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Fertilization of pasture-lands in central-western Spain

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Summary

An exposition is made of the results obtained by the fertilizing (NPK) of natural pasture communities in Central-Western Spain over a four year period; beginning with a description of the eadpho-climatic and anthropo-zoogenic factors which determine their formation and persistence.

The response of the grammineous plants to nitrogen stands out in the results obtained. This nutrient negatively affects the leguminous plants which disappear in the fourth year. The phospho-potassic fertilizer benefits the later and therefore the queality.

The addition of nitrogen with small dosages of phospho-potassium increases the production in 3000 kg/ha of the dry matter, while in the the other fertilizers (Ca, Mg, S, Cu, Mn, Zn, B, Mo) significant results were not obtained.

Introduction

Pasture-lands in the semi-arid zone of Western Spain, in which silicic, acid and oligotrophic soils dominate, are characterized by the notable diversity of species which make up its vegetative cover. This diversity is characteristic of zones which have ecotonic diversity, like the one we are to consider here, between the Mediterranean and the Nemoral Eurosiberian region, due to the altitude (600-900 m) and to the closeness of the Atlantic Ocean, which makes its influence felt more or less intensely, especially in mountains open to occidental effluvium.

Climatic and eadphic factors are greatly diversified by the topography: table-land, slopes with greater or lesser inclination, depressions, etc... all of which have a great influence on the availability of humidity and on the depth of the soil. Other factors which diversify those already mentioned are: intensity of radiation, wind, hydric capacity of the soil, etc..

Anthropo-zoogenic effects (mechanical actions, use, management, kind of livestock, etc., etc.) are responsible for the formation and persistence of the grassy community of the pastures which we are studying, and affect the production as well as the quality, even being capable of moving its phytosociological status. We do not want to forget to underline the enormous importance of livestock dejections which over milenia have been the principal mover of nutritive elements.

Finally, there are other active factors less manifest, although actually their function is of great importance, such as the case of tree cover which determines the preferable sites of the livestock and affects the distribution of radiation, light, shadow dew, wind, rainfall, contributions of elements from deep layers, etc., etc...

In the conditions that concern us, radiation as well as temperature in excess or defective, become limiting. The substratum is poor in nutritive elements, the humidity is deficient and badly distributed, since the greatest part occurs when the temperatures are lethal (fig. 1) (cold). That is to say, we are dealing with an adverse medium, which has determined the complex constitution of the herbaceous communities that persists due to the action of men and animals.

Experimental

Over the years 1969-70-71-72 and using as a base other studies (1, 2), four experimental plots were controlled, set up to determine the response of herbaceous communities of pastures to the addition of mineral fertilizer. In these plots nitrogen (N), phosphorus (P), and potassium (K) were tested, in the form of commercial fertilizers, at random blocks according to a similar method to that of Homes (5) (6) (7). In Table I the dosages and treatments used are listed.

The experiments were carried out in communities of ephemeral plants (*Helianthemetalia guttati* (Br. Bl. 1940)), in dominant grass communities (*Agrostidetalia annua* (Riv. God. 1957)) and in communities of *Holoschoenetalia* (Br. Bl. (1931) (1947)) (8) (9) whose dominant plants are given in the annexed list.

The tests in communities of *Helianthemetalia* gave no significant responses and therefore they are not included herein.

Also a study of the interaction of a few climatic factors (rainfall and temperatures) with fertilizers was made, but due to its length only the conclusions are included here.

The results obtained with phospho-potassic fertilizer was of little significance.

Likewise Cu, Mg, Ca, Mn, Zn, B and Mo were tested in other plots without obtaining significant results.

Results

The results obtained in experimental plot nº. 1 *(Holoschoenetalia)* are found in Fig. 2 and those of the other three plots (Agrostidetalia) in Fig. 3 and following. The thermo-pluviometric data in the closest station (20 km) are given in Fig. 1.

In all of them the response of nitrogen stands out as the primary factor in the production of grammineous plants, increasing the dry matter up to 3000 kg/ha.

The phosphorous and the potassium, principally phosphorous, only begin to become manifest as deficient when nitrogen stops being limiting, and this is not obtained in all the plots. The decreasing fraction of the curves (Fig. 2, to 9) is the manifestation of this fact.

Also the effect of the fertilizers on the relation grammineous/leguminous plants was controlled, finding that nitrogen is highly negativa for the later up to the extreme of eliminating them is the fourth year when the dosages are high.

The depressing effects of nitrogen on leguminous plants, especially on pasture-lands with grammineous and leguminous plants, is a sufficiently well known phenomenon, for which reason we will not stop to study it. However, it is very important to contribute quantitative facts in concrete cases. The evolution of the grammineous/leguminous relation with the different dosages of fertilizer are those which mark the discontinuous line on the graphs, and are measured on the right axis.

Conclusions

Therefore, when we try to activate production of such complex systems, using mineral fertilizers, we find a series of results whose conclusions are given as follows.

Greater production increases were gotten when fertilizing in spring rather than in autumn. This is possibly due to the fact that the contributions in autumn are not completely used by the plants, since the low temperatures and short photoperiods soon are converted into inhibitors; the non-used elements are fixed in the soil complexes or are lost by the intense washing during the winter in which the rains reach their maximum intensity. When the plant resumes growth in the spring, it no longer has at its disposal the major part of the added quantities. If the contributions are made in spring, the plant uses them to the maximum, since temperature, humidity, photo-period, etc., no longer act as inhibitors.

