EARLY PREDICTION OF NUTRIENT STATUS OF PATHARNAKH (*Pyrus pyrifolia* (Burm) Nakai) PLANTS

Duplicate

Thesis

SUBMITTED TO THE PUNJAB AGRICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF SCIENCE

in

HORTICULTURE (POMOLOGY)

(Minor Subject : Botany)

by

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1997

DEDICATED TO
MY RESPECTED PARENTS
WHOSE BLESSINGS,
INSPIRATIONS AND
SACRIFICES
BROUGHT ME HERE UPTO!

CERTIFICATE I

This is to certify that the thesis entitled ,**"Early prediction of nutrient status of Patharnakh (*Pyrus pyrifolia* (Burm) Nakai) plants"** submitted to the Punjab Agricultural University, Ludhiana, in partial fulfilment of the requirements for the degree of Master of Science in the subject of Horticulture (Pomology), Minor subject: Botany, is a bonafide research work carried out by **Rajan Seth** (L-94-A-158-M) under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

Raghbir Singh
16.6.97

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CERTIFICATE II

This is to certify that the thesis entitled, "**Early prediction of nutrient status of Patharnakh (*Pyrus pyrifolia* (Burm) Nakai) plants**" submitted by **Rajan Seth** (L-94-A-158-M) to the Punjab Agricultural University, Ludhiana, in partial fulfilment of the requirements for the degree of Master of Science in the subject of Horticulture (Pomology) (Minor subject : Botany), has been approved by the student's Advisory Committee after an oral examination on the same, in collaboration with an external examiner.

21.7.97

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ACKNOWLEDGEMENTS

First of all, I owe a debt to God, ***"The Almighty"*** *by whose kindness I have been able to complete another chapter of my life.*

I feel it my proud privilege to express my deep sense of gratitude to my esteemed major advisor - ***Dr. Raghbir Singh,*** *Senior Horticulturist, Department of Horticulture, Punjab Agricultural University, Ludhiana for his meticulous guidance, constant encouragement, valuable suggestions, keen supervision, constructive criticism and ever willing help throughout the course of this investigation and preparation of this manuscript.*

I am grateful to ***Dr. A.S. Sandhu,*** *Senior Horticulturist, Department of Horticulture,* ***Dr. O.S. Singh,*** *Professor-cum-Head, Department of Botany,* ***Dr. D.S. Dhillon,*** *Horticulturist, the members of my advisory committee for inspiring co-operation and sustained encouragement.*

My heartful and cordial thanks are also due to ***Dr. S.N. Singh,*** *Senior Horticulturist,* ***Dr. C.S. Malhi,*** *Professor of Horticulture,* ***Dr. K.K. Sharma,*** *Senior Horticulturist,* ***Dr. P.S. Sidhu,*** *Assistant Horticulturist and* ***Dr. N.S. Dhillon,*** *Senior Soil Chemist for their kind help, sincere involvement and encouraging attitude during my research period.*

I shall be failing in my duty if I do not thank my friends ***Harpal, Nav Prem, Manjeet, Gurbax, Mintoo, Dilpreet, Sarbdeep, Ranjan, P.S. Patiala, Jaswinder, Amarjit, Bhupinder, Harnek,*** *Parminder, Parvinder, Ashok, Jatinder, Sarbjeet, Buta Singh, Harvinder, Satnam, Gurjit, Vijay, Rajinder, Rajbir, Anmol, Manoj and Timmy who rendered all possible help in a willing manner at all stages during the course of this study.*

Words that I know are rather insufficient to convey my deep and grateful gratitude to ***my esteemed parents,*** *whose constant inspirations, moral encouragement, countless blessings, everlasting desires and untiring struggle brought me here upto.*

No appropriate words could be traced in the present lexicon to acknowledge the endless love and continuous encouragement rendered by my sister ***Ritu,*** *brother-in-law* ***Gaurav*** *and niece* ***Ankita.***

The valuable help rendered by the field and laboratory staff is also highly acknowledged.

The financial help in the form of ***University Merit Fellowship*** *provided by the Punjab Agricultural University during the course of this investigation is gratefully acknowledged.*

Last but not least thanks are also due to ***Mr. Amanjot*** *for meticulously typing this manuscript.*

Rajan Seth 16-6-97

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June ,1997 .

Title of the thesis	:	Early prediction of nutrient status of Patharnakh (*Pyrus pyrifolia* (Burm) Nakai) plants.
Name of the Student	:	Rajan Seth
Admission Number	:	L-94-A-158-M
Major Subject	:	Horticulture (Pomology)
Minor Subject	:	Botany
Name and designation of Major Advisor	:	Dr. Raghbir Singh Senior Horticulturist Department of Horticulture
Degree to be awarded	:	M.Sc.
Year of award of degree	:	1997
Total pages in the thesis	:	70 + V
Name of the University	:	Punjab Agricultural University Ludhiana - 141 004, Punjab India.

ABSTRACT

The present investigations on the "Early prediction of nutrient status of Patharnakh (*Pyrus pyrifolia* (Burm) Nakai) plants" were carried out in the college orchard of the Department of Horticulture, Punjab Agricultural University, Ludhiana during the year 1996. For the purpose of early prediction of nutrient status, the nutrients present in plant parts such as bark, spur and flower were evaluated. Coefficients of correlations were worked out between the nutrient status of bark, spur and flower with that of leaf and yield. A significant correlation (r = 0.4934) existed between nitrogen status of flower at PB (pre-bloom stage) and that of leaf. The phosphorus status of spur at SI (bud-dormant stage) depicted a significant correlation (r = 0.5149) with the yield. The phosphorus status of bark at SIII (full-bloom stage) was significantly correlated (r = 0.6678) with that of leaf. There was a significant correlation (r = 0.4501) between potassium status of bark at SIII (full-bloom stage) and yield. A negative significant correlation (r = -0.5395) was observed between iron status of spur at SII (bud-swelling stage) and yield. Manganese status of bark at SI (bud-dormant stage) depicted a negative significant correlation (r = -0.4708) with that of leaf.

Raghbir Singh 16-6-97

Signature of Major Advisor

Rajan Seth 16-6-97

Signature of Student

CONTENTS

CHAPTER I

INTRODUCTION

Sand pear (*Pyrus pyrifolia* (Burm) Nakai) is an important *Pome* fruit of Punjab. It belongs to family Rosaceae and is stated to be a native of China. Areawise, it occupies about one-tenth of total acreage under fruits and is next to Kinnow and mango in the State (Anon.,1995). In the Punjab Patharnakh is mostly grown cultivar of pear because of its wider adaptability, easy management and longer productive life. At present it is grown on an area of 8150 hectares with annual fruit production to the tune of 1,22,250 tonnes.

The diagnosis of nutrients through plant analysis constitutes the best and commonly used technique of evaluating the nutritional status of orchards. In pear, the leaf has so far been considered a standard sampling tissue for nutrient analysis. Ystaas (1971) and Embleton *et al.* (1973) have established relationship between nutrient status and yield of fruit trees. However, the practical application of leaf analysis technique has its limitations too. One of the important conditions is the time when its application is possible in pear. For example, the standard time of leaf sampling in Patharnakh pear is July to September. This period coincides with its fruit maturity and harvesting. Thus, any nutrient balancing advice carried out on the basis of leaf analysis does not improve the yield and quality of current crop. When applied for the next season, the soil: plant conditions may not remain the same. Bergmann (1992) strongly opined that any possible improvement in

yield and quality of crop by supplementing the fertilisation during the growth cycle will only be effective, if applied in time.

It is in the above mentioned situation that the present study aims at predicting the nutritional status of Patharnakh at an earlier stage by evaluating the nutrients in plant parts such as bark, spur and flower. The tissue in which nutrient status correlates with that of leaf and yield may offer a practical answer.

CHAPTER II

REVIEW OF LITERATURE

The available literature pertaining to the nutrient status of pear and some other fruit crops has been reviewed on such aspects as the nutrient status of leaf, twig, spur and flower. The nutrient status *vis-a-vis* yield and fruit quality has also been documented.

2.1 NUTRIENT STATUS OF LEAF

The most commonly used method of evaluating the nutritional status of fruit trees has been through the interpretation of foliar analysis.

Boesveld (1991) advocated the advantages of leaf analysis as a basis for determining the N, P, K, Ca and Mg contents for a wide selection of apple and pear cultivars. Casero and Feran (1985) studied the foliar nutrient levels of pear throughout the vegetative cycle in three consecutive years. They reported that Mg, Zn and B contents varied non-significantly. Kenworthy (1953) reported the average nutrient elements composition (per cent dry weight) of leaves of Bartlett pear: nitrogen-2.50, phosphorus-0.135, potassium-1.45, manganese-0.0133, iron-0.0140, and copper-0.0054 and the ranges of above elements were 2.75-2.13, 0.161-0.110, 2.16-0.80, 0.0220-0.0068, 0.0240-0.0028 and 0.0100-0.0005, respectively.

Singh and Salwan (1986) found that N, P and K levels of pear cultivars Smith, Keiffer and Baggugosha were the highest in fully expanded leaf. Kamboj *et al.*(1987) found that leaves from the middle portion of shoot of Patharnakh pear exhibited the least variation in leaf mineral nutrient content. They suggested that standard time of sampling was in July-September. Similarly Kahlon *et al.*(1988) reported that middle shoot leaves of

Patharnakh pear sampled during August and September, when they were about 6-7 months old, were the ideal to study the nutritional status. N, P and K contents declined with the leaf age. Terminal leaves had the highest N and P and Lowest K levels.

Sato (1952) reported N values as low as 0.83 per cent in leaf dry matter for nitrogen-deficient mid shoot leaves of pear sampled in August. Lewis and Kenworthy (1962) working with one year Bartlett pear trees in nutrient cultures found that leaves showing nitrogen deficiency symptoms in September contained 1.34 per cent nitrogen in leaf dry matter. Archibald and Cline (1962) in Canada found that the average leaf nitrogen concentration of pear orchards ranged from 1.67 per cent for poor orchards to 2.08 per cent for excellent orchards. Filippov and Pilipenko (1971) reported that nitrogen deficiency in several pear cultivars was shown by a drop in leaf nitrogen to 1.8 per cent or lower and K deficiency by a drop in leaf K_2O to 1.0 per cent or lower.

Ende and Leece (1975) developed leaf composition standards for pear trees in Goulburn Valley, Australia based on mid-shoot leaves sampled in mid-summer and reported an optimum leaf zinc values as 20-50 ppm. Shear and Faust (1980) reported that nutritional ranges of N, P and Cu of pear spur leaf were 1.8-2.6 per cent, 0.12-0.25 per cent and 6-20 ppm respectively and that of K, Mn, Fe and Zn of pear leaf were 1.0-2.0 per cent, 20-170, 100-800 and 20-60 ppm respectively.

