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FERTILISATION MINERALE DE PEUPLIERS SUR UN SOL PROFOND D'ALLUVIONS SABLONNEUSES

par

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RESUME

Un essai de fertilisation a été fait sur des peupliers dans un sol profond d'alluvions sablonneuses de la vallée du Pô. L'analyse a montré que le sol contenait peu d'azote et peu de matières organiques et on a employé un engrais complet (N_2:P_2O_5:K_2O; 20:10:10). L'engrais était placé dans le trou de plantation ou réparti sur toute la superficie, aux doses d' 1,66 et 3,32 kg par plant.

Il n'y a pas eu d'influence statistiquement significative sur la circonférence ou la section du fût à 1,30 m au-dessus du sol. La croissance des plants, y compris celle des témoins, a été excellente pendant la période étudiée (jusqu'à la cinquième année à partir de la plantation) et nettement plus forte qu'on n'aurait pu le prévoir d'après les teneurs en azote et en matières organiques fournies par l'analyse chimique du sol.

La cause de ce manque de réponse à une fertilisation minérale dans un sol si évidemment pauvre en azote et en matières organiques doit être recherchée dans la fertilité potentielle du sol et dans la capacité des plants d'explorer et d'utiliser une masse considérable de terre; il est probable que les racines utilisent de façon permanente une couche d'au moins deux mètres d'épaisseur et disposent donc d'une réserve considérable d'éléments nutritifs.

L'évaluation d'un sol d'après l'analyse chimique ne suffit pas pour déterminer la nature et la quantité d'engrais à employer. On obtient certainement des indications plus précises de la croissance possible si on tient compte des caractéristiques microbiologiques, physiques, mécaniques et hydrologiques du sol au voisinage des racines.

Communication non sollicitée

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SIMPOSIO INTERNACIONAL FAO/IUFRO SOBRE EL EMPLEO DE ABONOS EN LOS MONTES

París, 3 - 7 diciembre 1973

APLICACION DE FERTILIZANTES MINERALES AL ALAMO EN SUELOS PROFUNDOS, ALUVIALES Y ARENOSOS

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RESUMEN

Se realizó un experimento de aplicación de fertilizantes a álamos plantados en terreno profundo, aluvial, arenoso en el valle del Po. El análisis reveló que el suelo era pobre en nitrógeno y en materia orgánica. Se empleó una mezcla de fertilizantes (N_2:P_2O_5: K_2O, 20:10:10), que se puso en el hoyo antes de colocar la planta o se esparció por toda el área a razón de 1,66 y de 3,32 kg/planta.

La aplicación de fertilizante mineral en el hoyo o esparcido no surtió ningún efecto estadísticamente significativo sobre el incremento del tronco en circunferencia o en área basal a 1,30 m del suelo. Los incrementos de las plantas, inclusive las testigo en el período estudiado (hasta los cinco años de realizada la plantación) son excelentes y por consiguiente mayores de lo previsto, considerando las cantidades de nitrógeno y materia orgánica reveladas por el análisis químico del suelo. La razón de la falta de reacción del álamo a la aplicación de fertilizante mineral en un suelo tan evidentemente pobre en nitrógeno y en materia orgánica debe buscarse en la fertilidad agrícola potencial del suelo y en la capacidad de la planta de explorar y aprovechar una masa considerable de terreno. Se supone que la profundidad del suelo que se ve sometida permanentemente a la acción de las raíces es de por lo menos 2 m, de manera que la reserva de nutrientes disponibles es muy abundante.

La evaluación del suelo basándose en el análisis químico es insuficiente para averiguar el tipo y dosis de fertilizante que se precisa. No hay duda de que una evaluación del suelo tomando en consideración sus características microbiológicas, físicas, mecánicas e hidrológicas indica con mucha mayor precisión el potencial de crecimiento.

