I.J.S.N., VOL.9 (2) 2018: 201-205 ISSN 2229 – 6441

INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

EFFECT OF DIFFERENT FERTILIZER LEVELS ON NUTRIENT UPTAKE AND YIELD OF LITTLE MILLET (*Panicum sumatrense* Roth ex Roem. & Schult.)

Divyashree, U., Dinesh Kumar, M. and Ganapathi
Department of Agronomy, College of Agriculture, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India
*Corresponding author email: dinumallige@gmail.com

ABSTRACT
A field experiment was conducted during 2016 at Agronomy field unit, UAHS, Shivamogga. The experiment was laid out in a randomized complete block design with twelve treatments having three replications. The treatments comprised of combinations of three levels of nitrogen (10, 20 and 30 kg N ha^{-1}), two levels of phosphorus (10 and 20 kg P ha^{-1}) and two levels of potassium (0 and 10 kg K ha^{-1}). Among the different combinations of NPK fertilizers tested, application of 30 kg N and 20 kg P_2O_5 with or without 10 kg K_2O performed better for achieving good growth and uptake of major nutrients compared to its lower levels of fertilizers. The uptake was higher for nitrogen followed by potassium with least for phosphorus. In that, application of 30:20:10 kg NPK ha^{-1}retained higher content of major nutrients at any time of growth stage achieving maximum uptake of Nitrogen (35.48 kg ha^{-1}), Phosphorus (13.23 kg ha^{-1}) and Potassium (25.01 kg ha^{-1}) helped to obtain higher grain (1580 kg ha^{-1}), straw (1603 kg ha^{-1}) and protein (135.08 kg ha^{-1}) yield thereby remained best among the tested treatments. Partial factor productivity of nitrogen was non-linear while that of phosphorus and potassium was found maximum in treatments 30:10:10 kg NPK ha^{-1} (93.75 kg kg^{-1}) and 30:20:00 kg NPK ha^{-1}(112.59 kg kg^{-1}).

KEY WORDS: Fertilizer, millet, nutrient, protein, uptake.

INTRODUCTION

Little millet (*Panicum sumatrense* Roth ex Roem & Schult) is widely cultivated cereal across India, Nepal and Western Burma, grown up to an altitude of 2100 m MSL. Like other millets, it is also a reliable fast-grower with early maturity and resistant to adverse agro-climatic conditions. It is particularly important in the Eastern Ghat region of India, where it forms a major food of tribal agriculture (de Wet *et al*., 1984). Interestingly, it occurs as wild plant in north India and South Eastern Asia (Purseglove, 1985). In our country, the cultivation of little millet is mainly confined to Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Orissa, Bihar, Madhya Pradesh and Uttar Pradesh. In India, small millets cover an area of 818.5 thousand hectares with production of 729.6 thousand tonnes (Anon, 2012). Considering health consciousness and importance of nature's nutraceutical value, demand for these group of crops are ever increasing. To harness the ethical value of the people and to meet the demand, scientific advancements and technologies are essential and need of the hour. The soil heath ailments need proper and judicious management of applied resources. Nutrients as the basic input to soil paid its dividends for enhancing yield levels thereby showing its major role and continue to do so in future also for enhancing crop yield. Its timely availability is very crucial for crop production. Fertilizers need to be used rationally in order to avoid a negative ecological impact and undesirable effects on sustainability of crop production. Hence, nutrient management is a key issue in not only achieving higher biomass through its content and uptake in any plants but also for maintaining soil fertility thereby sustainability. Nitrogen is one of the most expensive essential nutrients to supply for any crops and judicious supply is a key factor in enhancing use efficiency with minimal environmental impact. Phosphorus is an essential macro-element, required for metabolic processes such as photosynthesis, energy transfer, synthesis and breakdown of carbohydrates. Potassium playing a major role in imparting drought resistance an disease resistance, it is very essential for the crop plants.

In this context, plant nutrients need to be supplied in balanced proportion and adequate quantity envisaging the fertilizer prescriptions need to be based on soil and location specific rather than state or regional recommendations. Also, management approaches substantially influence the soil processes and nutrient dynamics. The potentiality of little millet has not been exploited in India under ideal conditions of normal rainfall situations. Agronomic practices for this crop needs standardization for different eco-systems or locations to exploit its yield maxima. Hence, in the present study, different levels of nitrogen, phosphorus and potassium are evaluated under transitional tract conditions for achieving better nutrient uptake and yields.

