

## RESPONSE OF HYBRID POPLAR TO THE APPLICATION OF MAJOR FERTILIZER NUTRIENTS AT CHANGA MANGA

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### Abstract:

A study in a 4 year old crop of hybrid poplar (P x Ecr. 1-214) was conducted in Changa Manga plantation in 1978. Nitrogen, Phosphorus and Potash fertilizers alone and in different combinations were tried in these studies. Data on height and diameter of plants were recorded from 1978-82. The results did not reveal any significant differences in plant height and diameter. However, the nutrient uptake by the leaves of treated plants during the first vegetative growth period increased significantly.

### Introduction:

Hybrid poplar (P x Ecr. I-214) has become a common cash crop among the farmers of Pakistan in a short time due to its multipurpose utilization. Generally, this crop is raised on irrigated fields and ridges of cultivated lands. It can be raised on soils where higher watertable makes the successful growth of other field crops uneconomical. A poplar plant has a high water requirement and as such the evapo-transpiration losses of moisture are also high. Therefore, it can lower the watertable of the Fields to reversible depth.

Field observations in other countries have shown that poplar plantation grows well in areas where the soil is deep, non-calcareous and light in texture. The ideal growing conditions, among other things, include a moderate temperature and medium but well distributed rainfall. Furthermore, the area should be irrigated with an adequate internal soil drainage with depth from the surface to the watertable equal to or greater than 1.5m (moderate watertable), and it should be fertile and weeds free (Burg, 1977; Prison et al, 1982; and Woods and Hanover, 1982).

The purpose of this study was to evaluate the response of poplar to the application of N, P and K fertilizers alone and in various combinations.

### Materials and Methods:

(i) *Description of the Experimental Site:* Changa Manga lies at an altitude of 201 m above sea level. It is situated in Chunian Tehsil, 74 km south-east of Lahore. The plantation gets its water from the Upper Bari Doab Canal. The average annual rainfall is about 35 cm during monsoon with casual showers during winter. Temperature of the area differs widely in different seasons of the year and goes up to 50°C in summer and falls down to 8°C during winter. Frosty nights are common. Humidity is very high and the atmosphere is stuffy during monsoon season. Hot wind-storms in summer season are common. The plantation consists of shisham, mulberry and bakain as principal species; and some admixture of acacia, Farash,

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Jand and Mesquite also occur in some blank poor sites.

(ii). *Experimental Design*: An area of 1.2 hectare covering a healthy patch of uniform sized, four-year old crop of poplar planted at 5 x 5 m spacing at Changa Manga Forest Division (Punjab), was selected for this study during 1978. In order to obtain the best response of fertilizers on stand growth, the experimental area was ploughed with tractor and the weeds were removed to minimize the competition of the undesirable plants with poplar stand. Each tree was marked and the side branches were pruned off upto breast height. Eight fertilizer treatments, viz, control, N, PP K, NP, Nk, PK, and NPK were used in four replications in a "Factorial Design" taking sixteen plants as test material under each treatment. Urea (46%N), single superphosphate (20%  $P_2O_5$ ), and potassium sulphate (50%  $K_2O$ ), were broadcast on plot basis, on 21-8-1978 at the rates of 667, 750, and 288 kg per hectare on nutrient basis and worked into the soil thoroughly with plough. The experimental area was irrigated with canal water on the same day just after the application of fertilizers. Duncan Multiple Range test was applied and the measurement of height and diameter was recorded from 1978-82.

(iii) *Characteristics of Site Quality*: Soil fertility which partially controls the productivity of a soil and satisfies the plant needs within a climatic and genetic zone is ranked and assayed through soil and foliar analysis. The basic premise of soil analysis is that a plant responds to what it contains. What plants contain relates directly to how will they grow. It offers a direct means for determining soil nutrients availability & for recognising which nutrient is primarily restricting plant growth. Whereas the foliar analysis estimates the site productivity and screens out stands for fertilization.

To evaluate the site quality, soil sampling was done before fertilization at a depth of 0-30, 30-60, 60-90, and 90-120 cm, taking eight pits in each replication. In order to get representative samples of the entire study area, samples from different pits at similar depths were mixed up and made as "composite samples". In all four samples were prepared and analysed for physico-Chemical parameters (Table-1), using the standard methods outlined by Chapman and Pratt (1961); Lambert (1976); and Khan and Rafiq (1980).

