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Effect of Inorganic Fertilizers on Leaf Mineral Content of Plantain (CV. Nendran) and on the Nutritional Status of Studied Soil

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Abstract— *Nendran is the popular variety grown commercially in different regions due to its wider adaptability and high degree of tolerance to drought in a perennial cropping system and is the leading commercial cultivar of Kerala. A field experiment was laid out in randomised block design with ten treatments and three replications consisting of nitrogen and potassium at different combinations to know their nutrient concentrations in banana leaves and soil at different growth periods viz., vegetative stage, flowering stage and harvesting stage. The treatment $N_{250}P_{80}K_{400}$ grams/plant was recorded significantly higher leaf nitrogen, phosphorus and potassium during 9th month of vegetative stage (3.36, 0.5 and 4.37% respectively), shooting (2.94, 0.45 and 3.39% respectively), fruiting (2.67, 0.41 and 2.4% respectively) and harvesting stages (2.35, 0.36 and 2.03% respectively) than other treatments. Treatment T_9 ($N_{250}P_{80}K_{400}$ grams/plant) recorded significantly highest leaf nitrogen, phosphorus and potassium (384.71, 39.67 and 999.70 kg/ha respectively) during vegetative stage (9th month), shooting (371.71, 28.69 and 1271.71 kg/ha respectively), fruiting (303.85, 24.25 and 1084.96 kg/ha respectively) and harvesting stage (249.35, 23.91 and 894.56 kg/ha respectively) than untreated plants T_{10}. The highest micro nutrients were noted in T_9 in all the stages and Nendran supplemented through inorganic fertilizers @ $N_{250}P_{80}K_{400}$ can be recommended as optimum dose for this region.*

***Keywords—* Banana, Plantain, Nendran, Nitrogen, Phosphorus, Potassium, Leaf.**

I. INTRODUCTION

India is second largest diversified country of indigenous banana in the world. Among different banana cultivars, Nendran is included under plantain types having an AAB genome constitution. Presently plantains are of less importance than banana in terms of world trade in the genus but in West and Central Africa about 70 million people are estimated to derive more than one quarter of their food energy requirement from plantains (Robinson, 1996). Nendran is the popular variety grown commercially in different regions due to its wider adaptability and high degree of tolerance to drought in a perennial cropping system and is the leading commercial cultivar of Kerala. It bears long fingers in a bunch.

Banana being a great lover of applied nutrients requires enormous amount of essential plant nutrients for its vigorous growth and much higher yield and biomass production. Therefore, the proper fertilizer application has to be resorted for obtaining highest yields. In general Nendran is also moderately vigorous. Higher and earlier yields were recorded when NPK nutrients were supplied entirely through inorganic form of fertilizers. Nitrogen, potash and phosphorus are the major nutrients required in bulk quantities and can either be supplied by fertile soils or by commercial fertilizers (Zake *et al.,* 2000). Inflorescence emergence is accelerated and the period until harvest was shortened, compared with plants receiving no adequate NPK nutrients. These fertilizers are energy intensive and costly effective and requires finding out the considerable amounts of these mineral nutrients to maintain yields. The present study was initiated to determine the elemental levels in leaves and soil at different maturity stages as availability and uptake of inorganic nutrients by plants influences the overall growth and yields.

