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Relationship between total soil nutrients and nutrient uptake in Old Permanent Manurial experiments, Coimbatore *

by

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Synopsis : The relationship between soil content of the plant nutrient elements Nitrogen, Phosphorus and Potash, and their uptake by *cholam* crop was worked out for 3 irrigated and 2 dry crops, and was found to be close. Nutrient uptake by irrigated crops was perceptibly higher than for dry crops.

Introduction : The Old Permanent Manurial experiment at Coimbatore, was started in 1909 with the object of studying the effect of continuous manuring with organic manure and inorganic fertilizers supplying Nitrogen, Phosphorus and Potash, singly and in combination, year after year. A series of crops were raised in rotation under irrigated conditions till 1940, after which period, only dry crops were raised. So far 92 crops have been raised and their yields recorded. Chemical analysis of the produce has been done for most crops, and the soils analysed periodically.

Williams (1948) visualized the Phosphorus uptake by the crops to depend upon (1) the demand set up by the growth and normal functioning of various parts, and also the external concentration of nutrients. The uptake of nutrients depends upon a variety of factors like crop, variety, availability, climate and Fried and Dean (1952) assumed that a plant provided with two sources of nutrient, namely the soil and fertilizer Phosphorus, will absorb phosphorus from each in direct proportion to the amounts of these respective supplies. Mariakulandai and Thyagarajan (1959) have worked out the balance sheet of nutrients left in the soil in the Old Permanent Manurial experiments and have reported, that the nitrogen or phosphorus applied, is always efficiently utilized by the crop grown on the field and is not lost to any extent, as whatever is not utilized by the crop, is seen to be left in the soil, in spite of the number of years of experimentation.

So far no investigation seems to have been undertaken to study the relationship between the available nutrients in the soil and crop uptake in the Permanent Manurial experiments at Coimbatore. This investigation was therefore taken up to determine the relationship between the sum of

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the soil content of a nutrient and the amount of the same supplied through the fertilizer or manure application on one hand, and the crop uptake of this nutrient, on the other.

In the present investigation, the field experimental and analytical data accumulated over a number of years in the Chemistry Section, Agricultural College and Research Institute, Coimbatore from the Old Permanent Manurial experiments, were utilized for calculating the sum of nutrients in the soil after fertilizer or manure application, and the nutrient uptake by several crops, and for the study of the relationship between these quantities.

Materials and Methods : In the Old Permanent Manurial experiment, of the cholam crops raised so far, only 5 were taken up for this study, since complete data regarding the yield, composition of the crop and the relevant soil analytical data were available only for these crops in the records of the Section. Of these five crops, three, namely 37, 49 and 54 have been raised under irrigated conditions, and the other two, namely 82 and 85 under dry conditions. Crops 49 and 54 are *Chitrai cholam*-white, whereas crop No. 37 is *Chitrai cholam*-yellow. The two dry crops are of *Periamanjal cholam* variety. The crops were raised in rotation every year in the Old Permanent Manurial plots with the standard treatments followed year after year.

For each crop, yield data have been recorded immediately after harvest and samples of soil and plant material collected for laboratory analysis. The soil and plant materials have been analysed for Nitrogen, Phosphoric acid and Potash by standard methods. The uptake of nutrients was calculated by multiplying the yield of grain and straw by the composition.

The sum of nutrients present in the soil was calculated by taking the composition of the soil, namely total N, total P_2O_5 and total K_2O, present in the soil before raising the crop and multiplying the same by 2,000,000, which was taken as the weight of soil, in pounds, in the tillage layer in one acre. The amount of nutrient added to the soil through fertilizer was then added to the soil nutrient. The sum so obtained, namely the amount of nutrient present in the soil upto tillage depth and the amount added through fertilizer or manure, was taken to be the sum of nutrients present in the soil before raising the crop.

It has to be pointed out here that even though the analysis of the crop has been carried out for each and every crop, no corresponding analyses of soil have been carried out, immediately after the harvest of each crop. Thus in the case of crop No. 37, and 82 soil analysis has been carried out

after the harvest of the succeeding crops, namely crop No. 38 and 83, respectively. The analysis of soils, taken after the harvest of crop No. 47, crop No. 53 and crop No. 89 have been taken for the crops 49, 54 and 85 respectively. As this study was undertaken only to utilize the available data present in the records, these approximate values for sum of nutrients have been taken as representing the sum of nutrients of the crops under study before the crop was grown.

