10. Gupta N, Gupta AK, Gaur VS, Kumar A. Relationship of nitrogen use efficiency with the activities of enzymes involved in nitrogen uptake and assimilation of finger millet genotypes grown under different nitrogen inputs. Scientific World Journal. 2012, 1-10.
11. Hemalatha S, Chellamuthu S. Impacts of long term fertilization on soil nutritional quality under finger millet: Maize cropping sequence. Journal of Environmental Research Development. 2013; 7:1571-1576.
12. Kang RK, Jain R, Mridula D. Impact of indigenous fiber rich premix supplementation on blood glucose levels in diabetics. American Journal of Food Technology. 2008; 3(1):50-55.
13. Lakshmi KP, Sumathi S. Effect of consumption of finger millet on hyperglycemia in non-insulin dependent diabetes mellitus (NIDDM) subject. Food and Nutrition Bulletin. 2002; 23(3):241-245.
14. Mani AK. Effect of organic and inorganic fertilizer N on the yield of rainfed *ragi*. Madras Agricultural Journal. 1991; 78(5-8):210-212.
15. Majumder TK, Premavalli KS, Bawa AS. Effect of puffing on calcium and iron contents of ragi varieties and their utilization. J. Food Sci. Technol. 2006; 42(5):542-545.
16. Pilane MS, Salve RB, Pawar VS, Bhoi PG. Response of finger millet (*Eleusinecoracana*) varieties to nitrogen and phosphorus. Indian Journal of Agronomy. 1997; 42(4):637-640.
17. Ramachandrappa BK, Sathish A, Dhanapal GN, Babu PN. Nutrient management strategies for enhancing productivity of dryland crops in Alfisols. Indian Journal of Dryland Agricutural Research Development. 2014; 29:49-55.
18. Rangaraj T, Somasundaram E, Amanullah MM, Thirumurugan V, Ramesh S, Ravi S. Effect of agro-industrial wastes on soil properties and yield of irrigated finger millet (*Eleusine coracana* L. Gaertn) in coastal soil. *Research* Journal of Agricultural and Biological Sciences. 2007; 3:153-156.
19. Rao BKR, Krishnappa K, Srinivasarao C, Wani SP, Sahrawat KL, Pardhasaradhi G. Alleviation of multinutrient deficiency for productivity enhancement of rain-fed soybean and finger millet in the semi-arid region of India. Commuicationon Soil Science and Plant Analysis. 2012; 43:1427-1435.
20. Rurinda J, Mapfumo P, van Wijk MT, Mtambanengwe F, Rufino MC, Chikowo R *et al*. Comparative assessment of maize, finger millet and sorghum for household food security in the face of increasing climatic risk. European Journal of Agronomy. 2014; 55:29-41.
21. Sankar GRM, Sharma KL, Dhanapal GN, Shankar MA, Mishra PK, Venkateswarlu B *et al*. Influence of soil and fertilizer nutrients on sustainability of rainfed finger millet yield and soil fertility in semi-arid Alfisols. Communictaion on Soil Science and Plant Analysis. 2011; 42:1462-1483.
22. Sangita K, Sarita S. Nutritive value of malted flours of finger millet genotypes and their use inthe preparation of burfi. J Food Sci. Technol. 2000; 37(4):419-122.
23. Singh VP. Effect of organic and inorganic source of nutrients on finger millet (*Eleusine coracana*) under rainfed low hill situation. Indian Journal of Agronomy. 1999; 44(4):567-570.
24. Srinivasarao C, Wani SP, Sahrawat KL, Rego TJ, Pardhasaradhi G. Zinc, boron and sulphur deficiencies are holding back the potential of rainfed crops in semi-arid India: Experiences from participatory watershed management. International Journal of Plant Production. 2008; 2:89-99.
25. Sudhakara Rao R, Subramanian S, Palaniappan SP. Effect of moisture regimes and nitrogen on NPK uptake and yield of finger millet. Madras Agricultural Journal. 1991; 78(9-12):388 - 391.
26. Sunitha N, Ravi V, Reddappa Reddy. Nitrogen economy in finger millet through conjunctive use of organic manures and bio-fertilizers. Indian Journal of Agronomy. 2006; 21(2):96-98.
27. Tenywa JS, Nyende P, Kidoido M, Kasenge V, Oryokot J, Mbowa S. Prospects and constraints of finger millet production in Eastern Uganda. African Crop Science Journal. 1999; 7:569-583.
28. Tetarwal JP, Rana KS. Impact of cropping system, fertility level and moisture-conservation practice on productivity, nutrient uptake, water use and profitability of pearl millet (*Pennisetum glaucum*) under rainfed conditions. Indian Journal of Agronomy. 2006; 51(4):263-266.
29. Wadikar DD, Premvalli RS, Satyanarayanswamy YS, Bawa AS. Lipid profile in finger millet. Journal of Food Science Technology. 2007; 44(1):79-81.