The dosage as well as the proportions among nutrients, in order to obtain the maximum efficiency, depend on the kind of community and on the gram./leg. relation. Therefore, to obtain a profit, dosages and proportions must be well studied. The generalization of a single formula of fertilizer for a non-homogeneous extension will hardly be profitable given the scarce economical margin with which we are working.

The production is determined by the rainfall from October-November and April-May, diversified by the temperatures of those months, especially in May.

There is a limit of cover and botanical composition, after which no mineral fertilizer is profitable; firstly, it is necessary to obtain a good vegetative cover by the use of livestock and by the contribution of seeds, for example from hay. Then the first step in not applying the fertilizer without an increase in production is the choice of the area.

Small dosages do not give significant response.

The response of the fertilizer was always low the first year.

The response of the fertilizers in the following:

Nitrogen. The grammineous plants respond very well. If the cover is well chosen, the fertilizer produces good profits after a certain level. The profit is inversely proportional to the quantity of leminous plants. The interaction N-P and N-K is normally very high, for which reason the best results are obtained by small complementary dosages of P and K.

It eliminates leguminous plants; sometimes it makes them disappear in only two applications, if the dosage is high.

By eliminating leguminous plants, the possible (almost certain) deficiency of Ca, Mg, Zn and Cu is provoked since the grammineous plants do not cover the minimum required necessities in animal diet (4). This problem becomes worse in time if nitrogen is repeatedly used, since the extractions are forced; a moment will arrive when the deficiency will make itself felt in the plants themselves, already adapted to a poor madium.

Phosphorous and potassium. The grammineous plants do not acknowledge their contribution at all, except if they go along with nitrogen. The leguminous plants (clover) respond discreatly to P-K. These elements favor the leguminous plants, which will dominate, growing in quality; but the same problem is always raised: when the response begins to be noticeable, then there are no profits; the profits do not cover the costs. Significant responses were seldom gotten.

A significant response to Ca, Mg, S, Cu, Mn, Zn, B and Mo was not found.

The optimum is obtained with about 140 kg/ha/year of nitrogen and about 40–50 kg/ha/year of P_2O_5. It is adviceable to add restoring dosages of potassiun and of the other elements (Ca, Mg, etc.).

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TABLE I

TREATMENTS AND DOSAGES

Treatment	1st. level $N+(P_2O_5+K_2O) = 50$			2nd. level $N+(P_2O_5+K_2O)=100$			3rd. level $N+(P_2O_5+K_2O)=150$		
	N kg/ha	P_2O_5 kg/ha	K_2O kg/ha	N kg/ha	P_2O_5 kg/ha	K_2O kg/ha	N kg/ha	P_2O_5 kg/ha	K_2O kg/ha
A	0	0	0	0	0	0	0	0	0
B	0	30	20	0	60	40	0	90	60
C	5	27	18	10	54	36	15	81	54
D	10	24	16	20	48	32	30	72	48
E	15	21	14	30	42	28	45	63	42
F	20	18	12	40	36	24	60	54	36
G	25	15	10	50	30	20	75	45	30
H	30	12	8	60	24	16	90	36	24
I	35	9	6	70	18	12	105	27	18
J	40	6	4	80	12	8	120	18	12
K	45	3	2	90	6	4	135	9	6
L	50	0	0	100	0	0	150	0	0

List of dominante plants in the experimental plots

Experimental plot nº. 1

1. Bromus racemosus L.
2. Alopecurus pratensis L.
3. Festuca rubra L.
4. Poa bulbosa L.
5. Vulpia bromoides (L) Gray
6. Carex divisa Huds
7. Trifolium repens L.
8. Rumex crispus L.
9. Bellis perennis L.
10. Taraxacum D. Leonis Desf.

Experimental plot nº. 2

1. Holcus lanatus L.
2. Anthoxanthum aristatum Boiss
3. Agrostis castellano B.R.
4. Vulpia bromoides (L) Gray
5. Festuca rubra L.
6. Hypochaeris radicata L.
7. Moenchia erecta Fl. de Wet.
8. Thrincia hirta Roth.
9. Convolvulus arvensis L.
10. Ornithopus perpusillus L.
11. Trifolium laevigatum L.
12. Trifolium dubium Sibth
13. Trifolium subterraneum L.

Experimental plot nº. 3

1. Agrostis castellana B.R.
2. Anthoxanthum aristatum Boiss
3. Vulpia bromoides (L) Gray
4. Bromus mollis L.
5. Briza media L.
6. Convolvulus arvensis L.
7. Trifolium laevigatum Poir
8. Trifolium dubium Sibth
9. Lathyrus angulatus L.
10. Trifolium striatum L.
11. Moenchia erecta Fl. de Wet.
12. Festuca rubra L.