Results and Discussion : The composition of each soil, with reference to total nitrogen, total phosphoric acid and total potash (and not available nitrogen, available phosphoric acid, and available potash) was taken. The sums of nutrients present in the soils before the crop was grown, and after the addition of nutrients in the form of fertilizers are presented in Table I.

TABLE I

Sum of Nutrients (Amount present in lb. in the soil/Acre furrow slice + Amount added in lb. through fertilizer/Acre)

Treatments		1 Control	2 N	3 N+K	4 N+P	5 N+P+K	6 P+K	7 K	8 P	9 C. M.	10 C.M.R.
Cholam Crop Nos.				(1) Total Nitrogen (N): lb.							
Irrigated	37	700	862	922	942	882	780	760	720	1160	780
	49	540	722	842	882	882	780	640	580	1020	620
	54	640	702	662	802	722	740	800	780	1140	560
Dry	82	820	662	842	642	822	660	540	640	940	600
	85	1080	742	922	1022	1522	900	940	740	980	640
				(2) Total Phosphoric acid (P_2O_5): lb.							
Irrigated	37	440	540	500	2001	2281	2481	620	2361	750	400
	49	620	760	840	1641	1981	1821	1040	1521	890	640
	54	620	540	660	1741	1861	2461	820	2461	750	340
Dry	82	680	620	840	2261	2261	2461	740	2861	970	740
	85	580	420	620	2821	2901	2921	360	3181	1030	600
				(3) Total Potash (K_2O): lb.							
Irrigated	37	5540	5940	5999	5980	7019	8259	8759	6640	7371	5000
	49	4400	5000	8259	7400	9459	10659	11459	5800	6531	5400
	54	8200	11200	9059	5800	13859	12859	13259	12600	12331	9000
Dry	82	6800	9800	9859	8600	12259	18459	15259	15200	11131	15400
	85	12400	6000	6059	14200	10459	4259	6859	7800	10331	6800

It will be seen from the above data that in the case of the three irrigated crops, 37, 49 and 54 the sums of nutrients for Nitrogen, Phosphoric acid and Potash, are more than for the control. The same trend for Phosphoric acid and Potash only is noticed in the case of dry crops, namely 82 and 85.

TABLE II

Uptake of Nutrients by Crops—Total uptake (Grain + Straw)—lb./acre.

Treatments / Nutrients	1 Control	2 N	3 N+K	4 N+P	5 N+K+P	6 P+K	7 K	8 P	9 C.M.	10 C.M.R.
1. Crop No. 37; *Chitrai cholam* (yellow), irrigated:										
N	45·6	48·4	54·8	76·2	83·6	86·7	54·9	80·7	97·8	73·1
P_2O_5	17·2	29·8	19·5	41·1	69·1	45·9	17·5	38·9	38·2	18·5
K_2O	64·5	82·5	98·9	199·5	192·4	170·2	125·1	157·6	202·1	135·4
2. Crop No. 49: *Chitrai cholam* (white), irrigated:										
N	69·6	42·4	45·4	85·7	84·4	78·5	56·0	42·0	88·1	44·65
P_2O_5	19·2	8·3	12·3	26·9	38·0	33·5	16·8	16·7	31·6	33·5
K_2O	45·3	49·8	68·9	95·1	126·9	95·6	56·9	58·71	118·2	46·7
3. Crop No. 54; *Chitrai cholam* (white), irrigated:										
N	22·5	30·5	15·4	47·0	42·2	41·4	18·9	32·1	45·0	27·1
P_2O_5	5·8	6·0	10·0	17·1	16·1	16·5	5·4	9·7	25·0	8·0
K_2O	34·4	62·8	42·2	112·2	86·0	73·6	52·0	62·2	125·7	63·7
4. Crop No. 82; *Periamanjal cholam*, Dry:										
N	11·9	17·5	12·8	16·3	24·6	17·4	12·6	13·7	22·5	8·9
P_2O_5	8·4	5·8	6·5	10·0	11·7	12·4	8·1	9·3	19·6	5·3
K_2O	13·9	24·2	13·6	25·8	48·2	33·5	32·3	29·3	59·3	15·3
5. Crop No. 85; *Periamanjal cholam*, Dry:										
N	8·04	17·3	15·2	25·8	24·9	15·9	20·5	12·0	35·0	7·0
P_2O_5	3·3	11·0	8·2	21·5	16·9	10·9	11·1	7·1	24·4	6·1
K_2O	5·6	22·9	20·5	43·3	60·7	35·5	35·7	19·0	47·6	14·9