II. MATERIALS AND METHODS

An investigation was carried out at Uttar Banga Krishi Viswavidyalaya, Pundibari, during the year 2010-2012 to understand the effect of inorganic fertilizers on elemental leaf and soil status of plantain under the Terai Zone of West Bengal. The climatic condition of terai zone is characterized by high rainfall (above 3000 mm annually), high humidity, moderate temperature, prolonged winter with high residual soil moisture. The experiment was laid out in randomised block design in which there were ten main plot treatments taking ten treatment combinations of NPK nutrients through inorganic and replicated thrice. Nine different treatment combinations of inorganic fertilizers (Urea + Single Super Phosphate + Muriate of Potash) having 150, 200 and 250 grams N/plant; 300, 350 and 400 grams K/plant and 80 grams P/plant, respectively were compared with control (i.e. No N and K applied). Thus, the treatment combinations were $N_{150}P_{80}K_{300}$ (T_1), $N_{200}P_{80}K_{300}$ (T_2), $N_{250}P_{80}K_{300}$ (T_3), $N_{150}P_{80}K_{350}$ (T_4), $N_{200}P_{80}K_{350}$ (T_5), $N_{250}P_{80}K_{350}$ (T_6), $N_{150}P_{80}K_{400}$ (T_7), $N_{200}P_{80}K_{400}$ (T_8), $N_{250}P_{80}K_{400}$ (T_9) and $N_{Zero}P_{80}K_{Zero}$ (T_{10}) gm/plant. The banana suckers having 2.5 kg average weight planted at 2m x 2m spacing along with FYM @ 10 kg per pits with full dose of phosphorus were applied for proper growth and development of the plants. After 45 days of transplanting top dressing was done with 1/3 of nitrogen. The 2nd top dressing was done with second one of N and half K_2O on 5th month of transplanting. Again the rest (third of N and rest half K_2O) on 8th month of transplanting. From each treatment, four plants were used for nutrient uptake studies. Fertilizers as soil application were taken to evaluate their effects on the nutrient concentration in leaves of Plantain cv. Nendran at different growth stages. All the fertilizers were applied in split doses except phosphorus. Leaf samples were selected from the third fully opened leaf from the apex, counting the top most fully emerged leaf as the first leaf (Murray, 1960) at different stages of growth i.e. vegetative (3rd, 6th and 9th months after planting), shooting, fruiting and harvesting stage. The middle portion of lamina was kept for analysis. The leaf sample was dried in oven at 65-70 °C for 72 hours. After drying, leaf samples were grounded and collected in packet and kept in desicator. The total nitrogen content was determined by the Modified kjeldhal method (Jackson, 1973), phosphorus content was estimated calorimetrically by vanado-molybdate yellow colour method (Jackson, 1973) and total potassium in plant samples was estimated by flame photometer as proposed by Jackson (1973). Soil samples were collected from each treatment at 0-25 cm soil depth for the estimation of available nitrogen, phosphorus and potassium with the help of a soil auger at shooting, fruiting and harvesting. Available N was determined by the method of alkaline $KMnO_4$ developed by Subbiah and Asija, 1956, available P content of the experimental soils was determined by extracting 2.5g of each soil with a mixture of 25ml of 0.03 M NH_4F and 0.025 M HCl for 5 minutes (Bray and Kurtz, 1945), followed by colorimetric measurement of P by spectrophotometer and for determination of available potassium the soil samples were treated with neutral normal ammonium acetate solution (pH-7.0) in 1:10 ratio, after one hour shaking, followed by filtration, the leachate was used for the determination of K^+ was measured by using a Flame photometer (Jackson, 1973). The statistical analysis was done by employing the Indostat (Version-7.1) software packages.

III. RESULTS AND DISCUSSION

Mineral content of plantain leaves

In the present study indicated that as showed in table 1, the leaf nitrogen content gets significantly changed among the treatments at different growth stages. At vegetative growth (3rd to 9th MAP) stage nitrogen content was the highest i.e. from 2.42 to 3.36% recorded in T_9. At shooting stage, the total N content was highest (2.94%) in the treatment $N_{250}P_{80}K_{400}$ followed by $N_{250}P_{80}K_{350}$ (2.86%). Treatment supplied with $N_{250}P_{80}K_{400}$ also recorded maximum (2.67 and 2.35%) at fruiting and harvesting stages. The leaf nitrogen content was increased at early development stages 6th and 9th MAP. During the shooting and harvesting stages the leaf nitrogen content was reduced might be due to the movement of nutrients to shooting and fruit development. This is in accordance with the findings of (Ramaswamy and Muthukrishnana, 1974; Desai and Deshpande, 1978; George *et al.*, 1992 and Selvamani and Manivannan, 2009) in banana.