MATERIALS & METHODS

The study was conducted during *kharif* season of 2016 at College of Agriculture, Shivamogga (14º0'N to 14º1'N Lat and 75º40'E to 75º42'E Long) situated in southern transition zone of Karnataka. The soil of the experimental site is sandy loam with shallow depth, acidic in reaction (pH – 5.93), contains very low salt (0.29 dS m^{-1}), medium organic content (0.42 %), poor in available nitrogen

(152.80 kg ha^{-1}), rich in available phosphorus (58.45 kg ha^{-1}) and medium (232.65 kg ha^{-1}) with respect to available potassium status. The test variety was Hiriyur Local. The crop was sown during July 2nd fortnight and spaced at 30x10 cm. The experiment was laid out in Randomized Block Design with three replications. Three levels of nitrogen (10, 20 and 30 kg ha^{-1}), two levels of phosphorus (10 and 20 kg ha^{-1}) and two levels of potassium (0 and 10 kg ha^{-1}) formed 12 different treatment combinations such as T_1-10:10:0, T_2-10:10:10, T_3-10:20:0, T_4-10:20:10, T_5-20:10:0, T_6-20:10:10, T_7-20:20:0 (Recd. dose of nutrients), T_8-20:20:10, T_9-30:10:0, T_{10}-30:10:10, T_{11}-30:20:0, T_{12}-30:20:10. Nitrogen (N), Phosphorus (P) and Potassium (K) were applied in the form of urea, single super phosphate and muriate of potash respectively. A common dose of farm yard manure @ 10 t ha^{-1}was applied uniformly to all plots. Fertilizers were applied as basal at the time of sowing. Apart from the treatments, the crop was managed according to package of practices. Standard methods were adopted for analysis of major nutrients in soil and plant.

For available nitrogen, procedure of alkaline permanganate method from Subbaiah and Asija (1956) was employed. Available phosphorus was extracted using Brays extractant and the concentration of phosphorus present in the extract was determined by stannous chloride reduced molybdo phosphoric blue colour method in HCl system (Jackson, 1973). Potassium was extracted by shaking the requisite amount of soil sample with 1 N NH_4OAc solution as outlined by Jackson (1973). Plant samples were dried in an electric oven at 70ºC for 48 hours and powdered for further analysis. Total nitrogen was determined by using kjeldahl's method, phosphorus was measured by atomic absorption spectrophotometer. Potassium content of the plant was estimated using flame photometer.

Uptake of nutrient, partial factor productivity and protein yield were calculated as follows.

Uptake (%) = {Nutrient content (%) X Dry weight (g palnt^{-1})}/100

Partial factor productivity = (Yield/Nutrient applied) X 100

Protein yield (kg ha^{-1}) = Protein content X yield (kg ha^{-1})

RESULTS & DISCUSSION

Nutrient uptake and retentivity is a common physiological activity noticed along with the crop growth and largely helped by nutrient availability in the soil system at the time of plants need. More growth is always accomplished with more uptake and retentivity of various nutrients. Hence, yield maximization on the other hand includes all the processes associated with uptake of nutrients, translocation, partitioning, assimilation and mobilization of nutrients at different growth stages of crop. In the present study, all the major nutrient contents influenced by applied treatments significantly. These nutrients in the plants retained more at early stages of growth due to greater cell division and accumulation of protein at primordial stages then decreased due to increased dry weight, partitioning and less absorption due to decreased root activity. In both grain and straw the content of nitrogen was found more followed by potassium and the phosphorus content was least. At harvest, in straw the nitrogen content varied from 0.67 to 0.87%, phosphorus content varied from 0.19 to 0.26 % and potassium content from 0.39 to 0.86 %. Highest NPK application of 30:20:10 kg NPK ha^{-1}, retained higher content of these nutrients at any time of growth stage. The result corroborates the findings of Apoorva *et al.* (2010), Veeranagappa *et al.* (2010) and Anil Kumar (2000).The grains the ultimate sink and has the biological value. The nitrogen content in the grains found highest as the valued varied from 1.21 to 1.36% for different treatments and distinctly different proportions of NPK fertilizer levels influenced to retain higher nitrogen content. The phosphorus and potassium content in grains found to be almost half of the nitrogen content as phosphorus varied from 0.50 to 0.56% and potassium varied from 0.37 to 0.71% due to applied treatments. The results support the findings of Sathiyabama *et al.* (2003) and Mariaselvam *et al.* (2014).