The total uptake of nutrients by grain and straw of the crops is presented in Table II. From the composition of the crop, it will be seen that the Nitrogen and Phosphoric acid content is more in grain than in straw in both the irrigated and dry crops. On the other hand the Potash content is more in straw than in grain. The uptake of potash, has been considerably improved by the application of potash fertilizers in all the five crops except NK in crop No. 82. A similar result for Phosphoric acid is also obtained in all cases except in the treatment, P alone, in 49. Application of nitrogen has also increased the uptake of nutrient in all cases in the rainfed crops and also in the majority of cases in irrigated crops, the exceptions being the treatments N, NK, and C. M. R. in crop No. 49, and NK in crop No. 54. On the whole, the uptake of nutrients namely, Nitrogen, Phosphoric acid and Potash by the crop is more in crop No. 37 and 49, than in 54. The dry crops have recorded more or less the same uptake.

The relationship between the sum of nutrients in the soil and the uptake of nutrients was statistically analysed and the results are given in Table III. The scatter diagrams of these relationships are also given in Figure 1, 2 and 3.

TABLE III

Correlation coefficients for relationship between sum of nutrients in soil and uptake of nutrients by crop.

	Dry			Irrigated	
Cholam Crop No :—	37	49	54	82	85
Nutrients					
N	0·72*	0·80*	0·72*	0·50	0·38
P_2O_5	0·85**	0·52	0·75*	0·73*	0·75*
K_2O	0·71*	0·66	0·83*	0·57	0·68

* Significant at P = 0·05
** Significant at P = 0·01
Others : Not significant at P = 0·05

In the case of crops 37, and 82 all the factors have been taken up for analysis, while in the case of 49, 54 and 85 the treatments, control, C. M. and NKP, respectively, have been omitted from the statistical analysis for Nitrogen uptake, since, they are farther removed from the general pattern of the uptake. In the case of C. M. treatment, the values for most crops were more than those predicted from the regression equation. The deviation was fairly consistent.