Jelenic *et al.* (1986) reported that when intact pear roots were put into a bottle containing Fe, Zn, Mn or Cu solution, the levels of Fe, Mn and Zn showed some increase in leaves. Montanes *et al.* (1989) suggested that increased transfer of deficient elements like K and Ca to fruits resulted in a further reduction in leaf nutrient content in pear.

Borys (1990) reported that among pear, quince and apple scions grafted on Crataegus seedling rootstocks, pear scions developed Fe, Mn and Zn deficiency symptoms initially but appeared healthy in later years. In apple and pear height of grafting

also influenced leaf composition; the deficiencies becoming less severe with increasing height of grafting. Chaplin and Westwood (1980) reported that nitrogen was higher in the scions on Old Home X Farmingdale (OH X F) rootstocks but did not seem related to yield efficiency. Generally, the leaf element contents of Mg and Mn were lower and that of Fe higher in leaves of trees growing on OH X F clonal rootstocks when compared to trees on Bartlett seedling.

In general the leaf sampling is done during July-September but Leece and Gilmour (1974) reported that rate of change of leaf composition of peach Cvs. Golden Queen, Gaume and Halehaven was least during January and February in New Southwales. Similarly, Leece and Ende (1975) and Leece (1975) found that the rate of change of leaf composition was least during January and February in apricot and peach. Hence, diagnostic sampling should be confirmed to this period.

Khera *et al.* (1981) studied that terminal leaves of peach had the highest levels of nitrogen, phosphorus followed by mid and basal leaves and recorded opposite trend for potassium. Koo and Young (1977) found that terminal leaves of avocado were higher in nitrogen and phosphorus but lower in potassium. Neilson (1988) reported the seasonal variations in leaf Zn concentration of apple receiving dormant application of Zn. The cultivars Delicious, Golden Delicious, Spartan and McIntosh were considerably low in leaf Zn concentration which declined from a high value approaching or below 14 µg/g (deficiency concentration) despite annual sprays during the dormant season.

Dev and Kapoor (1973) studied the change in zinc content in leaves of apple cv. Golden Delicious. They found that it varied from 17.5 to 26.5 ppm in deficient trees and from 24.0 to 45.5 ppm in normal trees. Corresponding figures for Red Delicious were 13.0 to 28.5 ppm and 24.2 to 35.0 ppm. In both cultivars the correlation between soil and leaf zinc increased with soil depth down to 60 cm in Kullu valley of Himachal Pradesh.

Pant and Singh (1976) reported a general rise in nitrogen, phosphorus and potassium content towards the senescence stage in apple.

Reuther and Smith (1954) discussed tentative standards for classification of nutritional status of Valenica orange trees based on the concentration of mineral elements in 4 to 7 months old, spring cycle leaves from non-fruiting terminals. Embleton *et al.* (1963) reported small differences between basal and terminal leaves of orange regarding nutritional concentration. But they emphasised that inspite of small differences, it was desirable to collect the leaves from middle portion of the shoot.

2.2 NUTRIENT STATUS OF TWIG, ROOT AND WOOD

Woodbridge *et al.* (1952) studied the B content in the blossoms, leaves and twigs of healthy plants of pear at the flowering stage. They found the lowest content of boron in the twigs (4.0 ppm) and it was the highest in blossoms (17.5 ppm). The leaves had intermediate content (10.3 ppm) of boron. Taha *et al.* (1974) reported that during two seasons the Fe content of LeConte pear leaves was in the range of 60-193 ppm and that of the roots 358-828 ppm. Seasonal changes were inconsistent. The Mn concentration during both seasons varied from 16 to 40 ppm in leaves and from 8 to 38 ppm in roots. The changes in Mn content of leaves throughout the first season were not large whereas in the second season they were relatively higher in June and July than in other months. Roots sampled in second half of first season had significantly more Mn than in first half, while in second season the Mn was significantly lower in May and September. The roots generally contained higher levels of Cu than the leaves. The seasonal changes of Cu in leaves and roots did not show a consistent trend.

Nikolic (1988) studied the changes in minor element contents of 1 to 4-year old bearing wood of cv. William's Bon Chretien pear. They found that Fe content averaged 71.8mμg/g with the lowest values occurring in January and the highest in April

and July. The zinc content averaged 41.2mμg/g and was the lowest in February and highest in April. Mg content was the lowest in May and the highest in October. The B content was lowest in November and highest in April. These findings helped in planning nutrition and pruning.

2.3 NUTRIENT STATUS OF SPUR

Gouny and Huguet (1964) studied the seasonal nutrient changes in both laminae and petioles of spur leaf of pear. They found that total N decreased with season in laminae but remained constant from June onward in petioles; Ca increased in laminae and petioles; Mg remained fairly constant in both organs until mid-June after which the concentration decreased by half; K reached a peak in mid-June, decreased in July and increased again in August. The P increased with season in both organs.

2.4 NUTERIENT STATUS OF FLOWERS

The nutritional analysis of floral parts could give appreciably earlier results than leaf analysis in temperate fruit trees. Sanz *et al.* (1994) reported that Fe content of leaves taken 120 days after full bloom compared very well with Fe content in flowers of pear. They advocated that floral analysis in pear could be good way of predicting iron chlorosis. Johnson *et al.* (1955) studied that bud clusters contained more boron (38 ppm) than the leaves (16 ppm) of healthy pear plant.

Sanz *et al.* (1992) found close correlation between the nutrients (N, P, K, Ca, Mg, Fe, Cu and Zn) of leaves and that found in flowers of peach.

2.5 YIELD

Ystaas (1971) found significant increase in fruit size of pear when potassium concentration of mid-shoot leaves in July rose from 0.77 to 1.58 per cent in dry matter. On the other hand no effect on fruit size was noted when average level of leaf potassium prior to fertiliser application was about 0.96 per cent. Bergmann (1992) reported that

improvement of nutrition and yield of orchards on the basis of leaf analysis reports is possible only with the timely application of nutrients.

Jaumien (1983) studied the comparison of flower bud bearing inhibited shoots with chlormequat and spurs with non- inhibited control shoots, which do not bear flower buds and reported that flower initiation in pear is associated with high levels of organic and inorganic compounds. Banno *et al.* (1984) studied the relationship between flower bud formation and nitrogen nutrition in Japanese pear *(Pyrus serotina)*. They found that supplying N from June to July resulted in greatest increase in number of flower buds.

Sanchez and Silva (1994) studied the relationship between yield and mineral content in pear orchards. Thirty-seven commercial blocks of William's (Bartlett), Packham's Triumph and Beurred' Anjou pears were surveyed in Argentina. Yield ranged from 12.7 to 92.6 tons per hectare. There were significant negative correlations when nutrients were expressed on a per leaf area basis. High yielding plots corresponded with less amount of nutrient per leaf area expressions have been proposed for diagnostic assessments, it will be difficult to distinguish between low values associated with nutritional deficiencies and low values caused by high yields.

Raese and Staiff (1988) reported that high rate of N fertilisers resulted in greater tree vigour and higher yields of Golden Delicious apples and pear but were associated with higher incidence of fruit disorder. Embleton *et al.* (1963) studied that increase in the level of K from 0.3 to 0.7 per cent significantly increased the volume and yield of citrus fruit because of the effects on fruit size, increased fruit set and a reduction in pre-harvest fruit drop.

2.6 PHYSICO-CHEMICAL QUALITY

Koto *et al.* (1979) investigated the N, P, K, Ca, Mg, Mn and B contents of Japanese pear cv. Chojuro leaves and those of soils from 30 orchards. Multiple regression

to find the effect of chemical composition on the fruit sugar content indicated that high levels of phosphorus should be maintained in leaves and soils and that K_2O content of soil should be reduced. Ystaas (1990) reported that increase in N had no effect on trunk cross section area, fruit set, yield and fruit quality of pear.

Badwai *et al.* (1981) reported that spray of B+Zn+Ca (750 ppm) slightly increased fruit firmness of LeConte pear and fruit with this treatment had the least storage weight loss. Pant and Singh (1971) found that quality of Red Delicious apples in terms of colour was improved by potassium spraying.

CHAPTER III

MATERIALS AND METHODS

The present investigation on the early prediction of nutrient status of Patharnakh *(Pyrus pyrifolia* (Burm) Nakai) plants was carried out in the college orchard of Department of Horticulture, PAU, Ludhiana, during the year 1996. The materials used and the methods employed are described here under.

3.1 PLANT MATERIAL

Thirty-year-old, rejuvenated, apparently healthy trees of Patharnakh were used for the study. There were 20 trees in the experiment.

3.2 COLLECTION OF SAMPLES

The samples of different tissues namely bark, spur, flower and leaf were collected at different stages. The following procedures were followed for collecting the samples.

3.2.1 Bark samples

Bark samples were removed from the vicinity of spurs in the middle of a bearing branch. The bark was removed with the help of a budding knife at different stages and at different times which are given below:

STAGE	DATE OF SAMPLING
i. Bud-dormant stage (SI)	16-01-96
ii. Bud-swelling stage (SII)	12-02-96
ii. Full-bloom stage (SIII)	27-02-96

3.2.2 Spur samples

The spurs numbering 15-20 were removed with the help of secateur from the middle of bearing branches. The spurs were collected at different stages and at different times as given below:

STAGE	DATE OF SAMPLING
i. Bud-dormant stage (SI)	16-01-96
ii. Bud-swelling stage (SII)	12-02-96
ii. Full-bloom stage (SIII)	27-02-96

In case of full bloom stage, flower bearing spurs were selected for spur sampling.

3.2.3 Flower samples

Flower sampling was done at pre-bloom and full-bloom stages. The pre-bloom stage was considered when the white flower buds developed fully (Plate 1). The full-bloom stage reached when about 75 per cent flower buds opened (Plate 2). In case of pre-bloom stage, fully developed flower buds were collected from the spur with hand. For the full-bloom stage, fully opened flowers along with the pedicel were removed with hand. The time of flower sampling at two stages was as under:

STAGE	DATE OF SAMPLING
i. Pre-bloom stage (PB)	18-02-96
ii. Full-bloom stage (FB)	27-02-96

3.2.4 Leaf samples

Fully expanded, mature, disease-free 40 to 50 leaves from the middle of shoots were collected at standard time i.e. during July from all around each experimental tree.

Plate 1 : A portion of branch showing pre-bloom stage (PB)

Plate 2 : A portion of branch showing full-bloom stage (FB)

3.3 PREPRATION OF SAMPLES

Immediately after collection, the samples of spur, bark, flower and leaf were washed with tap water, 0.1 N HCl and finally with double distilled water in a sequence. These were dried in oven at 65°C for 48 hours. The samples were ground with the help of Wiley mill and stored in tissue paper bags to determine N, P, K, Fe, Cu, Zn and Mn contents.

3.4 NUTRIENT ANALYSIS OF SAMPLES

The total nitrogen was determined by Kjeldahl's method (AOAC, 1990).