Soil analysis indicate that the soil of the experimental area is alluvial, mostly silt-loam with varying proportion of clay fraction (18-22%) and a dominant ratio of silt particles (51-55%). In depth fairly uniform Kankars (Concretion of Lime) and on the surface Kallar (Alkali) are found in small patches. The surface soil is enriched with the deposits of regular leaf-fall and the canal silt. The pH is alkaline (7.8 - 7.9) with calcium carbonate contents (1.9-2.9%) and total soluble salts (0.026%). The total organic matter (0.9-0.4%); total nitrogen (0.092-0.046%), available phosphorus (13-8 ppm); and the exchangeable potassium (237-200 ppm) are higher at the surface layer and decrease at the lower depths (Table-1). Such physico-chemical characteristics of the experimental areas are moderate for the establishment of poplar plantations (Burg, 1977; Prison et al, 1982; and Woods and Hanover, 1982).

(iv). *Collection of Foliage Samples*: Four plants out of sixteen in a single treatment were randomly selected. The sampling was done from the upper, middle, and lower branches at crown levels and the leaves were mixed to get "composite sample" for a single treatment. Sampling was done in the month of August when the vegetative growth is held up and the



nutrient cycling from one vegetative part to the other is almost complete (Smalley, 1976). The samples were chemically analysed for N, P, and K contents following the procedure of Chapman and Pratt (1961); and Lambert (1976).

### Review of Literature:

(i). *Effect of Fertilization on Poplar Growth*: Fertilization studies of Poplar crop were conducted in France (IFC, 1976). N, P and K fertilizers were applied at the rate of 80, 150, and 80 kg of N,  $P_2O_5$ , and  $K_2O$  per hectare at the time of planting. The same fertilizer doses were repeated each year for consecutive eight years after planting. Results showed significant effect of fertilizers on the growth in 95% cases, the increase in girth was reported 1-2 cm per 3 to 4 year. Blackmon (1977), studied the effect of nitrogenous fertilizers and the site quality on cottonwood stand. He observed that the application of 336 kg N per hectare increased the diameter growth by 33% over control plants.

Burg (1977), studied the growth response of Euramerican poplar (Clones of Robusta & Gelrica) to N content of soil Organic matter upto 6% (at 0-25 cm depth) promoted significant growth. However clones of Gelrica showed some retarded growth due to heavy soil texture, K deficiency and pH value ranging less than 4.5 to 6.0. Burg and Peeters (1977), Studied the effect of N, P, K, and Mg fertilization on growth and foliar mineral composition of different tree species on young marine soils. They reported that Euramerican poplar responded well to Calcium ammonium nitrate (23%N) fertilization at the rate of 100-200 gram per tree during the first year after planting. However P, K, and Mg fertilizers did not improve the growth because of the presence of these nutrients in soils in an adequate amount.

Coyne and Cleve (1977), studied the influence of augment levels of N, P, and K fertilization at the rate of 111, 55, and 111 kg of N,  $P_2O_5$ , and  $K_2O$  per hectare on populus tremuloides Michx. They observed that the canopy leaf area, leaf biomass, specific leaf weight, and the height growth were doubled by N, P and K fertilization. Prison et al (1982), found iron chlorosis in poplar stands in Italy. They noticed that the abnormal crop growth and chlorosis resulted in planting sites where the soils were shallow in nature, heavy in texture, low in temperature, heavy in rainfall and irrigation (high watertable at 55 cm depth), dense in plantations; soils high in both total and active carbonate contents, and higher in pH values; soils containing higher O.M; available N, P, K, B, exchangeable Ca, Mg, Ca/Fe ratio,  $CO_2$  contents; and soils low in Mn and Zn contents. Likewise observations have been reported for the well establishment of poplar field crop by Woods and Hanover (1982).

(ii). *Effect of Site Quality and Fertilization on the Uptake of Mineral Nutrients in Foliage*: Studying the seasonal variation in nutrient composition of yellow poplar, Smalley (1976), found that foliar N content decreased during the growing season. It was constant in the middle of August and then decreased. The P content remained relatively stable but the K and Mg contents gradually increased. The Ca content increased rapidly in early summer and then decreased in the Middle of September and reached a seasonal high before leaf abscission. Blackmon (1977), studied cottonwood response to nitrogen related to plantations age and site quality. He observed that nitrogenous fertilization significantly increased the foliar N level regardless of the age factor.