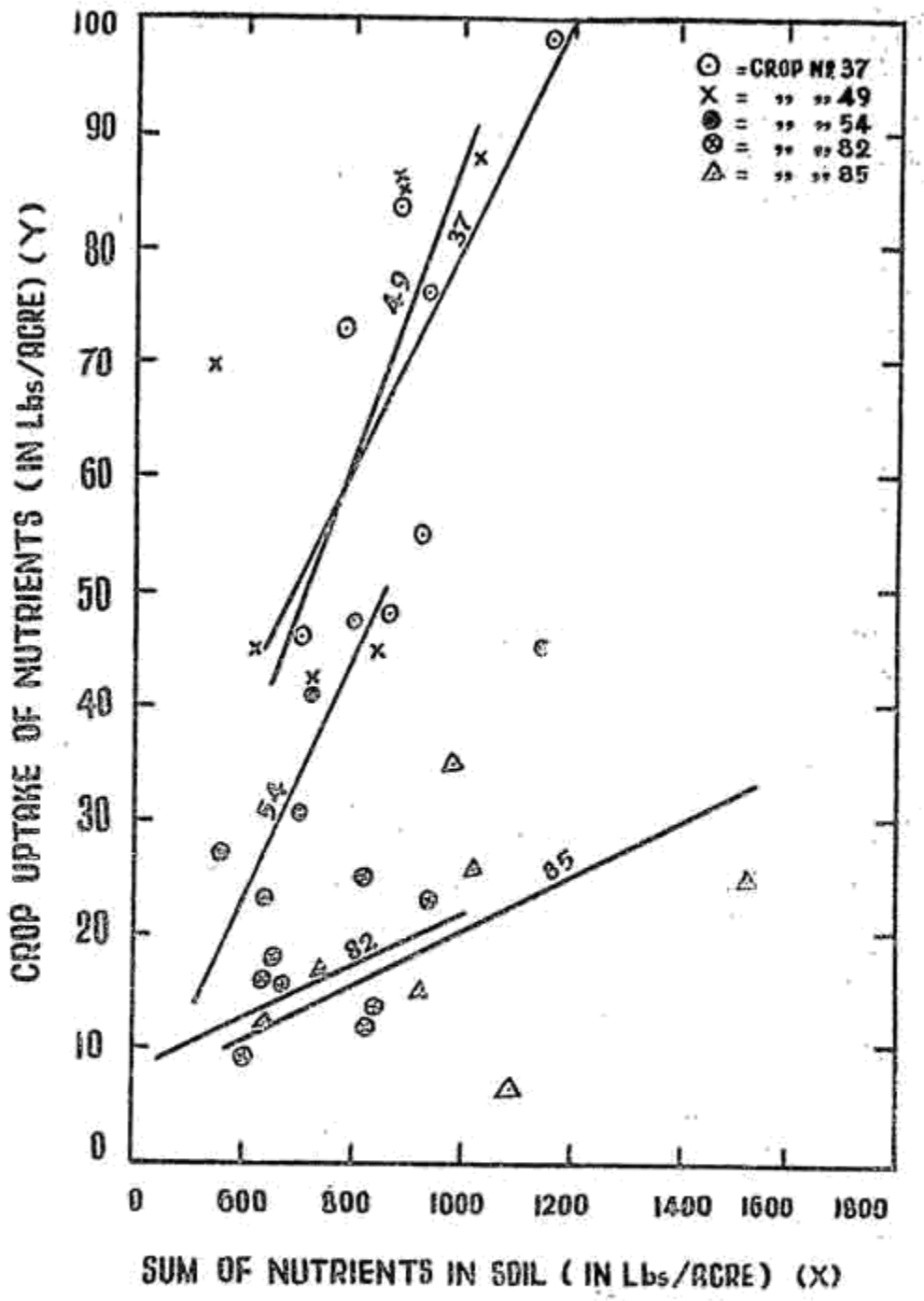
It was found that in crops 37 and 54, the correlation between sum of nutrients and the uptake of nutrients by the crop was statistically significant in the case of all the three nutrients, while in crop 49, only the nitrogen correlation was statistically significant.

In the case of crops 82 and 85, which have been raised under dry conditions and are of the *Periamanjal cholam* variety, only in the case of phosphorus, correlation between the sum of nutrients present in the soil and the uptake of nutrient is statistically significant.

It is also found that in the case of irrigated crops, the regression lines are steeper than for the dry crops in the case of Nitrogen, Phosphoric acid and Potash. This may be due to the fact that, though the amount of nutrients present in the soil is the same, the uptake is more under irrigated conditions, while it is low under dry conditions. It was observed that in the matter of higher plant uptake of nutrients under irrigated conditions and lower uptake under dry conditions both cattle manure and artificials behaved similarly.

Summary and Conclusions : The relationship between the uptake of nutrients by the crop and the sum of nutrients in the soil before raising the crop was statistically worked out. It is found that in the case of irrigated

