Ponnaiya, B. W. X. 1951. Studies in the genus *Sorghum*, II. The cause of resistance in *Sorghum* to the insect pest *Atherigona indica* M. *J. Madras Univ. B.* 21: 203-17.

Prat, H. 1932. L'Epiderme des Graminees Etuda anatomique et systematique. *Ann. des. Sci. nat., Bot.*, 14: 117-326.

Suryanarayana, S. and N. Krishnaswamy. 1948. An easy method of obtaining epidermal peels of grass leaves. *Curr. Sci.*, 17: 151.

Uber, F M. 1940. Micro-incineration and ash analysis. *Bot. Rev.*, 6: 204-26.

Werner, O. B. 1929. Ein neuer Apparat zur Gewinnung von Pflanzen fur Aschenbild-bestimmungen. Mikrochemie, 7: 110-5.

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Effect of Continuous Application of Fertilizers and Manure on the Yield and Composition of Certain Crops-1. Effect on *Ragi (Eleusine coracana)*

By

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Ragi forms one of the most important staple food crops in India and yet enough effort has not been made to assess precisely its response to manures and fertilizers. The importance of nitrogen in increasing cereal yields is widely accepted (Lipman, 1932; Karunakar, 1951 and Church, 1956). However, contradictions in opinions exist on the effect of nitrogen in increasing protein content in cereals. Ohlrogge (1949) and other workers opined that large increase in yield in relation to nitrogen was not accompanied by any change or decrease in protein, on the other hand, reverse was also true (Bisset and Andrews, 1954; Huppert and Buchner, 1957 and Miller, 1958). But instances at which higher doses of nitrogen decreasing protein content were also met with (Patterson, 1932). The indirect influence of nitrogen also found by its enhancing effect on the translocation of P from vegetative parts to grains (Bennet, 1939). Besides nitrogen, the effect and usefulness of P and K for satisfactory growth of *Ragi* crop have been reported by Govindarajan and Venkata Rao (1952) Thus a judicial combination of N, P and K was visualised and recommended for *Ragi* crop (Mariakulandai, 1960; Venkataramana and Krishna Rao, 1961 and Sanyasi Raju, 1952).

The effect of fertilizers on the quality of cereals is another important factor to be studied carefully. At present there seems to be no definite basis for predicting an increase in protein content of a crop as a result of N fertilizer

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(Miller, 1955). The interacting effects involving nutrient elements in plants have to be taken into account before any conclusion is made. Hence an attempt is made in this paper to study the antagonistic and synergistic effects of nutrient elements N, P, K on the composition of *Ragi* crop.

Material and Methods: The data taken up for investigation comprise sixteen years of experimentation conducted in the permanent manurial plots, Coimbatore. *Ragi* was cultivated as irrigated crop throughout these years. Following are the treatments employed.

Treatments	Nutrients supplied in lb per acre
1. Control	---
2. N	22 5 N
3. N + K	22.5 N + 54.0 K_2O
4. N + P	22.5 N + 60.5 P_2O_5
5. N + P + K	22.5 N + 60.5 P_2O_5
6. P + K	60.5 P_2O_5 + 54 0 K_2O
7. K	54.0 K_2O
8. P	60.5 P_2O_5
9. CM (Cattle Manure) 5 tons per acre	---
10. CMR (Cattle Manure Residual)	---

Fertilizers and manures were broadcast in one single dose as basal dressing prior to sowing. N, P and K were supplied in the form of Ammonium sulphate, Superphosphate and Potassium sulphate respectively. Soil samples were at 0-9" depth and analysed for their chemical constituents and mechanical components. After harvest, *Ragi* grain and straw samples were analysed for their nutrient concentrations adopting the methods recommended in AOAC (1960). The effect of fertilizers over the yield and nutrient concentrations of grain and straw samples was studied by the method of analysis of variance after transforming the percentage values into angles. The relationships between yield and N, P and K concentrations in grain and straw were studied by finding correlation coefficients. An attempt was also made to observe the antagonistic and synergistic effects of N, P and K in grain and straw samples through partial correlation studies.

Yield: The response of *Ragi* to manurial treatments studied over sixteen years were statistically analysed and the results presented in Table 1.