Burg and Peeters (1977), found deficiency symptoms in poplar plantations at the foliar N concentration less than 2.2% in first year planting. Coyne and Cleve (1977), reported that nitrogen fertilization significantly increased the foliar N content and reduced K, Ca, and Mg contents; total non-structural carbohydrate (TNC) contents in poplar. They postulated that the reduction of these constituents in poplar could be due to dilution effect resulting from the enhancement in growth by nitrogen fertilization. Whereas phosphorus fertilizer had not significant effect on foliar N content but increased the foliar P and Ca contents throughout the season and resulted in higher K content during the half of the season. Potash fertilization increased the foliar K content. They observed that nitrogen treated stand contained 3.1% N in foliage against 2.3% N in non-fertilized stand. Prison et al (1982), have reported 2.1-4.0% N, 0.2-0.5% P and 1.0 - 2.6% K respectively for healthy poplar foliar nutrient levels.

### Results and Discussions:

The statistical analysis indicated no significant effect of different rates of Fertilizers over the control (Table-2). The negative response observed for the N, P and K fertilization alone and in different combinations in respect of height and diameter growth, could be attributed to insufficient and unbalanced N, P and K fertilization for the establishment of poplar crop, as pointed out by (IFC, 1976; Blackmon, 1977; Burg 1977; Burg and Peeters, 1977; and Coyne and Cleve, 1977). It is therefore, emphasised that the crop needs the attention of proper cultural operation for weeds control and the application of judicious amount of N, P and K fertilizers each year at higher rates before the start of vegetative growth.



Table - 1  
Mechanical and Chemical Characteristics of Soil of Poplar Plantations at Changa Manga - Punjab

Physical Characteristics					Chemical Characteristics								
Sl. No.	Depth in cm	Sand percent	Silt percent	Clay percent	Textural class	pH (Sat. paste)	CaCO <sub>3</sub> equivalent %	ECx10 <sup>3</sup> e	T.S.S percent	O.M percent	N percent	P <sub>2</sub> O <sub>5</sub> ppm	K <sub>2</sub> O ppm
1.	0-30	27.0	55.0	18.0	Silt Loam	7.8	1.9	0.4	0.026	0.9	0.092	13	237
2.	30-60	25.0	53.0	22.0	—do—	7.8	1.4	0.4	0.026	0.6	0.069	8	237
3.	60-90	27.0	51.0	22.0	—do—	7.9	2.9	0.4	0.026	0.4	0.046	8	200
4.	90-120	26.0	53.0	21.0	—do—	7.9	2.8	0.4	0.026	0.4	0.046	8	200

Table - 2  
Effect of NPK Fertilization on Growth Rate and Foliar Mineral Composition of 4 Year old Hybrid Poplar Stand at Changa Manga (Punjab)

Sl. No.	Fertilizer Treatments	Growth Rate-Avg. values		Mineral composition-Avg. values		
		Height (m)	Diameter (cm)	N percent	P percent	K percent
1.	Control	21.8	25.6	2.2	0.2	1.5
2.	N = 667 kg N per hectare	22.8	25.4	3.8	0.3	1.7
3.	P = 750 kg P <sub>2</sub> O <sub>5</sub> per hectare	22.4	26.1	3.8	0.3	1.7
4.	K = 288 kg K <sub>2</sub> O per hectare	22.9	25.2	3.5	0.3	1.7
5.	NP = 667 kg N + 750 kg P <sub>2</sub> O <sub>5</sub> per hectare	21.9	25.2	5.1	0.5	1.8
6.	NK = 667 kg N + 288 kg K <sub>2</sub> O per hectare	22.9	25.4	4.5	0.4	1.8
7.	PK = 750 kg P <sub>2</sub> O <sub>5</sub> + 288 kg K <sub>2</sub> O per hectare	21.9	24.8	4.5	0.4	1.8
8.	NPK = 667 kg N + 750 kg P <sub>2</sub> O <sub>5</sub> + 288 kg K <sub>2</sub> O per hectare	21.8	24.0	5.5	0.6	1.9

(ii). All fertilizer treatments significantly affected the foliar mineral contents in general and the increase by NP and NPK was in particular during the first vegetative growth period after fertilization. The increase by NPK was 5.5% for N; 0.6% for P; and 1.9% for K contents which are highly significant at 1% level. These results are in close accordance with the findings of Blackmon (1977); Burg & Peeters (1977); Coyne & Cleve (1977); and Prison et al (1982) for healthy poplar leaves of almost similar planting age.