As a part of inorganic constituent in plant system, nutrients accomplish the growth enhancement. Hence, biomass and nutrient uptake are synergistic in bringing the crop for healthy production. Different treatments influenced the uptake of nitrogen, phosphorus and potassium significantly. Data permit to infer that grains retained more nitrogen (11.86 to 21.54 kg ha^{-1} by different treatments) and phosphorus (4.92 to 8.90 kg ha^{-1}) as compared to straw while potassium in straw was found more (4.15 to 13.82 kg ha^{-1}). Different levels of NPK influenced positively for uptake of all the major nutrients, where in lowest and highest levels successively resulted in retention of low and high uptake of nitrogen, phosphorus and potassium respectively. As a result the trend remained same for total uptake also. A maximum of 35.48 kg nitrogen ha^{-1}, 13.23 kg phosphorus ha^{-1} and 25.01 kg potassium ha^{-1} was found in the treatment of 30:20:10 kg NPK ha^{-1} application. Increased uptake of nutrients in plant system is a consequence of availability of nutrients, decomposition of organic matter applied resulting in mineralization of insoluble phosphate into more soluble phosphates and solubilising the native, fixed or non exchangeable form of potassium into soil solution. The results corroborate the findings of Roy *et al.* (2001), Basavarajappa *et al.* (2002) and Venugopal *et al.* (2005).

This trend setting response on nutrient uptake reflects on achieving differences in yield (Table 3). Application of lower level of NPK fertilizers i.e. 10:10:00 or 10:10:10 kg NPK ha^{-1} recorded lower growth, contents and uptake of nutrients resulting lower grain yield of 980 and 1060 kg ha^{-1} (Table 2). Further progressively increase in levels of NPK application helped to enhance growth, accordingly the contents and uptake. Recommended dose of fertilizer with 20:20:00 kg NPK ha^{-1} application resulted to obtain moderate yield of 1390 kg ha^{-1}andfurther increase in the NPK levels achieved maximum growth and uptake of nutrients as explained earlier to end up with increased yield. It is seen from the table that highest fertilizers application *i.e.* 30 and 20 kg N and P with 10 kg K ha^{-1} performed better with higher grain and straw yield of 1580and 1603 kg ha^{-1}, respectively, mainly due to even supply of nutrients coinciding higher growth than rest of the treatments under test. Further, computation of protein content and yield based on nitrogen content of grain was also more in the same treatment (131.05 kg ha^{-1}) compared to other treatments in test. These findings are in line with the reports of Nigade *et al.* (2011) and Shivakumar (1999). Based on these yield response, highest partial factor productivity of nitrogen was recorded in the treatment applied with 10:20:10 kg NPK ha^{-1} (53.19 kg kg^{-1}) and further decreased at higher levels indicating non linear response. However, partial factor productivity of phosphorus and potassium was found maximum in 30:10:10 kg NPK ha^{-1} (93.75 kg kg^{-1}) and 30:20:00 kg NPK ha^{-1}(112.59 kg kg^{-1}) respectively might be due to low application doses. Application of nutrients paves way for the better uptake of nutrients and ultimately results in higher yield.

TABLE 1: Effect of different levels of fertilizers on grain yield, straw yield, protein content and protein yield of little millet

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
T_1: 10 : 10 : 00 kg NPK ha^{-1}	980	1077	7.57	74.37
T_2: 10 : 10 : 10 kg NPK ha^{-1}	1060	1141	7.72	81.81
T_3: 10 : 20 : 00 kg NPK ha^{-1}	1140	1192	7.77	88.55
T_4: 10 : 20 : 10 kg NPK ha^{-1}	1250	1282	7.86	98.31
T_5: 20 : 10 : 00 kg NPK ha^{-1}	1360	1397	7.96	108.21
T_6: 20 : 10 : 10 kg NPK ha^{-1}	1290	1333	8.05	103.50
T_7: 20 : 20 : 00 kg NPK ha^{-1}	1390	1423	8.15	113.35
T_8: 20 : 20 : 10 kg NPK ha^{-1}	1440	1474	8.24	118.65
T_9: 30 : 10 : 00 kg NPK ha^{-1}	1470	1526	8.34	122.64
T_{10}: 30 : 10 : 10 kg NPK ha^{-1}	1500	1538	8.39	125.91
T_{11}: 30 : 20 : 00 kg NPK ha^{-1}	1520	1564	8.44	128.36
T_{12}: 30 : 20 : 10 kg NPK ha^{-1}	1580	1603	8.52	135.01
S.Em±	53	104	0.19	4.95
CD (P=0.05)	155	304	0.56	14.52