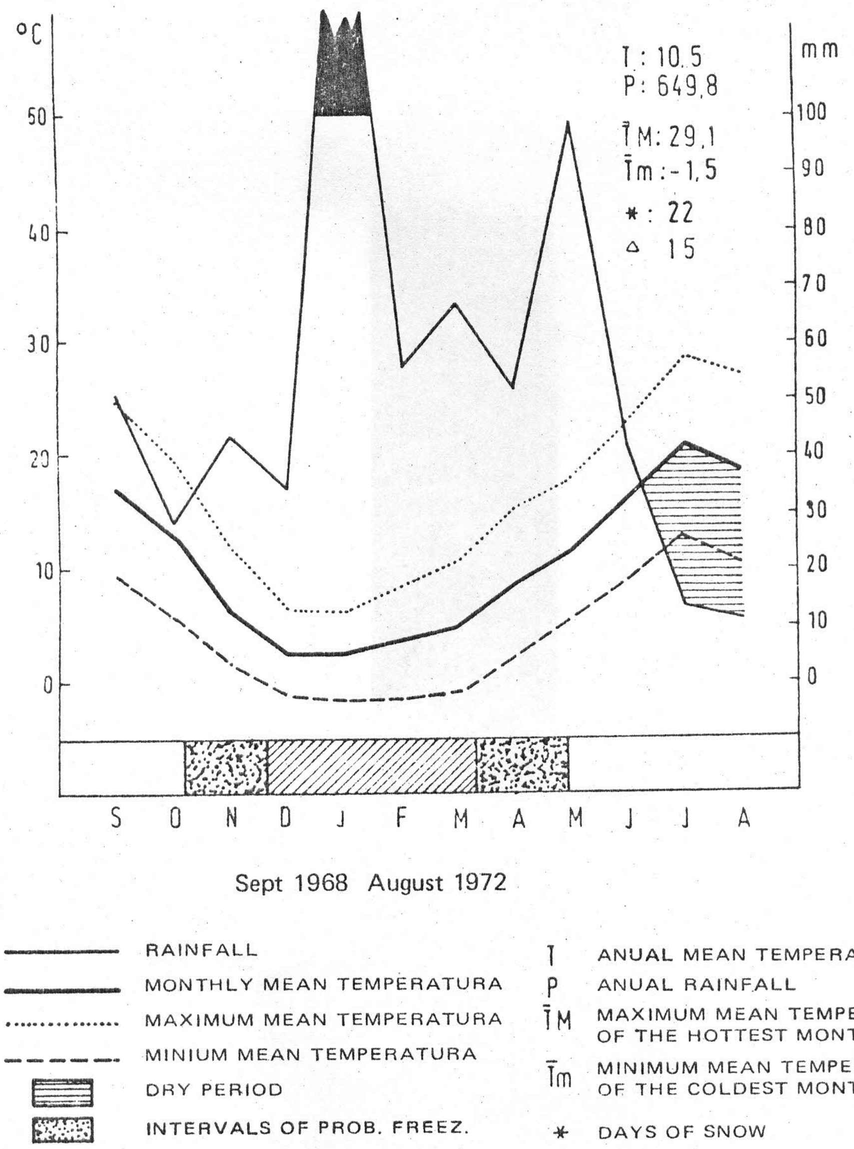
Experimental plot nº. 4

1. Agrostis castellana B.R.
2. Anthoxanthum aristatum Boiss
3. Vulpia bromoides (L) Gray
4. Festuca rubra L.
5. Vulpia myuros (L) Gmel.
6. Trifolium subterraneum L.
7. Merendora bulbocodium Ram
8. Myosotis sp.
9. Trifolium laevigatum Poir

ALMENDRA DAM (765 m)

mean values over four years

(1.969-72)



Sept 1968 August 1972

RAINFALL

MONTHLY MEAN TEMPERATURA

MAXIMUM MEAN TEMPERATURA

MINIUM MEAN TEMPERATURA

DRY PERIOD

INTERVALS OF PROB. FREEZ.

INTERVALS OF SURE FREEZING

RAINFALL SUPERIOR TO 100 mm.