For the estimation of P, K, Fe, Mn, Zn and Cu, one gram of sample was taken and digested in triple acid mixture of sulphuric acid, nitric acid and perchloric acid in the ratio of 9:3:1. Total phosphorus was estimated by Vanado-molybdo-phosphoric acid yellow colour method (Chapman and Pratt, 1990). Total potassium was estimated by Flame Emission Spectroscopy method (AOAC, 1975).

Micro nutrients (Fe, Mn, Zn and Cu) were determined with Atomic Absorption Spectrophotometer. The methods described by Bradfield and Spencer (1965) were followed.

3.5 YIELD PER PLANT

Yield of each tree was recorded during middle of July by count and weight of fruits. Yield was expressed in Kg tree-1.

3.6 PHYSICO-CHEMICAL CHARACTERS OF FRUIT

A sample of eight randomly picked fruits from a tree was used for studying the physico-chemical parameters of the fruit.

3.6.1 Fruit size

The fruit length and breadth were measured with the help of Vernier Callipers and average was worked out and expressed in centimetres.

3.6.2 Fruit weight

Weight of fruits was recorded and average weight per fruit (g) was calculated.

3.6.3 Total soluble solids

The juice of eight randomly selected fruits from each experimental unit was extracted and strained through a piece of muslin. The TSS content (%) in the juice was determined by using hand refractometer. The readings were corrected at 20 °C with the help of standard Table (AOAC 1990).

3.6.4 Acidity

Five ml of fruit juice was titrated against 0.1 N NaOH solution using phenolphthalein as an indicator. The end point was noted with change in colour to pink. The percentage acidity was calculated and expressed in terms of malic acid by using the following formula:

$$\text{Acidity}(\%) = \frac{0.0067 \times \text{Volume of 0.1 N NaOH used} \times 100}{\text{Volume of juice taken}}$$

3.7 STATISTICAL ANALYSIS

Correlations were worked out between the nutrient status of bark, spur and flower with that of leaf and yield of Patharnakh pear.

CHAPTER IV

RESULTS

Coefficients of correlation between nutrient status of bark, spur, flower and leaf and with that of yield of *Pyrus pyrifolia* (Burm) Nakai were worked out and are discussed in this chapter.

4.1 CORRELATIONS OF NITROGEN STATUS

The data regarding yield and the nitrogen status of different tissues of Patharnakh are presented in Tables 1 and 2.

The mean, maximum and minimum values of yield and nitrogen status of leaf and bark are presented in Table 1a. The nitrogen status of bark both at SI (bud-dormant stage) and SIII (full-bloom stage) showed a positive correlation with the yield. On the contrary, the nitrogen status of leaf and bark at SII (bud-swelling stage) depicted a negative correlation with yield. The data, however, were non-significant.

The data in Table 1b pertains to the mean, maximum and minimum values of yield and nitrogen status of spur and flower. The nitrogen status of spur at both SI and that of flower at PB was positively correlated with yield. Negative correlations were observed between yield and the nitrogen status of spur at SII, SIII and that of flower at FB (full-bloom stage). However, the data were non-significant.

Table 1(a) Correlations of yield with N status of leaf and bark in Patharnakh

Tree No.	Yield (Kg tree-1)	Leaf N (%)	Bark N (%)		
			S I	S II	S III
I	47.0	1.80	0.70	0.96	0.64
II	44.7	1.60	0.80	0.68	0.56
III	35.9	1.80	0.64	1.04	0.48
IV	37.9	2.04	0.74	0.88	0.70
V	46.0	2.20	1.00	0.76	0.50
VI	52.6	1.80	0.72	0.80	0.70
VII	43.7	2.20	0.82	1.04	0.76
VIII	57.7	2.10	0.92	0.78	0.84
IX	58.6	1.80	0.96	0.62	0.80
X	63.4	2.04	0.76	0.72	0.60
XI	55.6	1.92	0.72	0.96	0.64
XII	61.3	1.96	1.04	0.84	0.50
XIII	58.0	1.88	1.04	0.92	0.50
XIV	50.6	2.00	0.92	1.04	0.60
XV	36.5	1.70	0.88	0.96	0.60
XVI	61.4	1.80	0.84	0.88	0.70
XVII	68.0	1.60	0.68	0.76	0.64
XVIII	46.0	2.10	0.96	0.92	0.80
XIX	44.0	1.96	0.82	0.84	0.76
XX	64.5	2.04	1.04	1.04	0.84
'r' value	-	-0.06149	0.2665	-0.3172	0.1713
Range					
Maximum	68.0	2.20	1.04	1.04	0.84
Minimum	35.9	1.60	0.70	0.76	0.48
Mean	51.67	1.91	0.85	0.87	0.65

Table 1(b) Correlations of yield with N status of spur and flower in Patharnakh

Tree No.	Yield (Kg tree-1)	Spur N (%)			Flower N (%)	
		S I	S II	S III	PB	FB
I	47.0	0.84	0.92	0.80	2.64	2.64
II	44.7	0.74	1.04	0.76	2.00	2.80
III	35.9	0.80	1.04	0.82	3.04	2.96
IV	37.9	0.64	0.84	0.76	2.80	2.96
V	46.0	0.72	0.92	0.80	2.88	3.06
VI	52.6	0.90	1.12	0.84	2.80	3.12
VII	43.7	0.76	1.12	0.80	2.88	3.12
VIII	57.7	0.80	1.04	0.90	2.72	3.16
IX	58.6	0.96	0.76	0.80	2.80	2.96
X	63.4	0.80	0.90	1.04	2.96	3.12
XI	55.6	0.04	1.12	0.76	2.76	2.96
XII	61.3	0.72	1.04	1.04	2.84	2.84
XIII	58.0	0.68	1.04	0.92	2.60	2.72
XIV	50.6	0.76	0.84	0.80	2.84	2.88
XV	36.5	0.84	0.96	1.04	2.72	2.92
XVI	61.4	0.92	0.92	0.76	2.76	2.80
XVII	68.0	0.76	1.04	0.70	2.64	2.92
XVIII	46.0	0.96	0.92	0.84	2.64	2.96
XIX	44.0	1.00	0.96	0.96	2.68	2.76
XX	64.5	1.04	0.84	0.90	2.80	2.80
'r' value	-	0.1979	-0.0437	-0.0551	0.0467	-0.0263
Range						
Maximum	68.00	1.04	1.12	1.04	3.04	3.16
Minimum	35.90	0.68	0.76	0.76	2.00	2.64
Mean	51.67	0.83	0.96	0.85	2.74	2.92

It is clear from the data given in Tables 1a and 1b that the mean nitrogen content in flower was 2.74 to 2.92 per cent followed by leaf (1.91 per cent).The bark contained 0.65 to 0.87 per cent nitrogen. The mean nitrogen content in spur was only slightly higher than that in bark (0.83 to 0.96 per cent). Maximum N content was observed in flower at full-bloom stage (3.16 per cent) and minimum in bark at full-bloom stage (0.48 per cent).

The data tabulated in Table 2a show that nitrogen status of bark at SI, SII and SIII stages was positively correlated with the nitrogen status of leaf but the correlations were non-significant.

The data presented in Table 2b reveal that nitrogen status of spur at SIII stage was positively correlated with nitrogen status of leaf. On the other hand, nitrogen status of spur at both SI and SIII stages exhibited a negative correlation with the nitrogen content of leaf. The data, however, were non-significant.

An examination of data in Table 2c and shown in Fig.1 indicated a significant correlation ($r=0.4934$) between nitrogen status of leaf and flower at PB (pre-bloom stage). The nitrogen status of flower at FB was also positively correlated with the leaf nitrogen content. However, the correlation was non-significant.

Table 2(a) Correlations between N status of leaf and bark

Tree No.	Leaf N (%)	Bark N (%)		
		S I	S II	S III
I	1.80	0.70	0.96	0.64
II	1.60	0.80	0.68	0.56
III	1.80	0.64	1.04	0.48
IV	2.04	0.74	0.88	0.70
V	2.20	1.00	0.76	0.50
VI	1.80	0.72	0.80	0.70
VII	2.20	0.82	1.04	0.76
VIII	2.10	0.92	0.78	0.84
IX	1.80	0.96	0.62	0.80
X	2.04	0.76	0.72	0.60
XI	1.92	0.72	0.96	0.64
XII	1.96	1.04	0.84	0.50
XIII	1.88	1.04	0.92	0.50
XIV	2.00	0.92	1.04	0.60
XV	1.70	0.88	0.96	0.60
XVI	1.80	0.84	0.88	0.70
XVII	1.60	0.68	0.76	0.64
XVIII	2.10	0.96	0.92	0.80
XIX	1.96	0.82	0.84	0.76
XX	2.04	1.04	1.04	0.84
'r' value	-	0.4102	0.2445	0.2739
Range				
Maximum	2.20	1.04	1.04	0.84
Minimum	1.60	0.70	0.76	0.48
Mean	1.91	0.85	0.87	0.65

Table 2(b) Correlations between N status of leaf and spur

Tree No.	Leaf N (%)	Spur N (%)		
		S I	S II	S III
I	1.80	0.84	0.92	0.80
II	1.60	0.74	1.04	0.76
III	1.80	0.80	1.04	0.82
IV	2.04	0.64	0.84	0.76
V	2.20	0.72	0.92	0.80
VI	1.80	0.90	1.12	0.84
VII	2.20	0.76	1.12	0.80
VIII	2.10	0.80	1.04	0.90
IX	1.80	0.96	0.76	0.80
X	2.04	0.80	0.90	1.04
XI	1.92	1.04	1.12	0.76
XII	1.96	0.72	1.04	1.04
XIII	1.88	0.68	1.04	0.92
XIV	2.00	0.76	0.84	0.80
XV	1.70	0.84	0.96	1.04
XVI	1.80	0.92	0.92	0.76
XVII	1.60	0.76	1.04	0.70
XVIII	2.10	0.96	0.92	0.84
XIX	1.96	1.00	0.96	0.96
XX	2.04	1.04	0.84	0.90
'r' value	-	-0.03453	-0.1436	0.09967
Range				
Maximum	2.20	1.04	1.12	1.04
Minimum	1.60	0.68	0.76	0.76
Mean	1.91	0.83	0.96	0.85

Table 2(c) Correlations between N status of leaf and flower

Tree No.	Leaf N (%)	Flower N (%)	
		PB	FB
I	1.80	2.64	2.64
II	1.60	2.00	2.80
III	1.80	3.04	2.96
IV	2.04	2.80	2.96
V	2.20	2.88	3.06
VI	1.80	2.80	3.12
VII	2.20	2.88	3.12
VIII	2.10	2.72	3.16
IX	1.80	2.80	2.96
X	2.04	2.96	3.12
XI	1.92	2.76	2.96
XII	1.96	2.84	2.84
XIII	1.88	2.60	2.72
XIV	2.00	2.84	2.88
XV	1.70	2.72	2.92
XVI	1.80	2.76	2.80
XVII	1.60	2.64	2.92
XVIII	2.10	2.64	2.96
XIX	1.96	2.68	2.76
XX	2.04	2.80	2.80
'r' value	-	0.4934*	0.4244
Range			
Maximum	2.20	3.04	3.16
Minimum	1.60	2.00	2.64
Mean	1.91	2.74	2.92

* Significant at 5% level.