TABLE 2: Major nutrient content (%) in grains and straw at harvest of little millet as influenced by different levels of fertilizers

	Grains			Straw		
Treatments	N	P	K	N	P	K
T_1: 10 : 10 : 00 kg NPK ha^{-1}	1.21	0.50	0.37	0.67	0.19	0.39
T_2: 10 : 10 : 10 kg NPK ha^{-1}	1.24	0.51	0.57	0.68	0.19	0.68
T_3: 10 : 20 : 00 kg NPK ha^{-1}	1.24	0.54	0.39	0.70	0.24	0.42
T_4: 10 : 20 : 10 kg NPK ha^{-1}	1.26	0.56	0.60	0.70	0.24	0.74
T_5: 20 : 10 : 00 kg NPK ha^{-1}	1.27	0.50	0.40	0.77	0.19	0.45
T_6: 20 : 10 : 10 kg NPK ha^{-1}	1.29	0.51	0.64	0.78	0.21	0.78
T_7: 20 : 20 : 00 kg NPK ha^{-1}	1.30	0.55	0.42	0.78	0.25	0.50
T_8: 20 : 20 : 10 kg NPK ha^{-1}	1.32	0.56	0.65	0.79	0.25	0.82
T_9: 30 : 10 : 00 kg NPK ha^{-1}	1.33	0.51	0.44	0.83	0.22	0.53
T_{10}: 30 : 10 : 10 kg NPK ha^{-1}	1.34	0.52	0.69	0.85	0.22	0.84
T_{11}: 30 : 20 : 00 kg NPK ha^{-1}	1.35	0.56	0.47	0.86	0.26	0.57
T_{12}: 30 : 20 : 10 kg NPK ha^{-1}	1.36	0.56	0.71	0.87	0.27	0.86
S.Em±	0.03	0.02	0.03	0.02	0.01	0.03
CD (P=0.05)	0.09	0.05	0.10	0.07	0.02	0.08

A comparison was made between initial soil content of major nutrients to that of harvest. Compared to initial contents, phosphorus and potassium contents decreased while nitrogen content also showed the similarity except in four treatments wherein marginal increase was observed. The integrated application of farm yard manure with NPK fertilizers achieves high degree of synchrony between nutrient release and plant demand thereby enhanced available nutrient status being utilized by crop growth effectively. The dissolution of native phosphorus compounds due to presence of farm yard manure compiled within organic nitrogen and phosphorus presence made synergistic effect, paved way for retention of higher phosphorus in the soil. The uptake pattern, lesser availability, fixation might be the reasons for lower levels of potassium. The results are in line with the findings of Chesti *et al.* (2013), Gajanana*et al.* (2000), Prakash (2010) and Virupakshi (1988). On the basis of present investigation, it is concluded that, nitrogen @ 30 kg ha^{-1}, phosphorus @ 20 kg ha^{-1} and potassium @ 10 kg ha^{-1} recorded highest grain yield and can be practiced for transitional tract of Karnataka.

TABLE 3: Effect of different levels of fertilizers on the NPK uptake by little millet at harvest

Treatments	Nitrogen uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Potassium uptake (kg ha^{-1})		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_1: 10 : 10 : 00 kg NPK ha^{-1}	11.86	7.18	19.04	4.92	2.03	6.95	3.66	4.15	7.81
T_2: 10 : 10 : 10 kg NPK ha^{-1}	13.10	7.77	20.87	5.39	2.21	7.60	6.04	7.78	13.82
T_3: 10 : 20 : 00 kg NPK ha^{-1}	14.17	8.30	22.47	6.19	2.84	9.03	4.48	4.99	9.47
T_4: 10 : 20 : 10 kg NPK ha^{-1}	15.72	9.00	24.72	6.96	3.12	10.08	7.50	9.42	16.92
T_5: 20 : 10 : 00 kg NPK ha^{-1}	17.32	10.69	28.01	6.80	2.70	9.50	5.49	6.29	11.78
T_6: 20 : 10 : 10 kg NPK ha^{-1}	17.45	10.79	28.24	6.56	2.76	9.32	8.24	10.33	18.57
T_7: 20 : 20 : 00 kg NPK ha^{-1}	18.13	11.11	29.24	7.67	3.48	11.15	5.84	7.14	12.98
T_8: 20 : 20 : 10 kg NPK ha^{-1}	18.98	11.70	30.68	8.07	3.74	11.80	9.34	12.14	21.47
T_9: 30 : 10 : 00 kg NPK ha^{-1}	19.62	12.64	32.26	7.50	3.30	10.80	6.47	8.11	14.58
T_{10}: 30 : 10 : 10 kg NPK ha^{-1}	20.15	13.03	33.18	7.75	3.41	11.16	10.33	12.95	23.27
T_{11}: 30 : 20 : 00 kg NPK ha^{-1}	20.53	13.42	33.95	8.46	4.07	12.53	7.13	8.86	15.99
T_{12}: 30 : 20 : 10 kg NPK ha^{-1}	21.54	13.94	35.48	8.90	4.33	13.23	11.19	13.82	25.01
S.Em±	0.47	0.36	0.63	0.19	0.10	0.22	0.37	0.33	0.42
CD (P=0.05)	1.37	1.06	1.84	0.56	0.29	0.64	1.09	0.98	1.24