T ANUAL MEAN TEMPERATURA

P ANUAL RAINFALL

T̄M MAXIMUM MEAN TEMPERATURA OF THE HOTTEST MONTH

T̄m MINIMUM MEAN TEMPERATURA OF THE COLDEST MONTH

✱ DAYS OF SNOW

△ DAYS AF HAIL

FIG. 1

EXPERIMENTAL PLOT Nº 1

mean values over four years

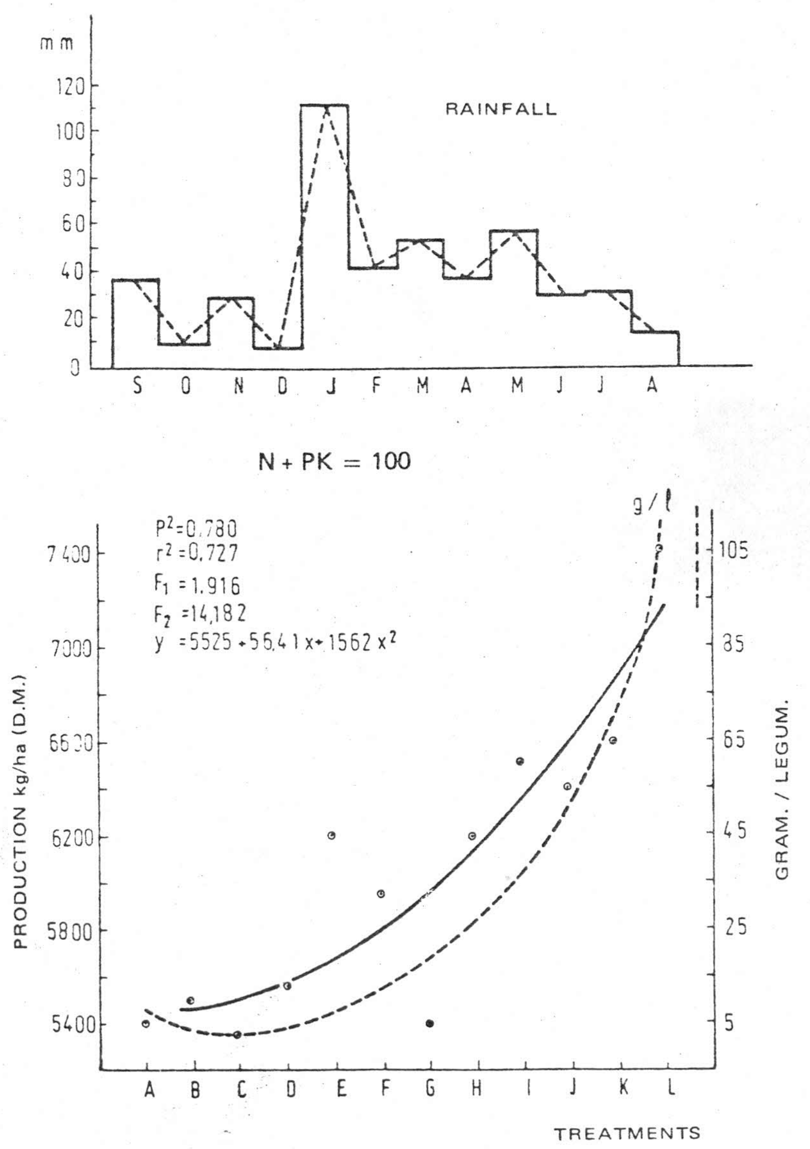


FIG. 2

EXPERIMENTAL PLOT Nº 2

mean values over four years

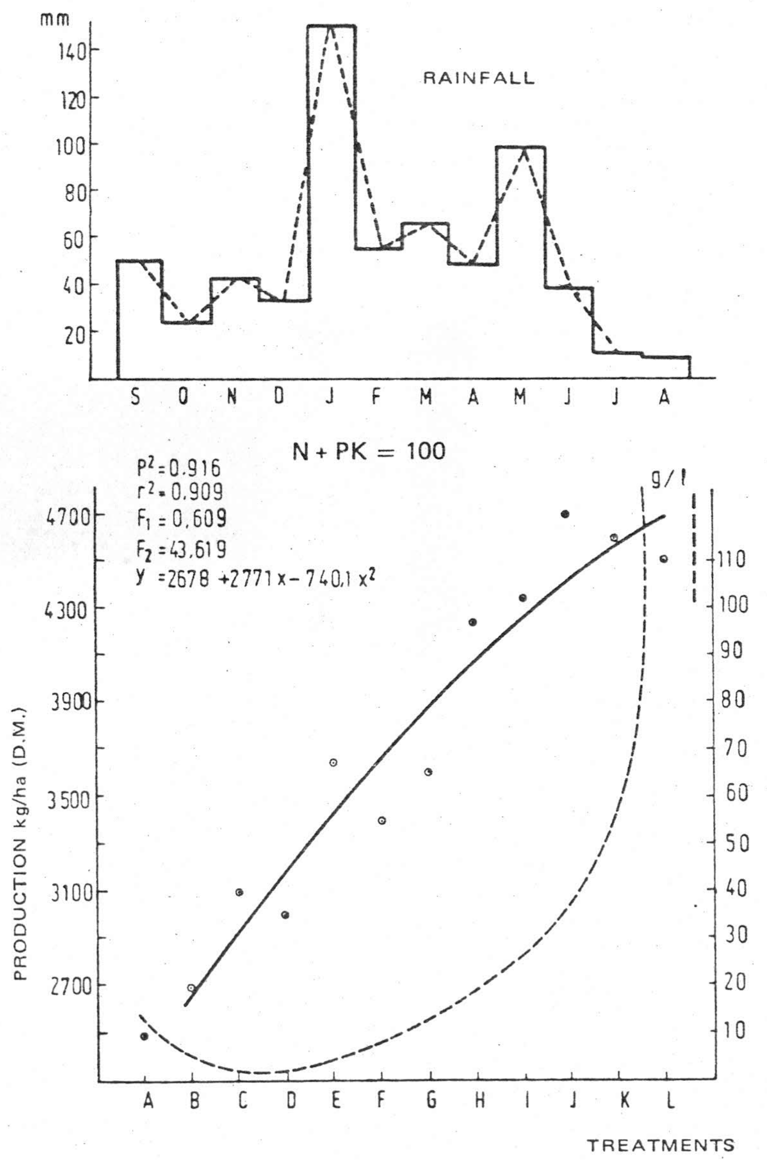