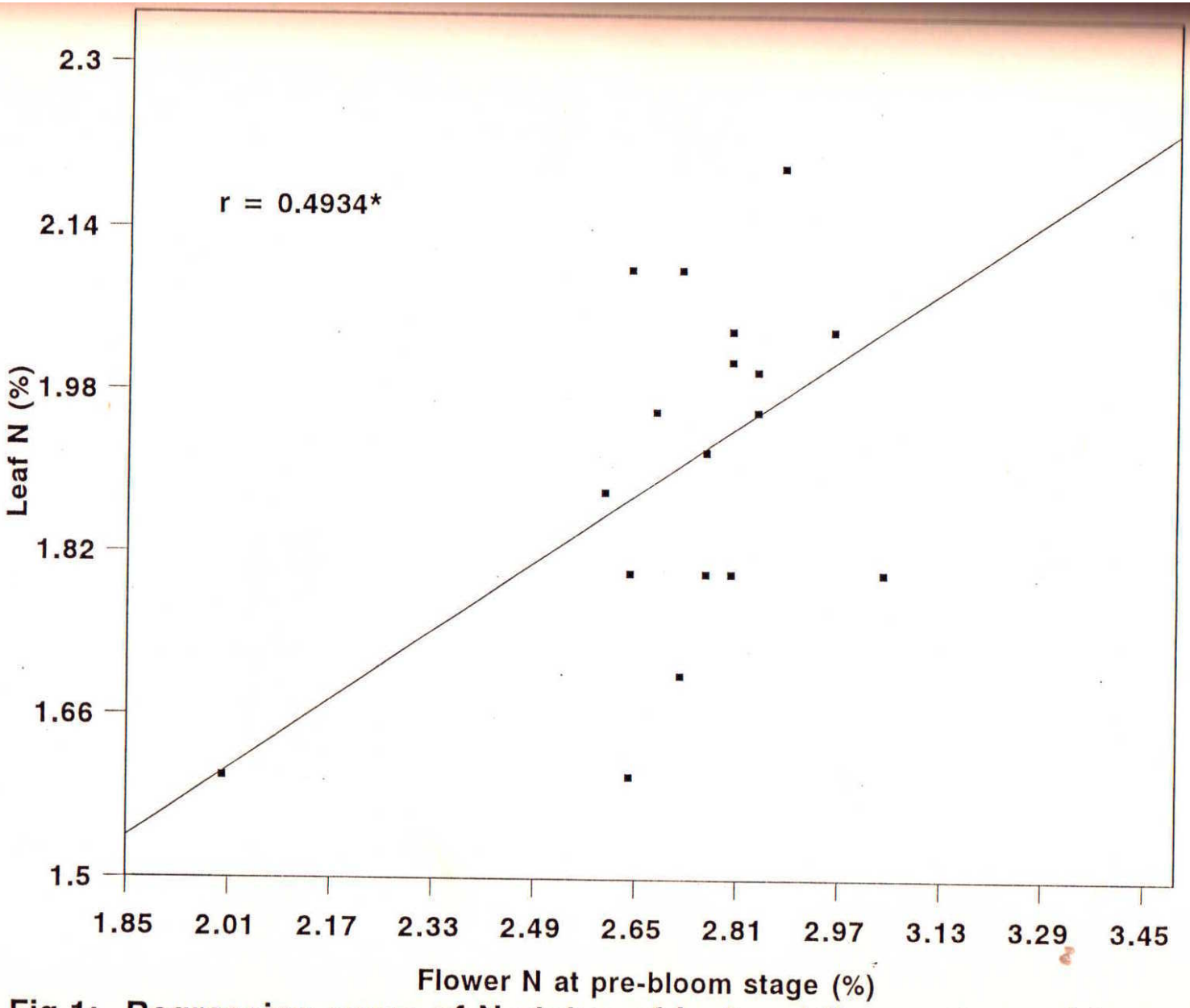

Fig.1: Regression curve of N status of leaf and flower at pre-bloom stage

4.2 CORRELATIONS OF PHOSPHORUS STATUS

The data pertaining to the yield and phosphorus status of different tissues of Patharnakh are tabulated in Tables 3 and 4.

An examination of data in Table 3a reveals mean, maximum and minimum values of yield and phosphorus levels of leaf and bark. The phosphorus status of bark at SIII (full-bloom stage) and leaf was positively correlated with yield. On the other hand, phosphorus status of bark at both SI (bud-dormant stage) and SII (bud-swelling stage) had negative correlation with the yield. The data, however, were non-significant.

The mean, maximum and minimum values of yield and phosphorus levels of spur and flowers are presented in Table 3b. The phosphorus status of spur at SI (bud-dormant stage) depicted a significant positive correlation (r=0.5149) with yield as shown in Fig.2. Although the phosphorus status of spur at SII (bud-swelling stage) and that of flower at PB (pre-bloom stage) and FB (full-bloom stage) had positive correlation with the yield, yet the correlations were non-significant.

It is apparent from the data in Tables 3a and 3b that the mean phosphorus content in flower was 0.135 to 0.143 per cent. With the exception of phosphorus status of spur at SIII both bark and spur contained markedly lower levels of phosphorus as compared to that of leaf. Maximum phosphorus content was observed in flower at FB stage (0.20 per cent) which was closely followed by that of flower at PB stage (0.18 per cent). The minimum phosphorus content was recorded in bark at SI stage and spur at SII stage (0.03 per cent).

Table 3(a) Correlations of yield with P status of leaf and bark in Patharnakh

Tree No.	Yield (Kg tree-1)	Leaf P (%)	Bark P (%)		
			S I	S II	S III
I	47.0	0.11	0.05	0.10	0.05
II	44.7	0.09	0.04	0.12	0.04
III	35.9	0.08	0.06	0.08	0.04
IV	37.9	0.07	0.04	0.09	0.06
V	46.0	0.10	0.07	0.06	0.08
VI	52.6	0.07	0.03	0.07	0.07
VII	43.7	0.08	0.03	0.08	0.04
VIII	57.7	0.09	0.07	0.10	0.09
IX	58.6	0.13	0.05	0.08	0.10
X	63.4	0.08	0.03	0.06	0.04
XI	55.6	0.12	0.04	0.08	0.08
XII	61.3	0.12	0.07	0.07	0.10
XIII	58.0	0.08	0.08	0.08	0.04
XIV	50.6	0.09	0.08	0.07	0.05
XV	36.5	0.08	0.08	0.09	0.07
XVI	61.4	0.07	0.04	0.07	0.04
XVII	68.0	0.10	0.03	0.08	0.08
XVIII	46.0	0.06	0.03	0.09	0.04
XIX	44.0	0.05	0.08	0.10	0.05
XX	64.5	0.10	0.07	0.10	0.09
'r' value	-	0.4054	-0.1260	-0.2864	0.4071
Range					
Maximum	68.00	0.130	0.080	0.120	0.100
Minimum	35.90	0.050	0.030	0.060	0.040
Mean	51.67	0.088	0.053	0.083	0.062

Table 3(b) Correlations of yield with P status of spur and flower in Patharnakh

Tree No.	Yield (Kg tree-1)	Spur P (%)			Flower P (%)	
		S I	S II	S III	PB	FB
I	47.0	0.08	0.07	0.10	0.15	0.20
II	44.7	0.05	0.05	0.10	0.16	0.18
III	35.9	0.07	0.06	0.12	0.09	0.10
IV	37.9	0.10	0.04	0.09	0.18	0.15
V	46.0	0.04	0.05	0.07	0.10	0.10
VI	52.6	0.09	0.07	0.08	0.17	0.14
VII	43.7	0.05	0.03	0.10	0.18	0.10
VIII	57.7	0.07	0.04	0.07	0.10	0.10
IX	58.6	0.08	0.04	0.10	0.14	0.12
X	63.4	0.11	0.04	0.10	0.14	0.10
XI	55.6	0.09	0.03	0.07	0.10	0.13
XII	61.3	0.08	0.03	0.10	0.10	0.20
XIII	58.0	0.08	0.06	0.09	0.11	0.16
XIV	50.6	0.07	0.05	0.07	0.13	0.18
XV	36.5	0.06	0.08	0.11	0.09	0.12
XVI	61.4	0.07	0.07	0.11	0.18	0.13
XVII	68.0	0.11	0.09	0.10	0.16	0.17
XVIII	46.0	0.07	0.05	0.13	0.10	0.14
XIX	44.0	0.08	0.07	0.09	0.15	0.19
XX	64.5	0.09	0.09	0.13	0.17	0.15
'r' value	-	0.5149*	0.1021	-0.0347	0.1666	0.1066
Range						
Maximum	68.00	0.11	0.090	0.130	0.180	0.200
Minimum	35.90	0.04	0.030	0.070	0.090	0.100
Mean	51.67	0.077	0.055	0.096	0.135	0.143

* Significant at 5% level.