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FAO/IUFRO - International Symposium on Forest Fertilization

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MINERAL FERTILIZING OF POPLAR ON DEEP, ALLUVIAL, SANDY SOIL

by

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INTRODUCTION

Reports of responses of poplar to fertilizers are not lacking in specialized literature. In France, Viart (1965) has found a positive response to phosphorus in soils deficient in this element. According to this author the response was still more pronounced when the phosphorus was used in conjunction with potassium particularly as potassium sulfate and the best treatment were those with PK or with NPK. The use of nitrogen alone had little effect on increment but it augmented the effect of PK and gave an impetus in periods of vegetative recovery such as that following attack by Dothichiza.

Positive responses of poplar to complete fertilizer (NPK) have also been obtained by the author in soils whose fertility was reduced as a consequence of agricultural cropping. The results will be published shortly.

Despite previous research (Giardini A., 1963; Tosi C., 1966) the significance of fertilizers in poplar production in the recent, deep alluvial soils of the Po Valley remains to be explained. The major part of the italian poplar stands are established on such soils.

Poplar over a rotation of 10-13 years on the basis of a dry weight production of 900 q/ha of bole and branches, 124 q/ha of stump and roots and 215 q/ha of leaves, absorbs from a hectare of soil 557 Kg of N_2, 172 Kg of P_2O_5, 625 Kg of K_2O and 1,650 Kg of CaO. Granted that all the leaves and roots remain in the soil then 163, 75, 239 and 580 Kg/ha of N_2, P_2O_5, K_2O and CaO respectively are removed. It seems likely that, at least in those soils not subject to annual flooding, it would be possible to show a consequent reduced fertility. This would necessitate the addition of fertilizers, at the appropriate time, to maintain if not to increase their present high productivity.

A fertilizer trial was set up to supply new experimental data. This was established near Torricella del Pizzo (Cremona) in an area used also for agriculture beeing protected from flooding by banks. The soil, reasonably representative of poplar plantings on the flood plain of Po and in which poplars had already been cultivated, was chemically analysed using methods described previously (Frison, 1969).

This analysis showed that surface zone (extending 70-100 cm from ground level) was sandy (sand 77%, silt 17%, clay 6%) with a slightly alkaline reaction, rich in readily accessible potassium (mean 30 p.p.m.), quite rich in total P_2O_5 (mean 1.23%) but poor in total nitrogen (mean 0.065%) and organic matter (mean 0.97%). At depth (extending from 1 to approx. 2 metres) where sand formed 98% the soil had a subalkaline reaction and was very poor in essential nutrients (P_2O_5 total = 0.6-0.8%, K_2O accessible = 4 p.p.m. and humus 0.35%).

The water table, recorded on a nearly area of the same farm, usually varied in depth from 2 to 3 metres in spring to 3.5 or 4.5 metres in summer-autumn. At the end of November 1968 the soil, which had been thought to be sufficiently protected from flooding, was unespectedly inundated and remained submerged for some days because of a rise in the Po.

Considering the analytical data given above a mixed fertilizer (20: 10: 10, N: P_2O_5 : K_2O ratio) was used. This was applied in rather large doses in the hope of obtaining a pronounced response

MATERIALS AND METHODS

-Factors studied: Means of applications of the N, P and K mixed fertilizer (control, localised application in the planting hole, distribution over le whole area) at dose levels of 1.66 and 3.32 Kg per plant.

-Experimental design: Completely randomized with five replications.

-Experimental unit: Plots of 1,282 m^2 (spacing 6.5 x 5.62 m equivalent to 36.53 m^2 per plant) comprising 35 plants of which only 15 were measured. These were selected in the centre of the plots to avoid edge effects.

-Clone : *Populus* x *euramericana* (Dode) Guinier, 'I-214'.

-Date of Establishment: Mid-February 1968

-Method of Planting: The two year old poplars were planted at a depth of 1.80-2.00 metres in holes bored with a soil bit. These holes were bored to a depth of 1 metre by a tractor operated bit of 50 cm diameter and bored to their final depth with a hand operated bit of 10 cm diameter. The deep establishement was made to ensure as far as possible to success of rooting.

-Method of fertilizer distribution: In the case of localized application of fertilizer the chemicals were thoroughly mixed with soil (about 20 Kg) and then placed in the planting holes around the boundary to avoid the possibility of burning the newly formed roots, at a depth of 15-65 cm.