FIG. 3

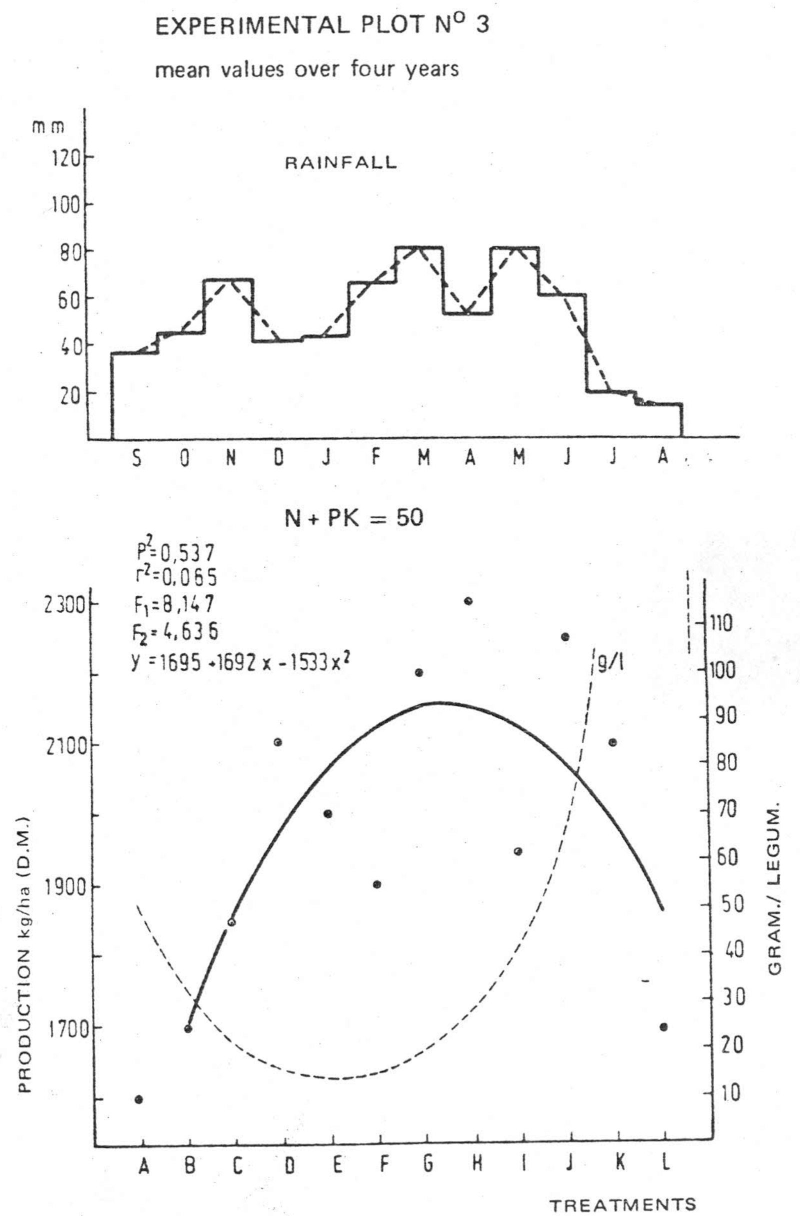

EXPERIMENTAL PLOT N° 3
mean values over four years
RAINFALL
m m
120
100
80
60
40
20
S O N D J F M A M J J A
N + PK = 50
P²=0,537
r²=0,065
F1=8,147
F2=4,636
y =1695 +1692 x -1533 x²
2300
2100
1900
1700
PRODUCTION kg/ha (D.M.)
g/l
110
100
90
80
70
60
50
40
30
20
10
GRAM./ LEGUM.
A B C D E F G H I J K L
TREATMENTS