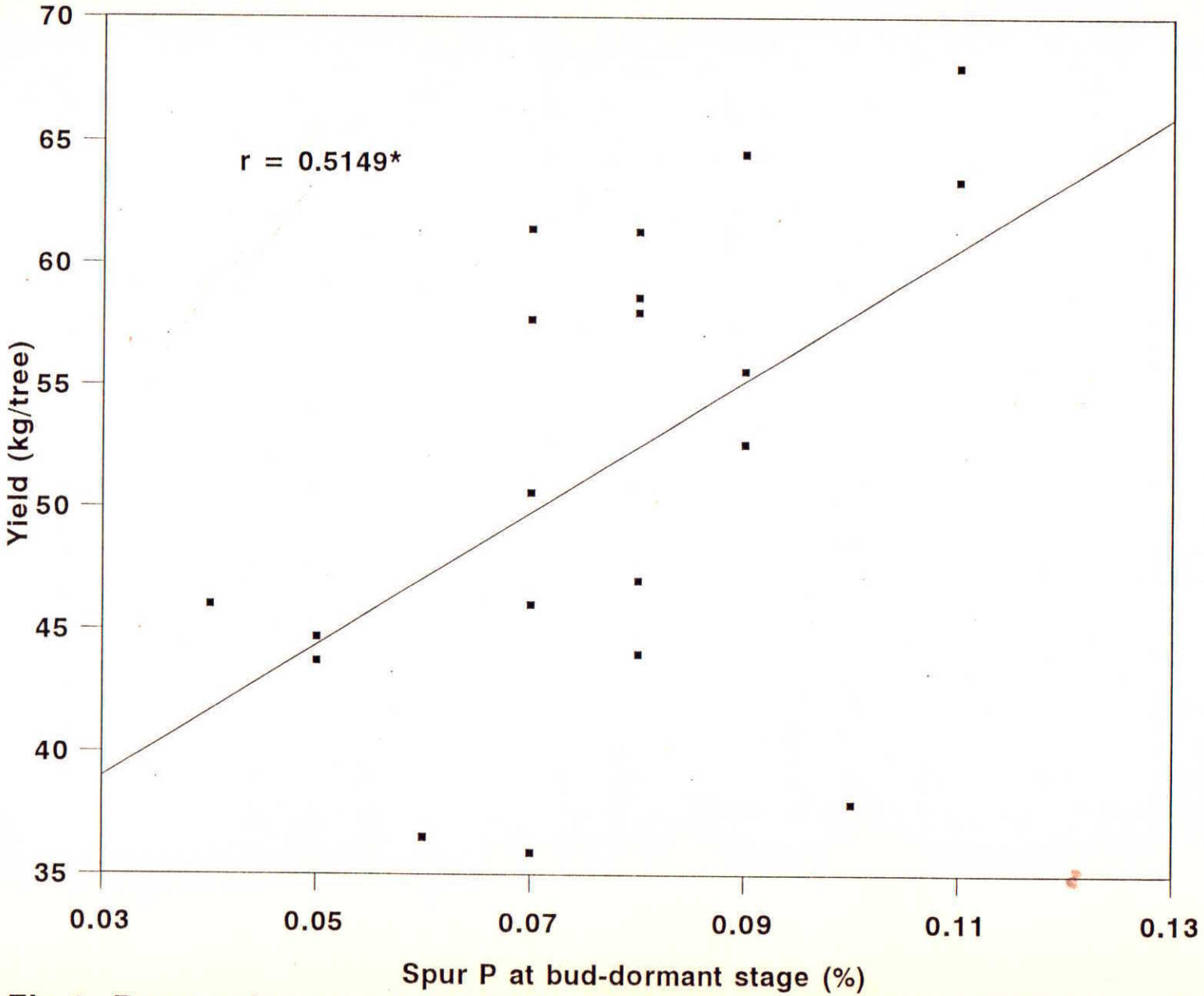

Fig.2 :Regression curve of yield and P status of spur at bud-dormant stage

A perusal of data in Table 4a exhibited a significant positive correlation (r=0.6678) between phosphorus status of bark at SIII and phosphorus status of leaf as shown in Fig.3. Although the phosphorus status of bark both at SI and SII stages had positive correlation with phosphorus status of leaf, yet the correlations were non-significant.

The data presented in Table 4b indicate that phosphorus status of spur at SI stage was positively correlated with the leaf phosphorus content. On the contrary, phosphorus status of spur both at SII and SIII stages depicted a negative correlation with phosphorus content of leaf. The data were non-significant.

A reference to the data in Table 4c indicates that there was non-significant correlation between leaf phosphorus status and phosphorus status of flower both at PB and FB stages.

4.3 CORRELATIONS OF POTASSIUM STATUS

The data concerning the yield and potassium status of different tissues of Patharnakh are presented in Tables 5 and 6.

The mean, maximum and minimum values of yield and potassium levels of leaf and bark are presented in Table 5a. There was a significant positive correlation (r=0.4501) between yield and potassium status of bark at SIII (full-bloom stage) as shown in Fig.4. The potassium status of leaf and bark at both SI (bud-dormant stage) and SII (bud-swelling stage) was positively correlated with the yield but the correlations were non-significant.

An examination of the data in Table 5b reveals that negative correlations were observed between yield and K status of spur at SI, SII and SIII stages and that of flower at PB (pre-bloom stage) and FB (full-bloom stage).

Table 4(a) Correlations between P status of leaf and bark

Tree No.	Leaf P (%)	Bark P (%)		
		S I	S II	S III
I	0.11	0.05	0.10	0.05
II	0.09	0.04	0.12	0.04
III	0.08	0.06	0.08	0.04
IV	0.07	0.04	0.09	0.06
V	0.10	0.07	0.06	0.08
VI	0.07	0.03	0.07	0.07
VII	0.08	0.03	0.08	0.04
VIII	0.09	0.07	0.10	0.09
IX	0.13	0.05	0.08	0.10
X	0.08	0.03	0.06	0.04
XI	0.12	0.04	0.08	0.08
XII	0.12	0.07	0.07	0.10
XIII	0.08	0.08	0.08	0.04
XIV	0.09	0.08	0.07	0.05
XV	0.08	0.08	0.09	0.07
XVI	0.07	0.04	0.07	0.04
XVII	0.10	0.03	0.08	0.08
XVIII	0.06	0.03	0.09	0.04
XIX	0.05	0.08	0.10	0.05
XX	0.10	0.07	0.10	0.09
'r' value	-	0.0643	0.0019	0.6678*
Range				
Maximum	0.130	0.080	0.120	0.100
Minimum	0.050	0.030	0.060	0.040
Mean	0.885	0.053	0.083	0.062

* Significant at 5% level.

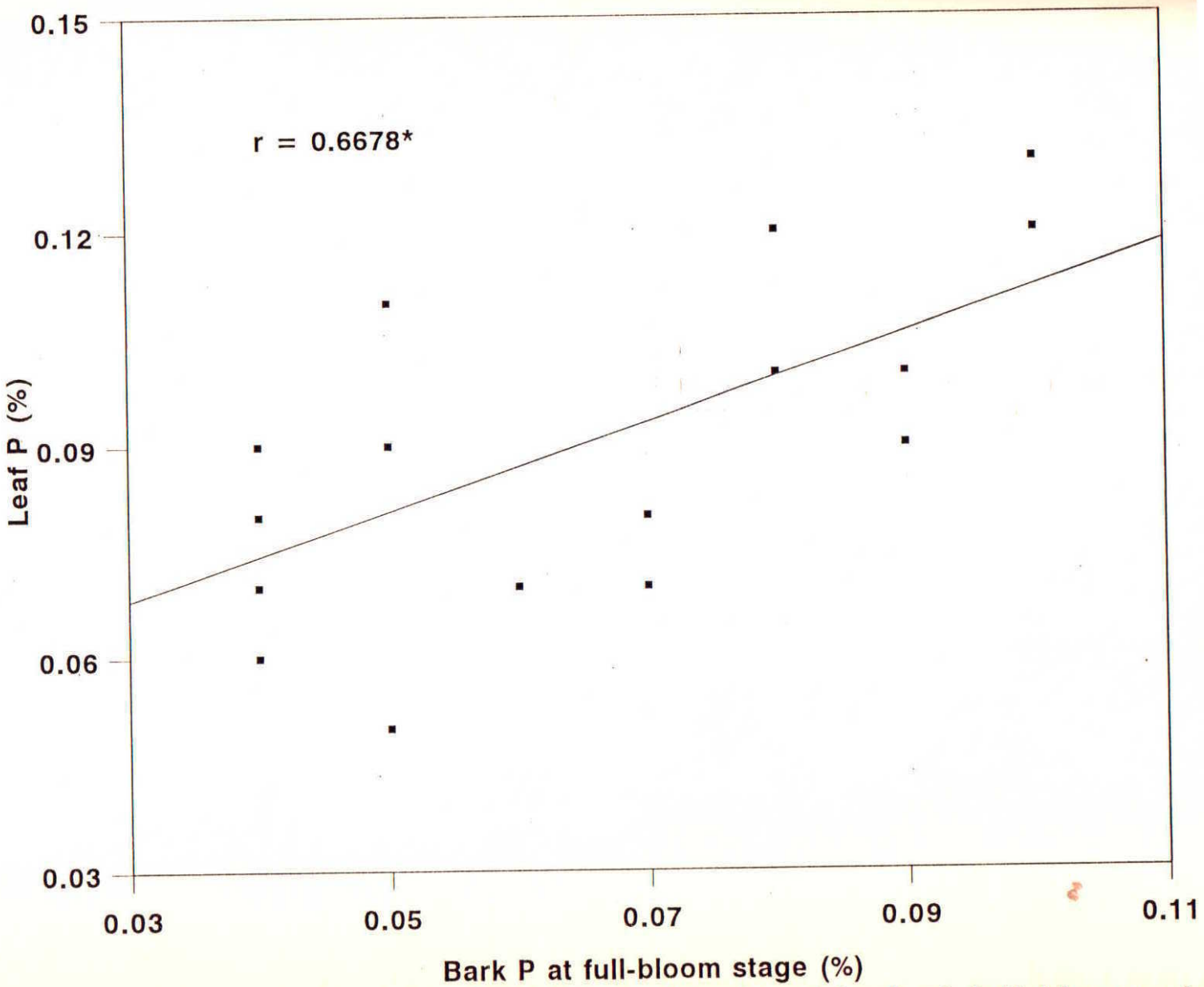

Fig.3 :Regression curve of P status of leaf and bark at full-bloom stage

Table 4(b) Correlations between P status of leaf and spur

Tree No.	Leaf P (%)	spur P (%)		
		S I	S II	S III
I	0.11	0.08	0.07	0.10
II	0.09	0.05	0.05	0.10
III	0.08	0.07	0.06	0.12
IV	0.07	0.10	0.04	0.09
V	0.10	0.04	0.05	0.07
VI	0.07	0.09	0.07	0.08
VII	0.08	0.05	0.03	0.10
VIII	0.09	0.07	0.04	0.07
IX	0.13	0.08	0.04	0.10
X	0.08	0.11	0.04	0.10
XI	0.12	0.09	0.03	0.07
XII	0.12	0.08	0.03	0.10
XIII	0.08	0.08	0.06	0.09
XIV	0.09	0.07	0.05	0.07
XV	0.08	0.06	0.08	0.11
XVI	0.07	0.07	0.07	0.11
XVII	0.10	0.11	0.09	0.10
XVIII	0.06	0.07	0.05	0.13
XIX	0.05	0.08	0.07	0.09
XX	0.10	0.09	0.09	0.13
'r' value	-	0.0546	-0.2432	-0.1787
Range				
Maximum	0.130	0.110	0.090	0.130
Minimum	0.050	0.040	0.030	0.070
Mean	0.885	0.077	0.055	0.096

Table 4(c) Correlations between P status of leaf and flower

Tree No.	Leaf P (%)	Flower P (%)	
		PB	FB
I	0.11	0.15	0.20
II	0.09	0.16	0.18
III	0.08	0.09	0.10
IV	0.07	0.18	0.15
V	0.10	0.10	0.10
VI	0.07	0.17	0.14
VII	0.08	0.18	0.10
VIII	0.09	0.10	0.10
IX	0.13	0.14	0.12
X	0.08	0.14	0.10
XI	0.12	0.10	0.13
XII	0.12	0.10	0.20
XIII	0.08	0.11	0.16
XIV	0.09	0.13	0.18
XV	0.08	0.09	0.12
XVI	0.07	0.18	0.13
XVII	0.10	0.16	0.17
XVIII	0.06	0.10	0.14
XIX	0.05	0.15	0.19
XX	0.10	0.17	0.15
'r' value	-	0.135	0.143
Range			
Maximum	0.130	0.180	0.200
Minimum	0.050	0.090	0.200
Mean	0.885	0.135	0.143

The data in Tables 5a and 5b further reveal that the highest range of potassium content was observed in flower (2.19 to 2.47 per cent) followed by leaf (1.29 per cent). Potassium content was the lowest in case of bark with the exception of SI stage (1.20 per cent) where it was slightly higher than that in spur at the same stage (1.15 per cent). Maximum potassium content was observed in flower at FB stage (2.93 per cent) followed by PB stage of flower (2.62 per cent). Minimum potassium content was recorded in bark at SII stage (0.43 per cent).