TABLE 4: Partial factor productivity of different nutrients as influenced by different levels of fertilizers

Treatments	Partial factor productivity (kg kg^{-1})		
	Nitrogen	Phosphorus	Potassium
T_1: 10 : 10 : 00 kg NPK ha^{-1}	41.70	61.25	72.59
T_2: 10 : 10 : 10 kg NPK ha^{-1}	45.11	66.25	45.11
T_3: 10 : 20 : 00 kg NPK ha^{-1}	48.51	43.85	84.44
T_4: 10 : 20 : 10 kg NPK ha^{-1}	53.19	48.08	53.19
T_5: 20 : 10 : 00 kg NPK ha^{-1}	40.60	85.00	100.74
T_6: 20 : 10 : 10 kg NPK ha^{-1}	38.51	80.63	54.89
T_7: 20 : 20 : 00 kg NPK ha^{-1}	41.49	53.46	102.96
T_8: 20 : 20 : 10 kg NPK ha^{-1}	42.99	55.38	61.28
T_9: 30 : 10 : 00 kg NPK ha^{-1}	33.79	91.88	108.89
T_{10}: 30 : 10 : 10 kg NPK ha^{-1}	34.48	93.75	63.83
T_{11}: 30 : 20 : 00 kg NPK ha^{-1}	34.94	58.46	112.59
T_{12}: 30 : 20 : 10 kg NPK ha^{-1}	36.32	60.77	67.23

TABLE 5: Available form of major nutrients at harvest as influenced by different levels of fertilizers

Treatments	Available form of major nutrients (kgha^{-1})		
	Nitrogen	Phosphorus	Potassium
T_1: 10 : 10 : 00 kg NPK ha^{-1}	126.56	49.88	191.16
T_2: 10 : 10 : 10 kg NPK ha^{-1}	128.67	50.60	206.75
T_3: 10 : 20 : 00 kg NPK ha^{-1}	129.45	53.19	192.38
T_4: 10 : 20 : 10 kg NPK ha^{-1}	132.00	53.70	208.77
T_5: 20 : 10 : 00 kg NPK ha^{-1}	140.11	51.35	194.09
T_6: 20 : 10 : 10 kg NPK ha^{-1}	141.33	51.69	209.80
T_7: 20 : 20 : 00 kg NPK ha^{-1}	143.43	55.08	197.17
T_8: 20 : 20 : 10 kg NPK ha^{-1}	145.54	56.28	212.54
T_9: 30 : 10 : 00 kg NPK ha^{-1}	156.87	52.33	200.32
T_{10}: 30 : 10 : 10 kg NPK ha^{-1}	158.20	52.61	216.72
T_{11}: 30 : 20 : 00 kg NPK ha^{-1}	160.42	56.80	202.11
T_{12}: 30 : 20 : 10 kg NPK ha^{-1}	163.19	57.92	219.43
S.Em±	4.72	1.61	5.98
CD (P=0.05)	13.84	4.73	17.54

Initial status: Nitrogen : 152.80 kg ha^{-1} Phosphorus: 58.45 kg ha^{-1} Potassium: 232.65 kg ha^{-1}

REFERENCES

Anil Kumar, B.H. (2000) Integrated use of organic and inorganic manures on growth and yield of finger millet [*Eleusine coracana* (L.) Gaertn.] under rain fed conditions. *M.Sc.(Agri) thesis*, Univ. Agric. Sci., Bangalore, Karnataka (India). p. 71

Anonymous, (2012) Annl. Rep. (2011-12), All India Coordinated Research Projectfor Dryland Agriculture, Univ. Agric. Sci., Bengaluru, p. 41-49.