FIG. 4

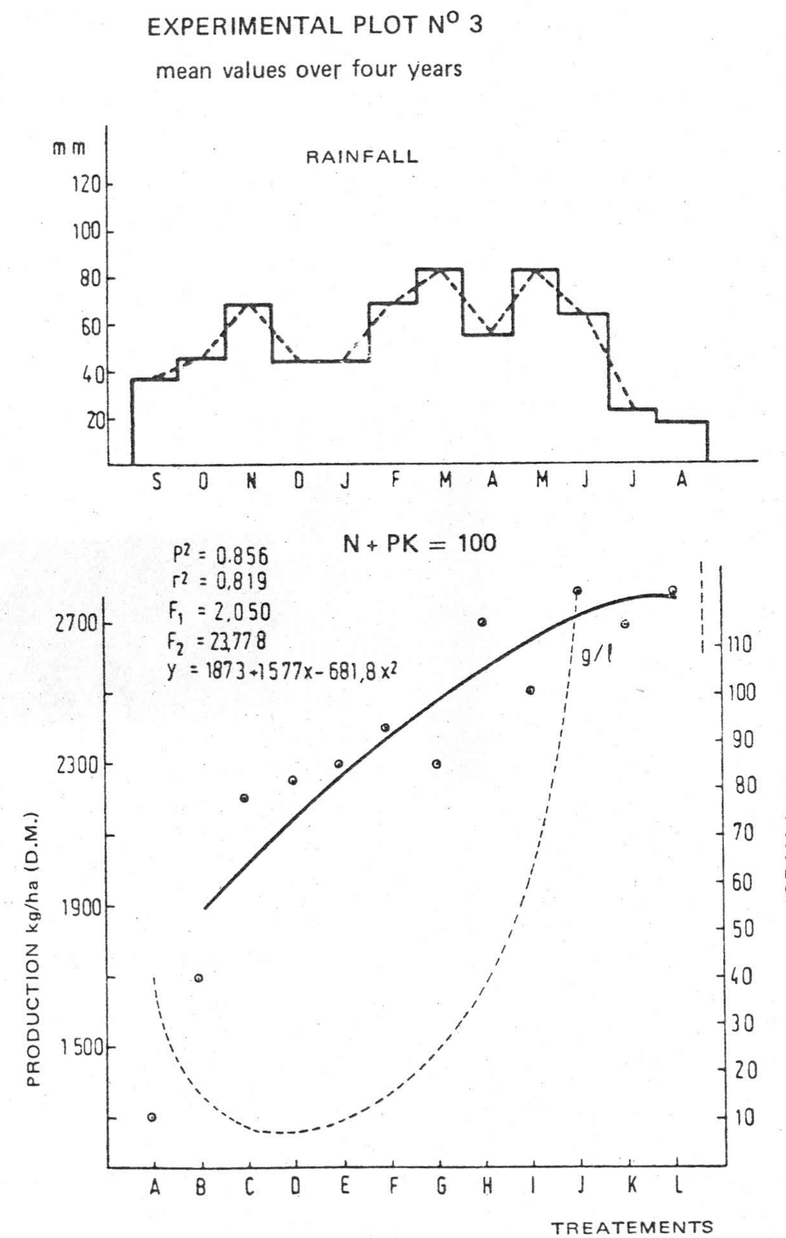
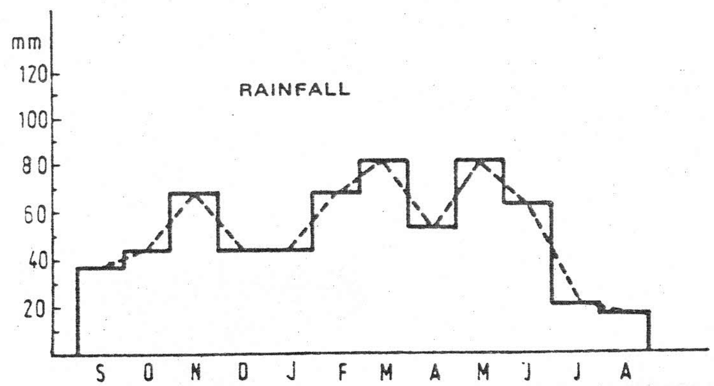

EXPERIMENTAL PLOT N° 3
mean values over four years
RAINFALL
m m
120
100
80
60
40
20
S O N D J F M A M J J A
N + PK = 100
P² = 0.856
r² = 0,819
F1 = 2,050
F2 = 23,778
y = 1873+1577x-681,8 x²
2700
2300
1900
1500
PRODUCTION kg/ha (D.M.)
g/l
110
100
90
80
70
60
50
40
30
20
10
GRAM./LEGUM.
A B C D E F G H I J K L
TREATEMENTS

FIG. 5

EXPERIMENTAL PLOT N° 3

mean values over four years



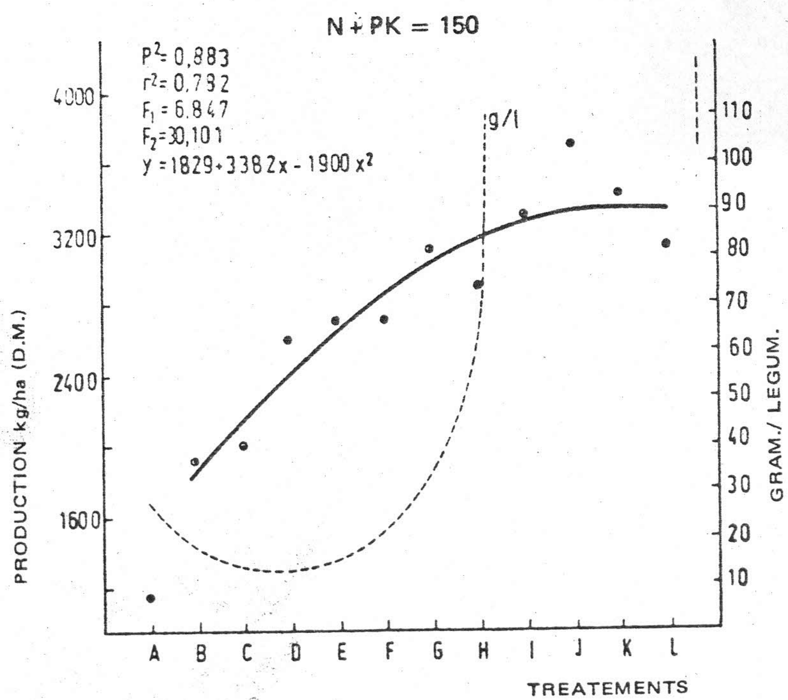
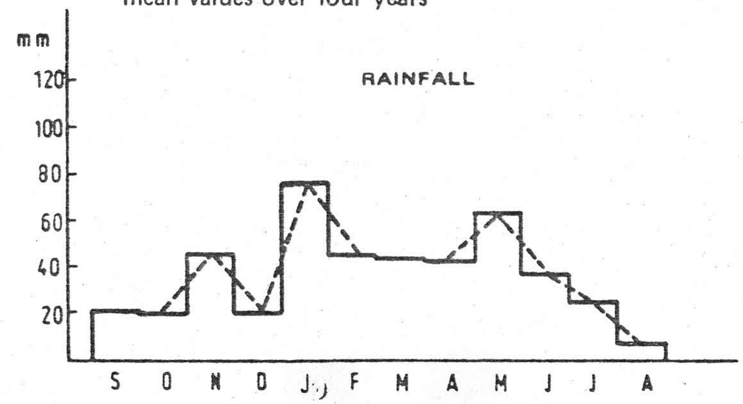