The data presented in Table 6a indicate that potassium status of bark at SI, SII and SIII stages were positively correlated with the potassium status of leaf but the correlations were non-significant.

A reference to the data in Table 6b reveals that there was negative correlation between potassium status of leaf and potassium status of spur at SI, SII and SIII stages.

A perusal of data presented in Table 6c reveals that potassium status of flower at FB stage had positive correlation with potassium status of leaf. On the contrary, the potassium status of flower at PB stage depicted negative correlation with the potassium status of leaf.

4.4 CORRELATIONS OF IRON STATUS

The data regarding the yield and iron status of different tissues of Patharnakh are presented in Tables 7 and 8.

Table 5(a) Correlations of yield with K status of leaf and bark in Patharnakh

Tree No.	Yield (Kg tree-1)	Leaf K (%)	Bark K (%)		
			S I	S II	S III
I	47.0	1.25	1.37	0.43	0.68
II	44.7	1.43	1.12	0.56	0.62
III	35.9	1.06	1.06	0.68	0.81
IV	37.9	1.43	1.50	0.56	0.68
V	46.0	1.12	1.12	0.93	1.06
VI	52.6	1.56	1.18	0.93	1.06
VII	43.7	1.30	1.06	0.81	0.75
VIII	57.7	1.25	1.00	0.93	0.62
IX	58.6	1.12	1.30	0.68	0.81
X	63.4	1.43	1.00	0.75	0.93
XI	55.6	1.18	1.37	0.62	1.00
XII	61.3	1.37	1.25	0.44	1.00
XIII	58.0	1.25	1.12	0.62	0.93
XIV	50.6	1.37	1.00	0.75	0.68
XV	36.5	1.06	1.30	0.68	0.75
XVI	61.4	1.43	1.50	0.87	0.93
XVII	68.0	1.30	1.37	0.81	1.00
XVIII	46.0	1.37	1.18	0.93	0.68
XIX	44.0	1.25	1.25	0.75	0.93
XX	64.5	1.30	1.12	0.62	0.87
'r' value	-	0.2863	0.0091	0.0689	0.4501*
Range					
Maximum	68.0	1.56	1.50	0.93	1.06
Minimum	35.9	1.06	1.00	0.43	0.62
Mean	51.67	1.29	1.20	0.71	0.83

* Significant at 5% level.

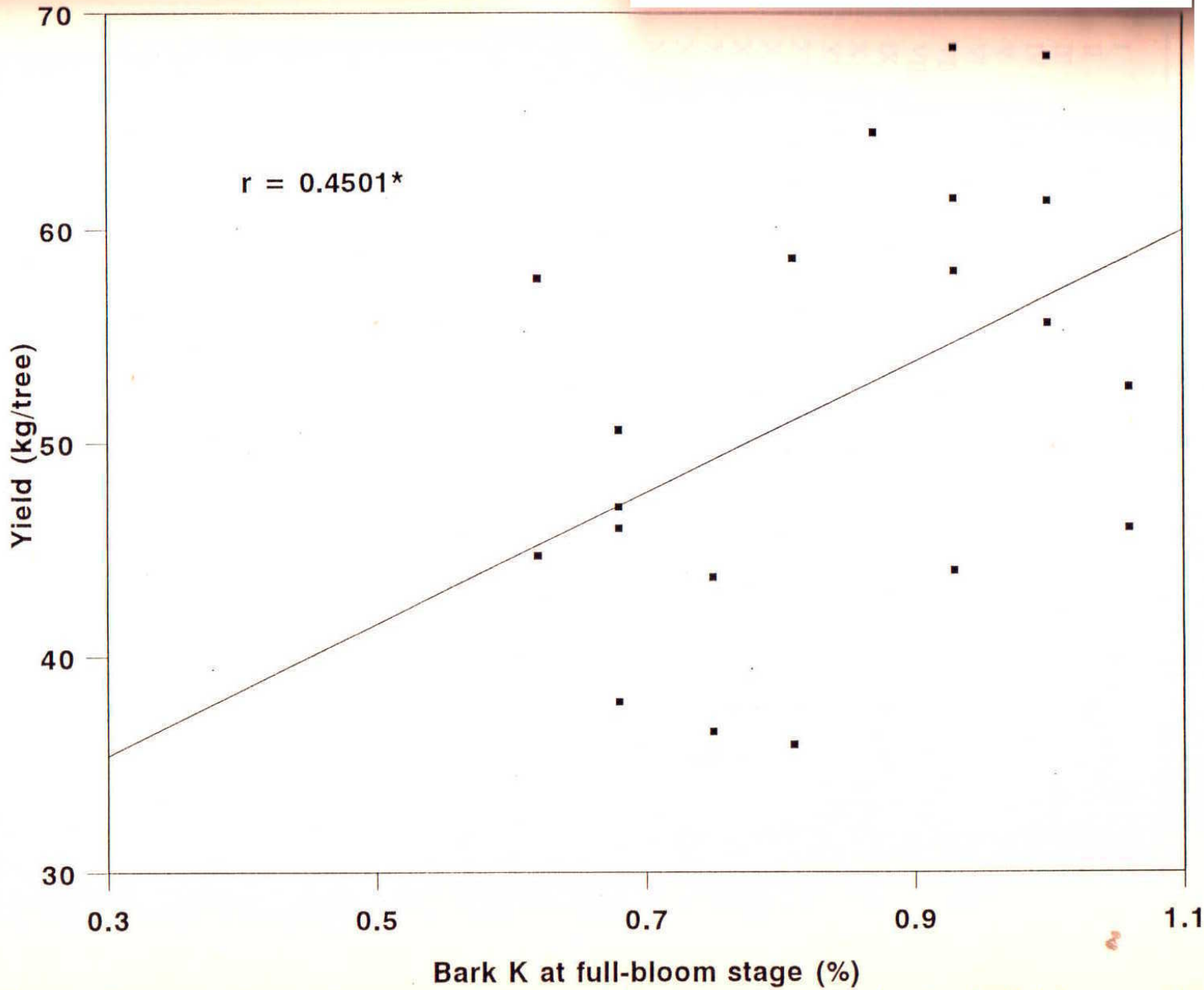

Fig.4 :Regression curve of yield and K status of bark at full-bloom stage

Table 5(b) Correlations of yield with K status of leaf and bark

Tree No.	Yield (Kg tree-1)	Spur K (%)			Flower K (%)	
		S I	S II	S III	PB	FB
I	47.0	1.25	0.87	1.12	2.56	2.81
II	44.7	1.12	0.93	1.06	2.62	2.62
III	35.9	1.43	1.06	1.00	2.50	2.87
IV	37.9	0.96	0.75	1.06	2.62	2.81
V	46.0	0.96	0.68	1.00	2.25	2.12
VI	52.6	1.00	0.62	1.18	1.87	2.93
VII	43.7	1.25	0.62	1.06	1.93	2.81
VIII	57.7	1.37	0.81	1.00	2.56	2.50
IX	58.6	1.25	0.68	1.06	2.50	2.56
X	63.4	1.00	0.87	0.81	2.25	2.81
XI	55.6	0.93	0.87	1.12	2.37	2.75
XII	61.3	1.18	0.75	1.12	2.06	2.93
XIII	58.0	1.25	0.81	0.81	2.00	2.12
XIV	50.6	1.43	0.93	0.75	2.12	2.00
XV	36.5	1.06	0.68	1.06	1.87	2.25
XVI	61.4	1.00	0.75	1.00	1.81	2.06
XVII	68.0	1.12	0.62	0.87	1.93	2.18
XVIII	46.0	1.25	0.81	0.75	1.93	2.25
XIX	44.0	1.37	0.75	0.93	2.12	2.12
XX	64.5	0.93	0.87	0.87	1.95	2.00
'r' value	-	-0.2386	-0.1497	-0.2466	-0.2794	-0.1970
Range						
Maximum	68.00	1.43	1.06	1.12	2.62	2.93
Minimum	35.90	0.93	0.62	0.75	1.81	2.00
Mean	51.67	1.15	0.78	0.98	2.19	2.47

Table 6(a) Correlations between K status of leaf and bark

Tree No.	Leaf K (%)	Bark K (%)		
		S I	S II	S III
I	1.25	1.37	0.43	0.68
II	1.43	1.12	0.56	0.62
III	1.06	1.06	0.68	0.81
IV	1.43	1.50	0.56	0.68
V	1.12	1.12	0.93	1.06
VI	1.56	1.18	0.93	1.06
VII	1.30	1.06	0.81	0.75
VIII	1.25	1.00	0.93	0.62
IX	1.12	1.30	0.68	0.81
X	1.43	1.00	0.75	0.93
XI	1.18	1.37	0.62	1.00
XII	1.37	1.25	0.44	1.00
XIII	1.25	1.12	0.62	0.93
XIV	1.37	1.00	0.75	0.68
XV	1.06	1.30	0.68	0.75
XVI	1.43	1.50	0.87	0.93
XVII	1.30	1.37	0.81	1.00
XVIII	1.37	1.18	0.93	0.68
XIX	1.25	1.25	0.75	0.93
XX	1.30	1.12	0.62	0.87
'r' value	-	0.0354	0.1017	0.0137
Range				
Maximum	1.56	1.50	0.93	1.06
Minimum	1.06	1.00	0.43	0.62
Mean	1.29	1.20	0.71	0.83

Table 6(b) Correlations between K status of leaf and spur

Tree No.	Leaf K (%)	Spur K (%)		
		S I	S II	S III
I	1.25	1.25	0.87	1.12
II	1.43	1.12	0.93	1.06
III	1.06	1.43	1.06	1.00
IV	1.43	0.96	0.75	1.06
V	1.12	0.96	0.68	1.00
VI	1.56	1.00	0.62	1.18
VII	1.30	1.25	0.62	1.06
VIII	1.25	1.37	0.81	1.00
IX	1.12	1.25	0.68	1.06
X	1.43	1.00	0.87	0.81
XI	1.18	0.93	0.87	1.12
XII	1.37	1.18	0.75	1.12
XIII	1.25	1.25	0.81	0.81
XIV	1.37	1.43	0.93	0.75
XV	1.06	1.06	0.68	1.06
XVI	1.43	1.00	0.75	1.00
XVII	1.30	1.12	0.62	0.87
XVIII	1.37	1.25	0.81	0.75
XIX	1.25	1.37	0.75	0.93
XX	1.30	0.93	0.87	0.87
'r' value	-	-0.2540	-0.0994	-0.0730
Range				
Maximum	1.56	1.43	1.06	1.12
Minimum	1.06	0.93	0.62	0.75
Mean	1.29	1.15	0.78	0.98