The leaf phosphorus content also follows the same tread as in nitrogen. The highest phosphorus content was recorded in treatment $N_{250}P_{80}K_{400}$gm/plant at all the growth stages (0.43, 0.49, 0.5, 0.45, 0.41, and 0.36%) while the lowest value recorded in control $N_{Zero}P_{80}K_{Zero}$ (0.17, 0.19, 0.27, 0.21, 0.19 and 0.17%). Increasing concentration of phosphorus in banana leaf even with application of constant dose of phosphate fertilizer with higher rate of nitrogen and potassium might be due to the fact that phosphorus uptake increase with increasing rate of potassium (Sheela *et al.*, 1990). Relatively lower phosphorus content with low levels of potassium was due to the decreased phosphorus uptake even with high available soil phosphorus as the specific phosphorus ion absorption site requires potassium for activation (Dibbs and Thompson, 1985). The total phosphorus showed the increasing trend with increasing dose of N and K fertilizer at shooting then decrease as crop advance. The decrease in leaf phosphorus content after shooting might be utilized for developing fruit bunches.

Similarly, the potassium content was highest at early stages i.e., 6th MAP and 9th MAP, after that there was

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reduction in leaf potassium levels. At 9th MAP, the highest value was observed in $N_{250}P_{80}K_{400}$ (4.37%), while the lowest value was observed in $N_{Zero}P_{80}K_{Zero}$(3.06). At shooting, the highest value was observed in $N_{250}P_{80}K_{400}$ (3.39%), while the lowest value was observed in $N_{Zero}P_{80}K_{Zero}$(2.49%). At fruiting and harvest stages also, $N_{250}P_{80}K_{400}$ recorded the highest value (2.4 and 2.03% respectively). $N_{250}P_{80}K_{400}$ recorded the maximum K content at all the stages followed by $N_{250}P_{80}K_{350}$, while $N_{Zero}P_{80}K_{Zero}$ recorded the minimum value. The highest leaf potassium content was recorded in treatment $N_{250}P_{80}K_{400}$ was due to the fact that increased levels of potassium which lead to higher content of leaf potassium. Increased potassium content might be also due to better utilization of applied inorganic fertilizer. Where potassium supply is abundant, large amounts of potassium is absorbed during the later half of the vegetative phase (Twyford and Walmsley, 1973; Randhawa *et al*., 1972 and Selvamani and Manivannan, 2009) and have a special effect on the maturation process (Fox, 1989). The reason for reduction of leaf potassium levels might be the nutrient transportation to fruit development. Moreover, a decline in potassium uptake in banana after emergence of inflorescence has been also reported by Von (1985).

Nutritional status of studied soil

The data in table 2 depicts that there was significant difference among the different treatments at all the stages with respect to nitrogen content in soil and maximum nitrogen content (371.71kg/ha) in soil was recorded under the treatment supplied with $N_{250}P_{80}K_{400}$ while the least nitrogen (246.94 kg/ha) content in soil was observed under T_{10} at flowering stage of plant. Similar observations like 326.85, 349.66, 384.71, 371.71, 303.85 and 249.35 kg/ha of available nitrogen were recorded at T_9 throughout the recorded period of plant. While comparing the values of available nitrogen at initial and final days of experiment, the available nitrogen showed the increasing trend with increasing dose of fertilizer which was reduced at the end of experiment. The similar trend was observed at all the treatments. The mineralization might have resulted in the higher nutrient contents. Similar findings are reported by Hasan *et al*, (1999b). Application of nitrogen at higher levels in combination with potassium substantially increases the soil nitrogen status (Suresh *et al*., 2002). Steineck (1974) stated the close linking in the physiological functions of nitrogen and potassium in the plant's production and the effect of potassium in increasing the efficiency of the use of nitrogen. Besides, potassium enables the plant to synthesize the organic components linked with the absorption of nitrogen. The reduction in soil nitrogen status after shooting was perhaps due to utilization by the plant and losses from soil in various forms.

The maximum phosphorus (28.69 kg/ha) content in soil was recorded under treatment T_9 whiles the least phosphorus (19.34 kg/ha) content in soil was observed under T_{10}-control at flowering stage of plant. Similar observations like 34.67, 42.37, 39.67, 28.69, 24.25 and 23.91 kg/ha available phosphorus was recorded at T_9 throughout the recorded period of plant. Available phosphorus showed the increasing trend with increasing dose of fertilizer which was reduced at the end of experiment. It was observed that there was a release of the available 'P' with the progress of time in each of the treatment combination under the addition of nitrogen and potassium fertilizer over control. Incorporation of potassium in combination with nitrogen considerably enhanced the available soil phosphorus content which is considerably reduced during shooting to harvesting stage (Suresh *et al*., 2002).