FIG. 6

EXPERIMENTAL PLOT N° 4

mean values over four years



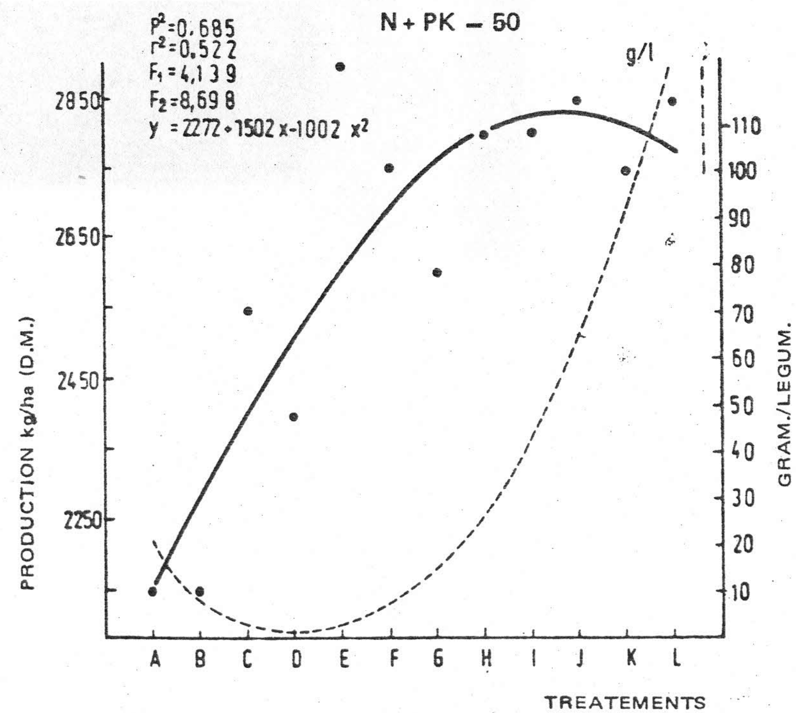


FIG. 7

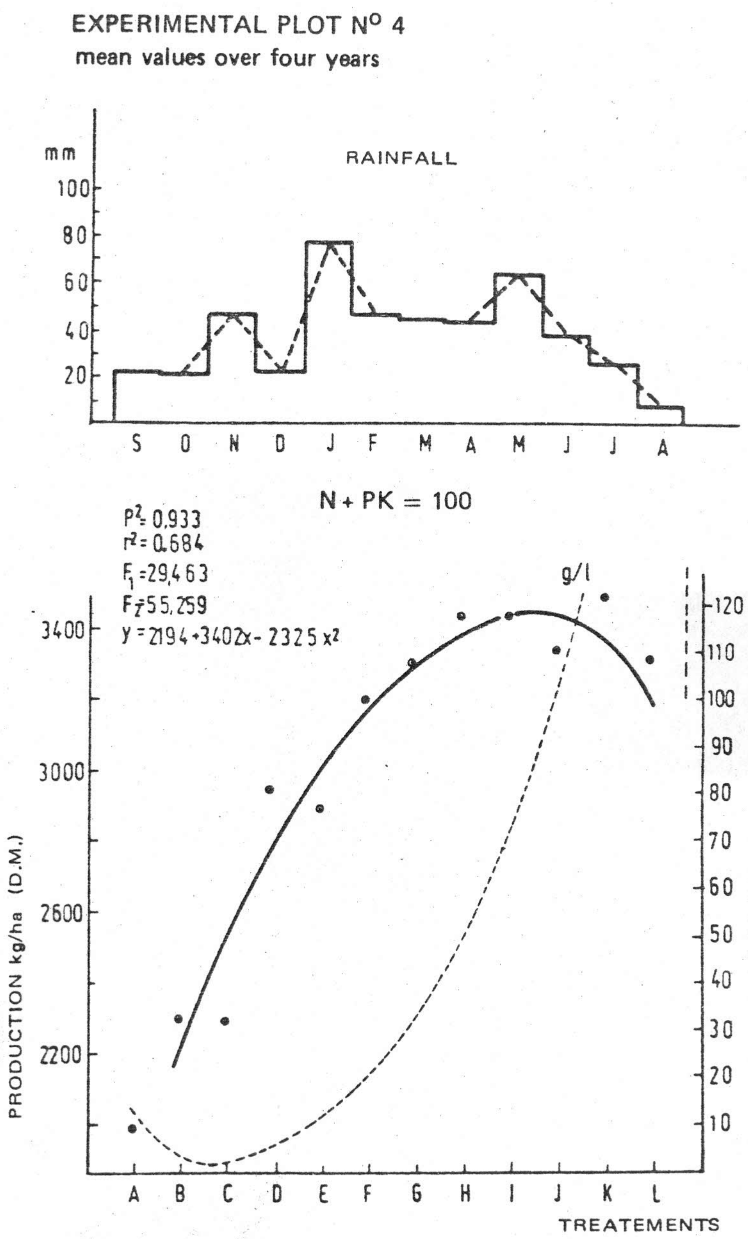

EXPERIMENTAL PLOT N° 4
mean values over four years
RAINFALL
mm
100
80
60
40
20
S O N D J F M A M J J A
N + PK = 100
P² 0,933
r² 0,684
F1 =29,463
F2 55,259
y = 2194 + 3402x - 2325 x²
g/l
3400
3000
2600
2200
120
110
100
90
80
70
60
50
40
30
20
10
PRODUCTION kg/ha (D.M.)
GRAM./LEGUM.