-Preceeding Culture-Poplars: After the felling of the poplars and extraction of the stumps, the soil was fertilized with Thomas phosphate (18% P_2O_5) and potassium sulfate (50% K_2O) at 8 and 3 q/ha respectively, ploughed to a depth of 0.7-0.8 m, and sown to wheat for one year.

-Culture Care :Frequent discing, some spraying and control treatments for parasites.

-Surveys:

a) To investigate the immediate response to manuring at the end of August 1968, when it was considered that the annual increment had been largely obtained, the contents of N_2, P_2O_5 and K_2O were evaluated, using analytical methods described previously (Frison, 1969). The analysis was performed on the fourth branch (from the top) of each of seven plants selected at random from each plot.

b) The effect on wood production was calculated in the year of treatments and also in the 4 years following by measurement of the circumference of the trunk at 1.3 m above ground level.

-Statistical analysis of data: analysis of variance of data. The significance of the means was then tested using Duncan multiple range test.

RESULTS

The data of increment at the conclusion of the first year (tables 2 and 3) suggest a reduced development of the plants fertilized with the highest level of fertilizer localized in the planting holes (3.32 Kg per plant). This was probably caused by the caustic effect of the fertilizer on the new roots despite the precautions taken in the application.

At the end of August 1968, the period when the variation in mineral concentration in tissue is minimal, no significant differences were apparent in nitrogen or phosphate level between branches selected from plants of the various treatments. Only the concentration of K_2O in the branches sampled from plants of the localized fertilizer treatments (3.32 Kg per plant) was higher than in comparable branches of plants

from the unfertilized or fertilizer distributed treatments (table 1). Hence in conditions of abundant available potassium poplar is able to absorb more of this element than it requires without improving the development or growth thus demonstrating luxury consumption.

Mineral fertilizing, whether localized or distributed, has had no statistically significant effect on increment of either circumference or basal area of the bole (tables 2 and 3). The increments of the plants, including that of the control, over the period studied (up to the 5th year from establishment in the field) are similar to those of trees in the first class of the schema of productivity of Prevosto (1965) for plantations of the same density. This is greater than would have been forecast taking into consideration the levels of nitrogen and organic matter indicated in the chemical analysis of the soil. Where the fertilizer was localized in the planting holes at a level of 1.66 Kg per plant there is a trend for a higher increment compared with that of the control, however the difference is not statistically significant ($P = 0.05$).

The reason for lack of response in the poplars to mineral fertilizing despite the evident poverty of the soil in total nitrogen and organic matter, must be looked for in potential agricultural fertility of the soil and the capacity of the plants to explore and draw upon a considerable mass of soil. This is true despite the unfortunate flooding which occured in 1968 and which must be considered as having affected the increment in 1969. In particular this would have affected the comparison between the control plots and those with fertilizer distributed over the whole area.

In regard to the volume of soil explored it must be remembered that the plants having been established at a depth of 2 metres have been able to draw on the soil water table which varied between 2 and 3 metres in spring. During the summer the ground-water table falls to below 4 metres on occasions and in such circumstances irrigation may be necessary.

The depth of soil permanently drawn on by roots is presumably at least 2 metres thus a considerable mineral reserve is available even considering the nutrient removed by the plants. The extent of this removal, as has already been indicated, is not negligible in poplar plantations.

The results of this experiment again demonstrate that evaluation of a soil on the basis of chemical analysis is insufficient to indicate the type and dosage of fertilizer required.

An evaluation of soil which takes into account its physical, mechanical, microbiological and hydrological characteristics in the root zone is certainly a more precise indicator of potential growth. The superficial layers of the soil in the experimental site had a textural condition very suitable for poplar growth. The structure was especially

favourable as a consequence of the repeated floodings in the past years.

The underlying texture was sandy and chemical analysis indicated that its nutrient content was poor. It is possible however that, at least as far as available potassium is concerned, the quantity of such element available to the roots is greater than the analysis indicates. The sand in these soils is very rich in silicates and in such instances chemical analysis does not always indicate the capacity for absorption on the part of the plant.