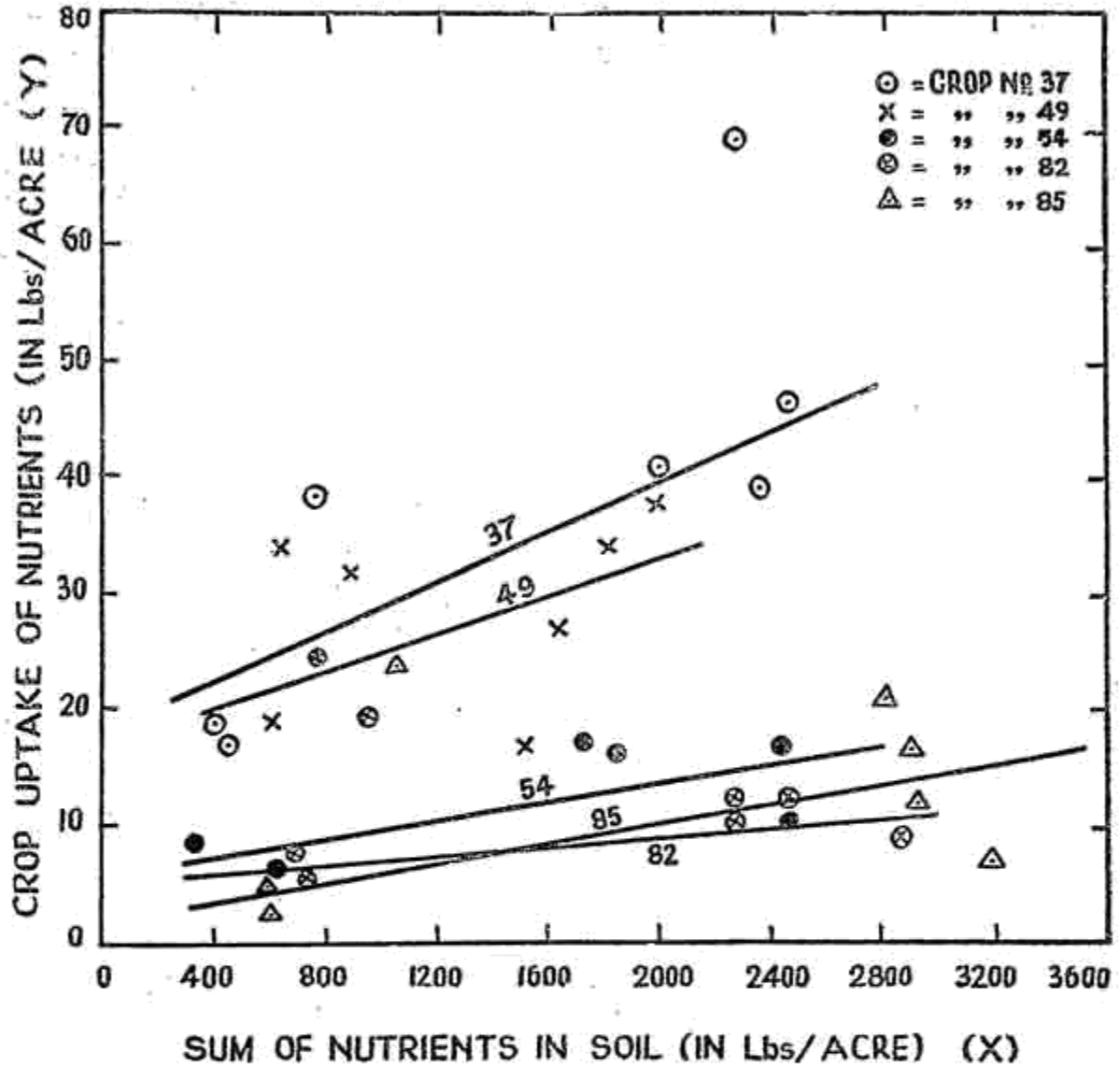
FIG. 1



RELATIONSHIP BETWEEN SUM OF NUTRIENTS IN SOIL AND CROP UPTAKE OF NUTRIENTS: NITROGEN (N)

crops all the three nutrients, namely Nitrogen, Phosphoric acid and Potash gave significant correlation, whereas, in the case of dry crops only in the case of phosphorus, correlation between the sum of nutrients present in the soil and the uptake of nutrient by the crop is statistically significant. It is also found that even though the sum of nutrients present in the soil is more or less the same, the uptake by the crop is more under irrigated conditions