Table 6(c) Correlations between K status of leaf and flower

Tree No.	Leaf K (%)	Flower K (%)	
		PB	FB
I	1.25	2.56	2.81
II	1.43	2.62	2.62
III	1.06	2.50	2.87
IV	1.43	2.62	2.81
V	1.12	2.25	2.12
VI	1.56	1.87	2.93
VII	1.30	1.93	2.81
VIII	1.25	2.56	2.50
IX	1.12	2.50	2.56
X	1.43	2.25	2.81
XI	1.18	2.37	2.75
XII	1.37	2.06	2.93
XIII	1.25	2.00	2.12
XIV	1.37	2.12	2.00
XV	1.06	1.87	2.25
XVI	1.43	1.81	2.06
XVII	1.30	1.93	2.18
XVIII	1.37	1.93	2.25
XIX	1.25	2.12	2.12
XX	1.30	1.95	2.00
'r' value	-	-0.2095	0.1609
Range			
Maximum	1.56	2.62	2.93
Minimum	1.06	1.81	2.00
Mean	1.29	2.19	2.47

A perusal of data in Table 7a indicates the mean, maximum and minimum values of yield and iron status of leaf and bark. There were positive correlations between yield and iron status of leaf and that of bark at SI (bud-dormant stage) and SII (bud-swelling stage) but all the correlations were non-significant. On the other hand, iron status of bark at SIII (full-bloom stage) depicted a negative correlation with yield

The mean, maximum and minimum values of yield and iron status of spur and flower are presented in Table 7b. A negative significant correlation (r=-0.5395) was depicted between yield and iron status of spur at SII as shown in Fig.5. There was positive correlation between yield and iron status of spur at SI and FB (full-bloom) stages of flower. Negative correlations were observed between yield and iron status of spur at SIII and that of flower at PB (pre-bloom) stage.

It is clear from the data in the Tables 7a and 7b that a variation in the iron content was observed in different tissues at various stages of observation. However, the iron level was maximum in bark at SII stage (358.0 ppm) and was closely followed by that at SI stage (355.0 ppm). However, minimum iron level was observed in leaf (135.0 ppm).

The data presented in Table 8a reveal that there was a negative correlation between iron status of leaf and bark.

An examination of the data in Table 8b indicates that iron status of leaf was positively correlated with iron status of spur at both SI and SIII stages. However, the correlations were non-significant. Negative correlation was observed between iron status of leaf and that of spur at SII stage.

A reference to the data in Table 8c reveals that there were positive correlations between iron status of leaf and that of flower at PB and FB stages but the correlations were non-significant.

Table 7(a) Correlations of yield with Fe status of leaf and bark in Patharnakh

Tree No.	Yield (Kg tree-1)	Leaf Fe (ppm)	Bark Fe (ppm)		
			S I	S II	S III
I	47.0	203	295	221	231
II	44.7	211	329	210	225
III	35.9	195	265	339	277
IV	37.9	270	275	205	224
V	46.0	215	220	281	221
VI	52.6	135	258	275	228
VII	43.7	235	235	358	180
VIII	57.7	242	310	285	225
IX	58.6	185	355	324	200
X	63.4	235	285	278	246
XI	55.6	205	315	310	180
XII	61.3	236	275	261	185
XIII	58.0	198	282	315	207
XIV	50.6	202	261	290	172
XV	36.5	215	292	225	210
XVI	61.4	247	230	235	175
XVII	68.0	194	310	256	164
XVIII	46.0	201	245	246	188
XIX	44.0	210	271	263	190
XX	64.5	298	255	242	200
'r' value	-	0.1259	0.1876	0.0624	-0.4172
Range					
Maximum	68.00	298.0	355.0	358.0	277.0
Minimum	35.00	135.0	220.0	205.0	164.0
Mean	51.67	216.6	278.1	270.9	206.4

Table 7(b) Correlations of yield with Fe status of spur and flower in Patharnakh

Tree No.	Yield (Kg tree-1)	Spur Fe (ppm)			Flower Fe (ppm)	
		S I	S II	S III	PB	FB
I	47.0	258	304	202	186	285
II	44.7	205	280	208	178	279
III	35.9	137	341	185	190	223
IV	37.9	188	262	179	164	282
V	46.0	263	253	168	155	225
VI	52.6	195	267	139	139	264
VII	43.7	146	248	175	195	267
VIII	57.7	242	240	180	180	225
IX	58.6	225	252	143	175	239
X	63.4	190	242	158	201	277
XI	55.6	210	226	175	198	270
XII	61.3	178	229	160	175	240
XIII	58.0	182	240	178	163	275
XIV	50.6	208	232	169	202	277
XV	36.5	167	245	164	215	278
XVI	61.4	175	241	172	210	276
XVII	68.0	170	228	176	192	279
XVIII	46.0	184	252	169	215	245
XIX	44.0	210	248	189	195	240
XX	64.5	225	265	171	189	280
'r' value	-	0.1782	-0.5395*	-0.3179	-0.0162	0.1314
Range						
Maximum	68.00	263.0	304.0	208.0	215.0	285.0
Minimum	35.90	137.0	226.0	139.0	139.0	223.0
Mean	51.67	197.9	254.7	173.0	185.8	261.3

* Significant at 5% level.

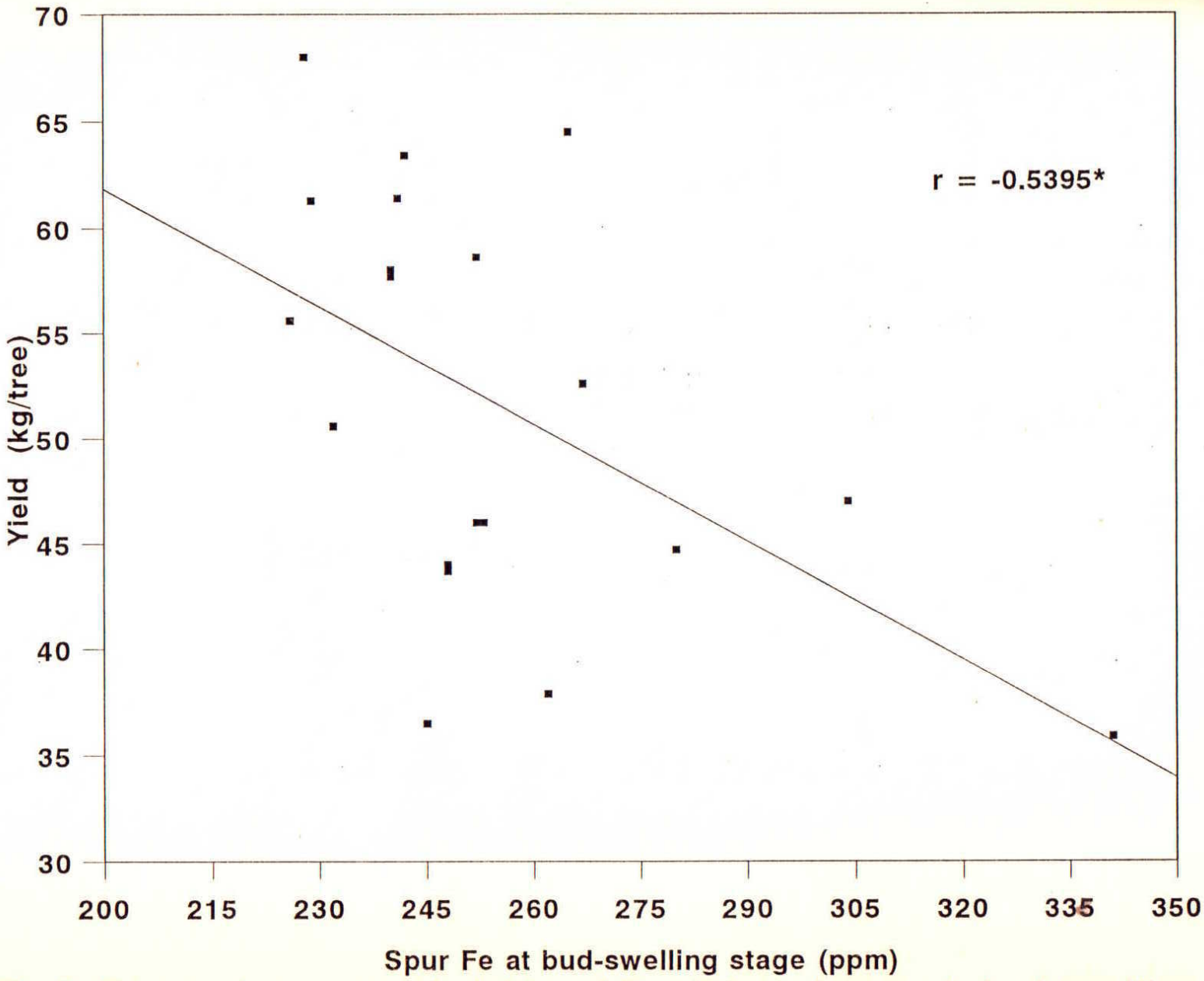

Fig.5 :Regression curve of yield and Fe status of spur at bud-swelling stage

Table 8(a) Correlations between Fe status of leaf and bark

Tree No.	Leaf Fe (ppm)	Bark Fe (ppm)		
		S I	S II	S III
I	203	295	221	231
II	211	329	210	225
III	195	265	339	277
IV	270	275	205	224
V	215	220	281	221
VI	135	258	275	228
VII	235	235	358	180
VIII	242	310	285	225
IX	185	355	324	200
X	235	285	278	246
XI	205	315	310	180
XII	236	275	261	185
XIII	198	282	315	207
XIV	202	261	290	172
XV	215	292	225	210
XVI	247	230	235	175
XVII	194	310	256	164
XVIII	201	245	246	188
XIX	210	271	263	190
XX	298	255	242	200
'r' value	-	-0.1087	-0.4135	-0.0835
Range				
Maximum	298.0	355.0	358.0	277.0
Minimum	135.0	220.0	205.0	164.0
Mean	216.6	278.1	270.9	206.4

Table 8(b) Correlations between Fe status of leaf and spur

Tree No.	Leaf Fe (ppm)	spur Fe (ppm)		
		S I	S II	S III
I	203	258	304	202
II	211	205	280	208
III	195	137	341	185
IV	270	188	262	179
V	215	263	253	168
VI	135	195	267	139
VII	235	146	248	175
VIII	242	242	240	180
IX	185	225	252	143
X	235	190	242	158
XI	205	210	226	175
XII	236	178	229	160
XIII	198	182	240	178
XIV	202	208	232	169
XV	215	167	245	164
XVI	247	175	241	172
XVII	194	170	228	176
XVIII	201	184	252	169
XIX	210	210	248	189
XX	298	225	265	171
'r' value	-	0.0542	-0.1325	0.2381
Range				
Maximum	298.0	263.0	304.0	208.0
Minimum	135.0	137.0	226.0	139.0
Mean	216.6	197.9	254.7	173.0

Table 8(c) Correlations between Fe status of leaf and flower

Tree No.	Leaf Fe (ppm)	Flower Fe (ppm)	
		PB	FB
I	203	186	285
II	211	178	279
III	195	190	223
IV	270	164	282
V	215	155	225
VI	135	139	264
VII	235	195	267
VIII	242	180	225
IX	185	175	239
X	235	201	277
XI	205	198	270
XII	236	175	240
XIII	198	163	275
XIV	202	202	277
XV	215	215	278
XVI	247	210	276
XVII	194	192	279
XVIII	201	215	245
XIX	210	195	240
XX	298	189	280
'r' value	-	0.2648	0.1750
Range			
Maximum	298.0	215.0	285.0
Minimum	135.0	139.0	223.0
Mean	216.6	185.8	261.3

4.5 CORRELATIONS OF MANGANESE STATUS

The data regarding the yield and manganese status of different tissues of Patharnakh are presented in Tables 9 and 10.