Summary

A fertilizer trial was carried out on poplars established in deep, alluvial sandy soil of the Po Valley. Analysis indicated that the soil was poor in nitrogen and organic matter and a mixed fertilizer (N_2 :P_2O_5: K_2O , 20: 10: 10) was used. The fertilizer was localized in the planting hole or distributed over the whole area at dose level of 1.66 and 3.32 Kg per plant.

Mineral fertilizing, whether localized or distributed had no statistically significant effect on increment of either circumference or basal area of the bole at 1.30 m above ground level. The increments of the plants, including that of the control, over the period studied (up to the 5th year from establishement in the field) are excellent and consequently greater that could have been forecast considering the levels of nitrogen and organic matter indicated in the chemical analysis of the soil.

The reason for lack of response in the poplars to mineral fertilizing in a soil so obviously poor in nitrogen and organic matter, must be looked for in potential agricultural fertility of the soil and the capacity of the plants to explore and draw upon a considerable mass of soil. The depth of soil permanently drawn on by roots is presumably at least 2 metres thus a considerable nutrient reserve is available.

The evaluation of a soil on the basis of chemical analysis is insufficient to indicate the type and dosage of fertilizer required. An evaluation of soil which takes into account its microbiological, physical, mechanical and hydrological characteristics in the root zone is certainly a more precise indicator of potential growth.

tab. 1

Mean length, dry weight and N_2, P_2O_5 and K_2O content of the fourth branch (from the top) of poplars fertilized at planting with mixed fertilizer (N_2: P_2O_5: K_2O, 20:10:10). The plants were established in mid-February 1968 and sampled the 27th August 1969

Treatment	Length (m)	Dry weight (g)	% dry weight		
			N_2	P_2O_5	K_2O
Control	1.51	34.45	0.768	0.268	0.852 aA
Kg 1.66 in planting hole	1.48	31.60	0.786	0.276	0.893 abcAB
Kg 3.32 in planting hole	1.39	28.16	0.808	0.287	0.956 cB
Kg 1.66 distributed	1.59	37.94	0.714	0.262	0.808 abA
Kg 3.32 distributed	1.60	37.08	0.779	0.259	0.801 aA
Value F_c	2.60 n.s.	1.92 n.s.	2.59 n.s.	1,25 n.s.	8,27 ++

n.s. = not significant

\+ = significant P = 0.05 ; ++ = significant P = 0.01

F_t : 3.01 (P = 0.05); 4.77 (P = 0.01)

Any two means marked by the same letter are not significantly different (small letter for a 5% level test, capital letter for a 1% level test).

Tab. 2

Mean girth (cm) at 1.30 m above ground level

Treatment	At planting	end 1968	end 1969	end 1970	end 1971	end 1972
Control	13.87	20.66 b	38.30	49.47	61.53	72.01
Kg 1.66 in planting hole	13.72	20.79 b	39.39	52.09	64.92	75.24
Kg 3.32 in planting hole	13.41	19.20 a	37.04	49.51	61.89	71.97
Kg 1.66 distributed	13.67	20.66 b	37.49	48.89	60.65	71.27
Kg 3.32 distributed	13.67	20.76 b	36.89	48.79	60.31	71.09
Value F_c	0.76 n.s.	3.62 +	1.13 n.s.	1.34 n.s.	1.24 n.s.	1.12 n.s.

Tab. 3

Mean basal area increment (cm^2) at 1.30 m above ground level

Treatment	Basal area at planting	Annual increment					Basal area end 1972
		1968	1969	1970	1971	1972	
Control	15.32	18.89 b	83.21	78.49	107.33	110.45	414
Kg 1.66 in planting hole	14.99	19.53 b	89.34	93.59	120.01	114.42	452
Kg 3.32 in planting hole	14.32	15.21 a	80.66	86.32	110.57	106.31	413
Kg 1.66 distributed	14.88	19.33 b	78.68	78.69	102.91	111.21	406
Kg 3.32 distributed	14.88	19.23 b	74.83	80.90	100.22	112.57	403
Value F_c	0.96 n.s.	3.23 +	1.17 n.s.	1.99 n.s.	1.48 n.s.	0.20 n.s.	1.14 n.s.

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