FIG. 2

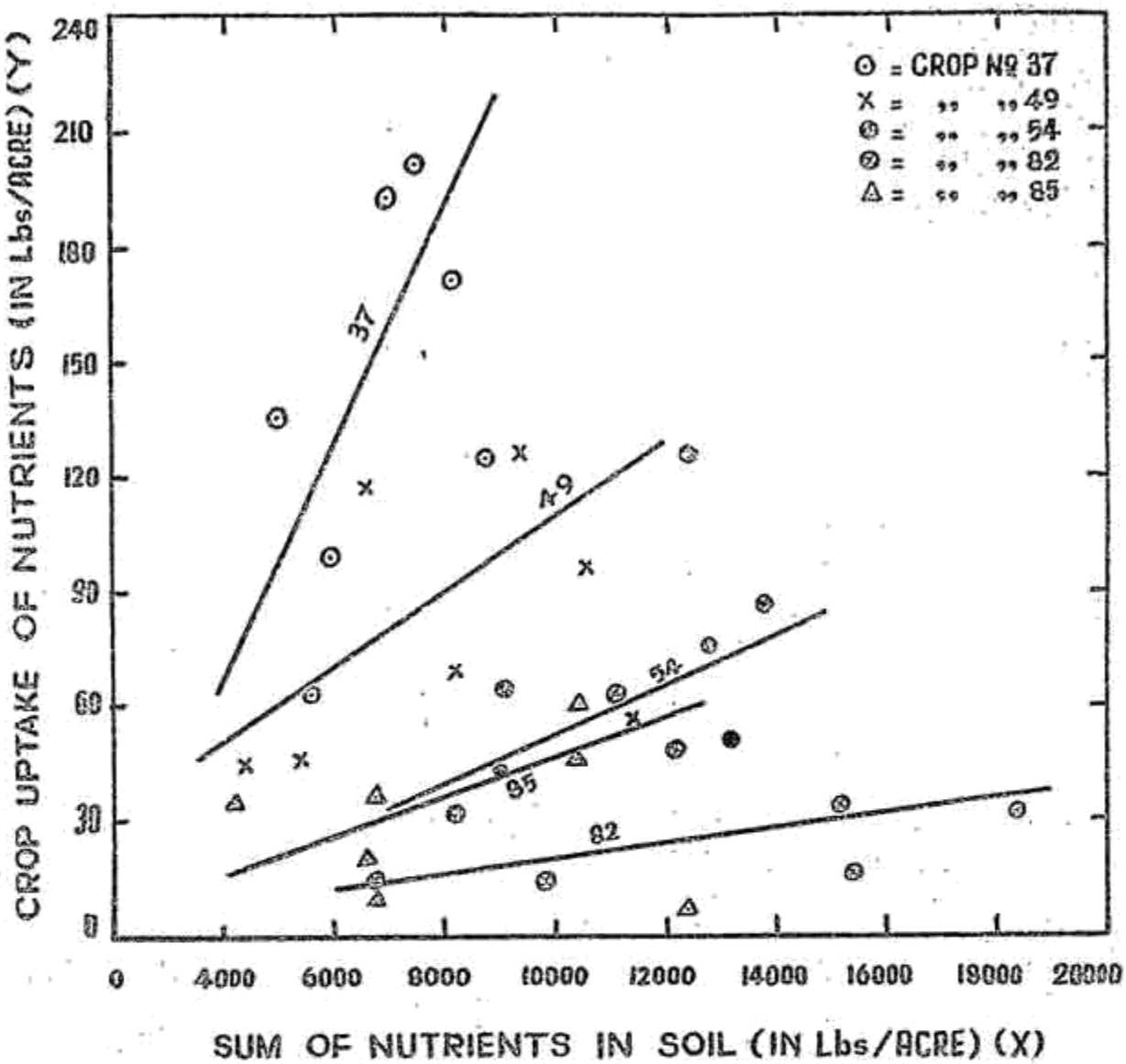


RELATIONSHIP BETWEEN SUM OF NUTRIENTS IN SOIL AND CROP UPTAKE OF NUTRIENTS: PHOSPHORIC ACID (P_2O_5)

than under dry conditions. This was true for nutrient elements supplied through cattle manure as well as artificials. Thus the difference between the irrigated and dry crops is shown by the steep regression line obtained in the case of irrigated crops, and a line almost parellel to the sum of nutrients axis (X-axis) in the case of dry crops.

The close dependence, of the plant uptake, on the sum of nutrients in soils indicates that the quality of the produce can be influenced favourably by suitably adjusting the sum of the soil nutrients and the nutrients applied through the fertilizers or manure. It is also seen that, operating with the same level of applied nutrients, it is possible to increase plant uptake of nutrients considerably by the introduction of irrigation.

FIG. 3



RELATIONSHIP BETWEEN SUM OF NUTRIENTS IN SOIL AND CROP UPTAKE OF NUTRIENTS : POTASH (K_2O)

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