TABLE 1. *Mean yield of ragi in lb per acre*

N_0	N_1	P_0	P_1	K_0	K_1	No CM	C.M.	S.E.	C.D.
915	1121	623	1413	917	1119	908	1295	35.5	105

Application of N, P, K and CM have independently increased the yield significantly, P recording the maximum of all other levels. First order interactions between years and the various nutrients *viz.*, N, P, K, NPK, and CM were also studied. Only "years x P" interaction was significant and positively linear.

Plant Composition: After each harvest, the quality of grain and straw were studied chemically for their nutrient concentration. The effect of manurial treatments over these elements were statistically analysed and presented in Table 2.

TABLE 2. *Mean values of N, P and K concentrations in grains and straw expressed as percentage (transformed values)*

Concentration	N_0	N_1	P_0	P_1	K_0	K_1	S.E.	C.D.
a) *Grain*								
N	1.32	1.37	1.41	1.28	1.35	1.33	0.007	0.02
P_2O_5	0.61	0.58	0.49	0.70	0.58	0.61	0.007	0.02
K_2O	0.63	0.62	0.62	0.63	0.63	0.62	0.010	...
b) *Straw*								
N	1.12	1.16	1.21	10.6	1.14	1.13	0.011	0.032
P_2O_5	0.89	0.88	0.84	0.93	0.88	0.89	0.010	0.020
K_2O	1.45	1.46	1.48	14.3	1.44	1.47	0.014	0.040
							(P = 0.05)	

Interaction effect between N and P, both in grain and straw were also noted and presented in Table 3.

TABLE 3. *Comparison of N × P interaction*

	N_0	N_1	S.E.	C.D.
a) *Grain N*				
P_0	1.36	1.45	0.014	0.04
P_1	1.27	1.28		
b) *Straw N*				
P_0	1.17	1.25	0.014	0.06
P_1	1.06	1.06		
			(P = 0.05)	

The relations between the grain and straw nutrients with final yield were studied and the results are presented in Table 4.

TABLE 4. *Relationship between yield and the nutrient concentrations*

(n−2) = 58

Relationship	Correlation coefficients (r)
Yield of grain Vs. grain N	— 0.436 ***
Yield of grain Vs. grain P_2O_5	0.473 ***
Yield of grain Vs. grain K_2O	— 0.070
Yield of grain Vs. straw N	— 0.521 ***
Yield of grain Vs. straw P_2O_5	0.299 *
Yield of grain Vs. straw K_2O	— 0 003

* P = 0.05 ; *** P = 0.001

The interactions among nutrients concentrations in grain and straw were also studied to find out the mode of translocation of nutrients for grain formation (Vide Table 5).

TABLE 5. *Relationship between straw and grain nutrients.*

(n—2) = 58.

Relationship	Correlation coefficients (r)
Straw N Vs. Grain N	0.849 ***
Straw N Vs. Grain P_2O_5	— 0.381 **
Straw N Vs. Grain K_2O	0.169
Straw P_2O_5 Vs. Grain N	— 0.334 **
Straw P_2O_5 Vs. Grain P_2O_5	0.712 ***
Straw P_2O_5 Vs. Grain K_2O	0.145
Straw K_2O Vs. Grain N	0.319 **
Straw K_2O Vs. Grain P_2O_5	0.217
Straw K_2O Vs. Grain K_2O	0 249

** P = 0.01 ; *** P = 0.001

Discussion : The yield of *ragi* is found to be increased by the application cattle manure, N, P or K, but the maximum increase in yield is caused only by P application. Seasonal vagaries are found to depress the yield. Continuous application of P not only adds to the soil resources but acts against seasonal odds as indicated by the significant positive linear relationship between application of P and years. This explains the non-mobile nature of P which gets fixed up in the soil and is released to the solution phase based on the

intensity and capacity of the soil phase. The other nutrients N and K, being more mobile get mostly leached away of their excess quantity. Cattle manure which itself is a complete fertilizer increases yield and the magnitude is only second to that of P application. This may be due to the inability of cattle manure, to meet the immediate requirements of the crop.