A B C D E F G H I J K L
TREATEMENTS

FIG. 8

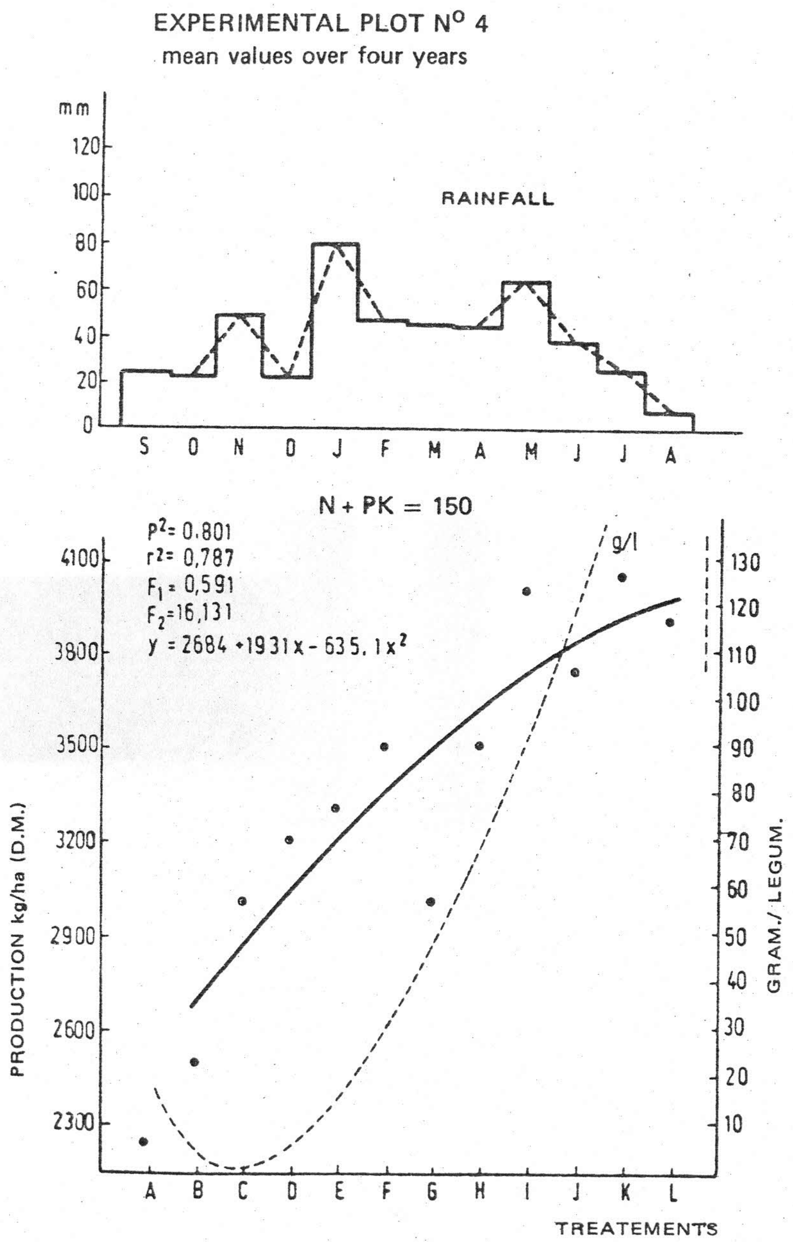

EXPERIMENTAL PLOT N° 4
mean values over four years
RAINFALL
mm
120
100
80
60
40
20
0
S O N D J F M A M J J A
N + PK = 150
P²= 0,801
r²= 0,787
F1 = 0,591
F2 = 16,131
y = 2684 + 1931x - 635,1x²
g/l
4100
3800
3500
3200
2900
2600
2300
130
120
110
100
90
80
70
60
50
40
30
20
10
PRODUCTION kg/ha (D.M.)
GRAM./LEGUM.
A B C D E F G H I J K L
TREATEMENTS

FIG. 9