Anonymous, (2012) Annl. Rep. (2011-12), AICRIP on millets, Bangalore, p. 37-39.

Apoorva K.B., Prakash, S.S., Rajesh, N.L. and Nandini, B. (2010) STCR approach for optimizing integrated plant nutrient supply on growth, yield and economics of finger millet (*Eleusine coracana*). *EJBS.*, **4(1)**: 19-27.

Basavarajappa, R., Prabhakar, A.S. & Halikatti, S.I., (2002) Effect of tillage, organics, nitrogen and their interactions on yield attributes and yield of foxtail millet (*Setaria italica*) under shallow alfisol during rainy season. *Indian J. Agron.*, **47(3)**:390-397.

Chesti, M.H., Kohli, A. & Sharma, A.K., (2013) Effect of integrated nutrient management on yield of and nutrient uptake by wheat and soil properties under intermediate zone of Jammu and Kashmir. *J. Indian Soc. Soil Sci.*, **61(1)**:1-6.

De Wet, J.M.J., Prasadaroa, K.E., Brink, D.E. & Mengesha, M.H. (1984) Systematics and evolution of *Eleusine coracana*. *American J. Botany.*,**71**:550-557.

Gajanana, G.N., Shankar, M.A., Somashekar, K. & Krishnappa, A.M. (2000) Importance of plant nutrient management in dry land agriculture, Bulletin, All India Coordinated Research Project on Dryland agriculture, Univ. Agric. Sci., Bangalore, Karnataka (India) p.33-36.

Jackson, M.L., (1973) *Soil chemical analysis.* Prentice hall India Pvt. Ltd., New Delhi, p. 498.

Mariaselvam, A.A., Dandeniyai, W.S., Indraratne, S.P. and Dharmakeerthi, R.S. (2014) High C:N materials mixed with cattle manure as organic amendments to improve soil productivity and nutrient availability. *Tropical Agricultural Res.*, **25(2)**:201-213.

Nigade, R.D., Jadhav, B.S. and Bhosale, A.S. (2011) Response of long duration finger millet (*Eleusine coracana* L.) variety to different levels of nitrogen under rainfed condition. *Int. J. Agric. Sci*., **7(1)**:152-155.

Prakash, H.C., Sunitha, B.P. And Gurumurthy, K.T. (2010) Effect of INM approaches on productivity and economics of rice cultivation (*Oryza sativa*) in Bhadra command area, Karnataka in relation to soil properties. *Mysore J. Agric. Sci.,* **44(4)**:786-792.

Purseglove, J.W., (1985) *Tropical crops.* Monocotyledons, London.

Roy, D.K., Chakraborty, T., Sound, G. And Maitra, S. (2001) Effect of fertility levels and plant population on yield and uptake of nitrogen, phosphorus and potassium infinger millet of West Bengal. Indian *J. Agron.*,**46 (4)**:707-711.

Sathiya Bama, K.G., Selvakumari, R., Santhi and Singaram, P. (2003) Effect of humic acid on nutrient release pattern in an *Alfisol* (*Typic Haplustalf*). *Madras Agric. J.,* **90(10-12)**:665-670.

Shivakumar (1999) Effect of farm yard manure, urban compost and NPK fertilizers on growth and yield of finger millet, *M.Sc. (Agri.) thesis*. Univ. Agric. Sci., Bangalore, Karnataka (India). P. 97.

Subbaiah, B.V. and Asija, C.L. (1956) A rapid procedure for the estimation of available nitrogen in soils. *Curr. Sci.,* **25**:259-260.

Veeranagappa, P., Prakasha, H.C., Basavaraja, M.K. and Mohamed Saqeebulla, H. (2010) Effect of zinc enriched compost on yield and nutrient uptake of rice. *EJBS.*, **3(1)**:23-29.

Venugopal, N.V., Shankar, M.A., Gajanana, G.N. and Ganapathi (2005) Low till farming strategies and integrated plant nutrient supply for rain fed semi arid tropics. *Annual progress report on dry land agriculture.* pp: 65-67.

Virupakshi, B.E. (1988) Available micronutrients and Yield of finger millet (*Eleusine Coracana* (L.) Gaertn.) in alfisols of Bangalore as influenced by intensive manure and cropping sequence, *M.Sc.(Agri.) thesis*, Submitted to Univ. Agric. Sci., Bangalore, Karnataka (India). p. 107.