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Fertilizer treatments		Height (m)	Diameter (cm)	Volume (m <sup>3</sup> )
1. Control		31.8	53.0	3.4
2. N = 500 kg N + 250 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
3. P = 500 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
4. K = 500 kg K <sub>2</sub> O		31.8	53.0	3.4
5. N = 500 kg N + 250 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
6. P = 500 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
7. K = 500 kg K <sub>2</sub> O		31.8	53.0	3.4
8. N = 500 kg N + 250 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4

Fertilizer treatments		Height (m)	Diameter (cm)	Volume (m <sup>3</sup> )
1. Control		31.8	53.0	3.4
2. N = 500 kg N + 250 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
3. P = 500 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
4. K = 500 kg K <sub>2</sub> O		31.8	53.0	3.4
5. N = 500 kg N + 250 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
6. P = 500 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
7. K = 500 kg K <sub>2</sub> O		31.8	53.0	3.4
8. N = 500 kg N + 250 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4

Table - 5

Fertilizer treatments		Height (m)	Diameter (cm)	Volume (m <sup>3</sup> )
1. Control		31.8	53.0	3.4
2. N = 500 kg N + 250 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
3. P = 500 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
4. K = 500 kg K <sub>2</sub> O		31.8	53.0	3.4
5. N = 500 kg N + 250 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
6. P = 500 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4
7. K = 500 kg K <sub>2</sub> O		31.8	53.0	3.4
8. N = 500 kg N + 250 kg P <sub>2</sub> O <sub>5</sub> + 500 kg K <sub>2</sub> O		31.8	53.0	3.4

# REFERENCES

1. Blackmon, B.G. (1977). Cottonwood response to nitrogen related to plantation age and site. USDA. For. Serv. Resh. Note So - 299, 3P, South For. Expt. St (170), New Orlean La.
2. Burg, J.V.D. (1977). Growth of Euramerican poplar and N content of soil organic matter. Poplar, 14:55-58.
3. -----; and Peeters, J.P. (1977). Fertilization and mineral nutrition of hardwoods on young marine soils. Nederlands Boshouw Tijdschrift. 49: 253-263.
4. Chapman, H.D; and Pratt, P.F. (1961). Method of Analysis for Soils, Plants and Waters. Univ. Claif. Div. Agric. Sci. Berkley.
5. Coyne, P.I; and Cleve, K.V. (1977). Fertilizer induced morphological & Chemical response of Quaking Aspen stand in Interior Alaska-For, Sci. 23: 92-102.
6. International Fertilizer Correspondent-IFC. (1976). International Potash Inst; CH-3048, Berne-Worblaufen/ Switzerland. Vol. XVII. No.4.
7. Khan, G.S; and Rafiq, M. (1980). Chemical Analysis of Soils and Waters. Soil Survey of Pakistan. Bull. 14, Ministry of Food Agric; Govt. of Pakistan.
8. Lambert, M.J. (1976). Methods of Chemical Analysis. Tech. Paper 25. Wood. For.Resh. Div; Comm. NSW-Australia.
9. Prison, G; Anselmi, N; and Boccone, A. (1982). Research on Iron Chlorosis of Poplar. FAO International Poplar Commission Casale. Monferrato (Italy), Sept. 6-10, 1982. Working Group on Disease-XXII-Session.
10. Smalley, G.W. (1976). Seasonal variations in nutrient composition of yellow poplar levels. Proc. Cent. 158, Hardwood, Conf. 337-385.
11. Woods, F.R; and Hanover, W..J. (1982). Growth of Imperial Carolina Poplar over a range of Soil types in Lower Michigan. USDA. For. Serv. 33: 8-13.