A noticeable change in the soil available potassium content was recorded due to application of different levels of nitrogen and potassium throughout the recorded stages of plant. Maximum potassium content (1271.71 kg/ha) in soil was recorded under T_9 ($N_{250}P_{80}K_{400}$) while the least potassium content (730.89 kg/ha) in soil was observed at T_{10}-control at flowering. Similar observations like 987.9, 993.56, 999.70, 1271.71, 1084.96 and 894.56 kg/ha available potassium was recorded at T_9 throughout the recorded period of plant. The available potassium content showed increasing trend in all treatments but only upto flowering stage. But potassium content in soil and the corresponding foliar concentration showed a reduction from the vegetative to the shooting stage (Hasan, 1999b and Suresh *et al.,* 2002) is attributed to high potassium uptake by the plants during vegetative to harvest. A decline in potassium uptake in banana plants after emergence of inflorescence has been reported by Von (1985).

IV. CONCLUSION

The treatment T_9 supplied with maximum nitrogen and potassium ($N_{250}P_{80}K_{400}$) recorded significantly higher leaf and soil nitrogen, phosphorus and potassium during all the stages than untreated plants ($N_{Zero}P_{80}K_{Zero}$). These nitrogen, phosphorus and potassium content was increased at early development stages then decreases as crop advance and this might be due to the movement of nutrients to shooting and fruit development. The results clearly showed that supply of nutrients through inorganic fertilizers significantly influenced the elemental status of plantain leaf and soil and indicate the beneficial effect of

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fertilizers and Nendran supplemented through inorganic fertilizers @ $N_{250}P_{80}K_{400}$ can be recommended as optimum dose for this region.

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Table 1. Effect of N and K application on leaf mineral content of Plantain (cv. Nendran)

Treatment	Total nitrogen content (%) of leaf					
	3rd month	6th month	9th month	Shooting	Fruiting	Harvesting
T_1	2.07	2.18	3.03	2.43	2.28	1.93
T_2	2.16	2.41	3.18	2.62	2.47	2.11
T_3	2.31	2.68	3.26	2.75	2.58	2.21
T_4	2.11	2.25	3.12	2.51	2.37	1.97
T_5	2.21	2.53	3.22	2.66	2.51	2.17
T_6	2.36	2.72	3.31	2.86	2.63	2.26
T_7	2.12	2.32	3.15	2.57	2.39	2.02
T_8	2.28	2.61	3.23	2.71	2.54	2.24

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T_9	2.42	2.84	3.36	2.94	2.67	2.35
T_{10}	1.06	1.32	2.49	1.75	1.62	1.34
SEm ±	0.017	0.016	0.017	0.020	0.016	0.024
CD(P=0.05)	0.036	0.034	0.037	0.043	0.035	0.050
Total phosphorus content (%) of leaf						
Treatment	3rd month	6th month	9th month	Shooting	Fruiting	Harvesting
T_1	0.25	0.31	0.33	0.24	0.23	0.21
T_2	0.26	0.33	0.34	0.27	0.25	0.22
T_3	0.27	0.34	0.36	0.34	0.26	0.24
T_4	0.31	0.39	0.41	0.36	0.31	0.27
T_5	0.32	0.41	0.43	0.37	0.32	0.29
T_6	0.34	0.43	0.44	0.40	0.34	0.30
T_7	0.37	0.44	0.46	0.41	0.37	0.32
T_8	0.39	0.46	0.47	0.42	0.39	0.34
T_9	0.43	0.49	0.50	0.45	0.41	0.36
T_{10}	0.17	0.19	0.27	0.21	0.19	0.17
SEm ±	0.012	0.008	0.010	0.009	0.008	0.009
CD(P=0.05)	0.025	0.018	0.023	0.019	0.018	0.019
Total potassium content (%) of leaf						
Treatment	3rd month	6th month	9th month	Shooting	Fruiting	Harvesting
T_1	2.85	3.34	4.05	3.13	2.12	1.53
T_2	2.88	3.35	4.08	3.15	2.13	1.57
T_3	2.93	3.36	4.12	3.17	2.16	1.59
T_4	3.09	3.44	4.24	3.22	2.22	1.73
T_5	3.11	3.45	4.26	3.25	2.24	1.76
T_6	3.14	3.46	4.27	3.31	2.27	1.77
T_7	3.25	3.53	4.30	3.34	2.33	1.95
T_8	3.29	3.55	4.33	3.35	2.36	1.96
T_9	3.32	3.58	4.37	3.39	2.4	2.03
T_{10}	2.72	2.96	3.06	2.49	1.37	1.26
SEm ±	0.018	0.014	0.014	0.017	0.016	0.018
CD(P=0.05)	0.039	0.029	0.030	0.035	0.035	0.039