The increase of yield due to fertilizers seems to be due to the increased uptake of nutrient elements as seen from the Table 2. But this relationship is not so simple as interaction effects are noted between N and P concentrations in both grain and straw. While increase in N concentration is coupled with decreased P concentration and *vice versa*, application of P seems to balance the N concentration in plant tissues, irrespective of N application. But the relationships between yield and the nutrient element concentrations expressed by correlation studies differ in their behaviour in increasing the yield. N concentrations both in grain and straw bear a negative relationship with yield, while it is positive with P concentrations. However, this negative relationship of yield with N concentrations can only be apparent. Nitrogen, while increasing the vegetative growth gets diluted, even if there is increased uptake of N. In fact decrease of grain yield per unit of vegetative tissue due to N application has been reported (Black, 1959). Hence the apparent decrease of N concentration indicates only increased N uptake and this helps in the increased absorption of P by the crop. This effect is also found in the inter-relations of nutrient elements of grain and straw where positive relations exist between the two fragments for the same nutrient elements N and P and antagonism betwee them. In fact more of N and P are translocated to grain from straw for their formation and this is indicated by their higher concentrations in grains than in straw. Potash application neither seems to increase its concentration in plant parts nor its concentration is related to the yield. Perhaps the effect may be indirect such as enhancing P uptake by the crop.

Summary and Conclusion: The response of *ragi* in quantity and quality due to the continuous application of fertilizers and manure was studied. Application of CM, N, P or K independently increased the yield of *ragi*, P application recording the maximum of all. Continuous application of P exhibited a positive linear relationships with years, while other growth factors had no effects over years. Application of N and P fertilizers influenced their concentration in plants positively, while interacting with each other negatively. The apparent negative relationship of N concentration with yield denoted only the dilution effect due to increased vegetative growth and increased uptake of N only helped to the increased absorption of P for increasing the final yield. The effect of potash over yield was indirect as it increased the P absorption by

the crop. Though CM increased the yield of *ragi*, the magnitude was only second to that of P application. Thus CM with P may be a better manure than NPK fertilizers for increasing the yield of *ragi*.

REFERENCES

Anon. 1960. A O.A.C., P.O. 540, Benjamin Franklin, Station, Washington 4 D.C.

Bennet, N. F. 1939. Effect of N on P absorption by plants. *Field Crop Abstr.* **12**: 1940.

Bisset, W. J. and C. S. Andrews. 1954. The effect of N on the yield and the N content and baking quality of wheat grown on the Darling. Downs Queensland. *J. Australian Inst. agric. Sci.* **19**: 40-4.

Black, C. A. 1960. *Soil and Plant Relationship.* John Wiley & Sons, Inc., New York.

Church, D. M. 1956. Cereal manuring in England and Wales. *J. Sci. Fd. Agric.* 7: 711-21.

Govindarajan, S. V., and B. V. Venkata Rao. 1952. Manures and Fertilizers: Their efficient and effective use for increased crop production. *J. Mysore Agric. Expt.* **28**: 77-91.

Huppert, N. and A. Buchner. 1957. Nitrogen fertilizing and protein content of cereals *Soils & Fert.* **15**: 1952.

Karunakar, P. D. 1951. Maximisation of crop growth to manuring. *Madras agric. J.* **38**: 45-9.

Lipman, J. G. 1923. The nitrogen outlook. *J. Agric. Soc. Agron.* **24**: 227-37.

Mariakulandai, A. 1960. Future planning for production and utilization of chemical fertilizer in India. Paper presented at Crops and Soil Wing, Board of Agriculture at Ranchi - 1960.

Miller, C. E. 1958. *Soil Fertility.* John Wiley & Sons, Inc., New York, 436.

Ohlrogge, A. J. 1949. Victory Farm Forum. Chilean nitrate Education Bureau (Cited by Miller, C. E. *Soil Fertility*, 114, 1955.

Patterson, H. B. 1932. Effect of N fertilizer on yield and protein content of winter wheat in Utah. *Bull. Utah. Agric. Expt. Sta.* 353.

Sanyasi Raiu, M. 1952. The role of organic manures and inorganic fertilizers in soil fertility. *Madras agric. J.* **39**: 130-47.

Venkataramana, R. S. and D. V. Krishna Rao. 1961. Chemical composition of nutrient uptake of *ragi*. *J. Indian Soc. Soil Sci.* 9: 245-52.