Table 2. Effect of N and K application on the nutritional status of studied soil of Plantain (cv. Nendran) orchard

Treatment	**Available nitrogen content (kg/ha) of soil**					
	3rd month	6th month	9th month	Shooting	Fruiting	Harvesting
T_1	262.12	294.64	314.45	309.45	257.45	190.86
T_2	269.81	303.83	322.66	318.66	264.22	193.44
T_3	274.32	312.56	329.78	324.78	269.59	198.92
T_4	282.65	316.38	336.24	331.24	274.48	222.11
T_5	287.55	319.74	345.89	341.23	281.52	226.78
T_6	291.62	327.82	353.62	349.62	288.68	229.21
T_7	301.34	333.28	362.89	354.89	293.87	242.89
T_8	312.38	338.65	373.58	360.24	297.62	245.65
T_9	326.85	349.99	384.71	371.71	303.85	249.35
T_{10}	212.11	231.85	258.94	246.94	235.34	163.75
SEm ±	4.2946	5.3878	4.5246	4.9871	1.3973	1.1994
CD(P=0.05)	9.0227	11.319	9.5057	10.477	2.9357	2.5199
Available phosphorus content (kg/ha) of soil						

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Treatment	3rd month	6th month	9th month	Shooting	Fruiting	Harvesting
T_1	24.00	31.67	33.00	23.32	17.74	16.75
T_2	26.50	34.83	34.83	24.42	18.65	18.38
T_3	30.17	38.17	36.00	25.62	20.31	19.85
T_4	24.14	33.33	33.33	23.40	18.38	17.64
T_5	26.58	35.00	35.33	25.05	19.85	18.65
T_6	30.83	38.67	37.33	26.28	21.19	21.19
T_7	24.67	33.45	33.45	23.99	19.42	17.74
T_8	26.63	35.33	35.50	25.07	19.27	17.92
T_9	34.67	42.37	39.67	28.69	24.25	23.91
T_{10}	20.91	28.17	26.65	19.34	15.72	13.84
SEm ±	1.456	1.262	1.175	1.053	0.882	0.765
CD(P=0.05)	3.060	2.651	2.468	2.212	1.854	1.608
Available potassium content (kg/ha) of soil						
Treatment	3rd month	6th month	9th month	Shooting	Fruiting	Harvesting
T_1	609.66	739.45	743.00	883.62	739.45	626.53
T_2	624.78	756.33	759.45	911.98	763.46	641.78
T_3	643.13	773.13	878.8	934.80	786.33	664.80
T_4	767.05	833.71	857.71	1045.20	833.71	730.38
T_5	776.31	856.31	876.38	1062.85	866.31	756.31
T_6	787.88	877.88	937.88	1083.96	887.88	787.88
T_7	857.53	955.31	955.20	1235.73	1031.2	857.53
T_8	865.31	974.20	974.31	1254.41	1062.85	875.31
T_9	987.90	993.56	999.70	1271.71	1084.96	894.56
T_{10}	526.53	563.20	596.53	730.890	663.200	607.660
SEm ±	37.182	6.7032	4.0346	6.6327	6.6243	6.1033
CD(P=0.05)	78.117	14.082	8.4764	13.934	13.917	12.822