The data in Table 9a indicate the mean, maximum and minimum values of yield and manganese level of leaf and bark. There was a positive correlation between yield and Mn status of bark at SI (bud-dormant stage), SII (bud-swelling stage) and SIII (full-bloom stage) but the correlations were non-significant. On the contrary, manganese status of leaf exhibited a negative correlation with the yield.

A perusal of data in Table 9b reveals that manganese status of spur at SI, SII and SIII stages and flower at both PB (pre-bloom stage) and FB (full-bloom stage) was positively correlated with the yield but the correlations were non-significant.

It is apparent from the data in Tables 9a and 9b that the mean manganese content was highest in leaf (66.2 ppm) followed by flower (22.3 to 22.4 ppm). The mean manganese content in spur was 15.3 to 16.6 ppm.

The data given in Table 10a depict that manganese status of bark at SI, SII and SIII stages bore negative correlation with leaf manganese status. The correlation ($r = -0.4708$) was found to be negative significant at SI stage as shown in Fig.6.

An examination of the data in Table 10b reveals that manganese status of spur at both SI and SIII stages was positively correlated with the manganese status of leaf but correlations were non-significant. On the other hand, manganese status of spur at SII stage exhibited a negative correlation with manganese status of leaf.

There were non-significant positive correlations between manganese status of leaf and that of flower at PB and FB stages (Table10c).

Table 9(a) Correlations of yield with Mn status of leaf and bark in Patharnakh

Tree No.	Yield (Kg tree-1)	Leaf Mn (ppm)	Bark Mn (ppm)		
			S I	S II	S III
I	47.0	50	19	15	18
II	44.7	52	24	21	21
III	35.9	80	22	20	20
IV	37.9	82	25	25	16
V	46.0	45	23	27	19
VI	52.6	77	18	19	18
VII	43.7	70	20	21	19
VIII	57.7	67	21	24	21
IX	58.6	71	19	26	23
X	63.4	55	26	24	25
XI	55.6	68	22	20	28
XII	61.3	43	28	22	20
XIII	58.0	58	24	19	22
XIV	50.6	60	22	21	26
XV	36.5	58	23	18	19
XVI	61.4	82	19	17	21
XVII	68.0	65	30	22	19
XVIII	46.0	84	20	20	23
XIX	44.0	78	18	16	18
XX	64.5	79	21	19	23
'r' value	-	-0.0943	0.2506	0.0864	0.4029
Range					
Maximum	68.00	84.0	30.0	27.0	28.0
Minimum	35.90	43.0	18.0	15.0	16.0
Mean	51.67	66.2	22.2	20.8	20.9

Table 9(b) Correlations of yield with Mn status of spur and flower in Patharnakh

Tree No.	Yield (Kg tree-1)	Spur Mn (ppm)			Flower Mn (ppm)	
		S I	S II	S III	PB	FB
I	47.0	16	22	11	25	25
II	44.7	22	20	10	22	21
III	35.9	11	19	17	22	23
IV	37.9	17	16	13	22	24
V	46.0	15	19	11	20	22
VI	52.6	16	17	11	23	20
VII	43.7	14	14	15	19	17
VIII	57.7	21	11	18	26	29
IX	58.6	24	16	13	25	30
X	63.4	20	15	13	22	21
XI	55.6	19	18	11	24	19
XII	61.3	17	21	24	22	23
XIII	58.0	16	19	18	21	17
XIV	50.6	22	15	15	18	21
XV	36.5	18	13	12	21	18
XVI	61.4	15	18	17	26	26
XVII	68.0	17	16	10	19	29
XVIII	46.0	21	14	26	27	21
XIX	44.0	20	11	24	24	22
XX	64.5	16	19	18	20	18
'r' value	-	0.2040	0.0980	0.0815	0.0353	0.2895
Range						
Maximum	68.00	24.0	22.0	26.0	27.0	30.0
Minimum	35.90	11.0	11.0	10.0	18.0	18.0
Mean	51.67	17.8	16.6	15.3	22.4	22.3

Table 10(a) Correlations between Mn status of leaf and bark

Tree No.	Leaf Mn (ppm)	Bark Mn (ppm)		
		S I	S II	S III
I	50	19	15	18
II	52	24	21	21
III	80	22	20	20
IV	82	25	25	16
V	45	23	27	19
VI	77	18	19	18
VII	70	20	21	19
VIII	67	21	24	21
IX	71	19	26	23
X	55	26	24	25
XI	68	22	20	28
XII	43	28	22	20
XIII	58	24	19	22
XIV	60	22	21	26
XV	58	23	18	19
XVI	82	19	17	21
XVII	65	30	22	19
XVIII	84	20	20	23
XIX	78	18	16	18
XX	79	21	19	23
'r' value	-	-0.4708*	-0.2010	-0.0479
Range				
Maximum	84.0	30.0	27.0	28.0
Minimum	43.0	18.0	15.0	16.0
Mean	66.2	22.2	20.8	20.9

* Significant at 5% level.

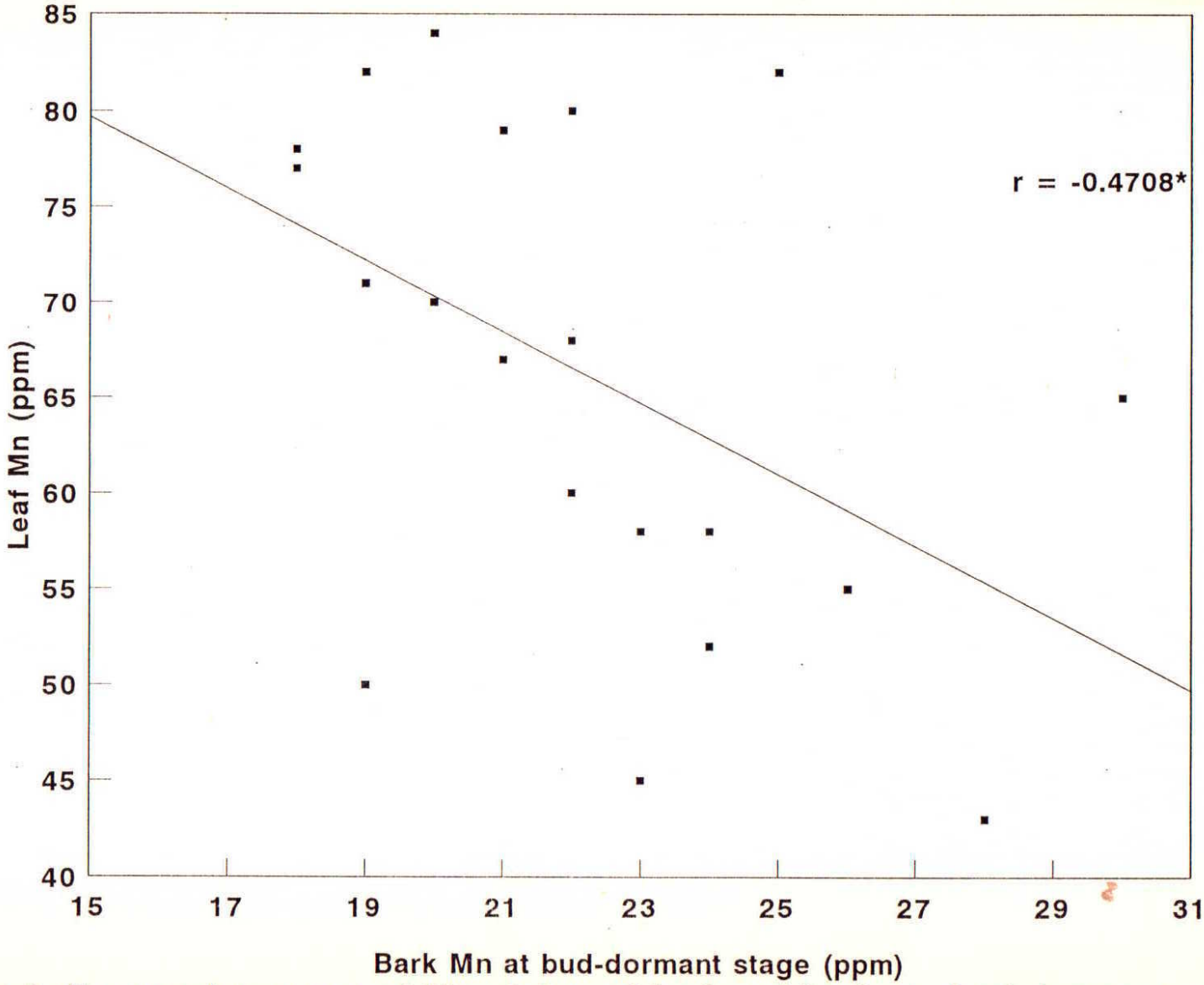

Fig.6 :Regression curve of Mn status of leaf and bark at bud-dormant stage

Table 10(b) Correlations between Mn status of leaf and spur

Tree No.	Leaf Mn (ppm)	Spur Mn (ppm)		
		S I	S II	S III
I	50	16	22	11
II	52	12	20	10
III	80	11	19	17
IV	82	17	16	13
V	45	15	19	11
VI	77	16	17	11
VII	70	14	14	15
VIII	67	21	11	18
IX	71	24	16	13
X	55	20	15	13
XI	68	19	18	11
XII	43	17	21	24
XIII	58	16	19	18
XIV	60	22	15	15
XV	58	18	13	12
XVI	82	15	18	17
XVII	65	17	16	10
XVIII	84	21	14	26
XIX	78	20	11	24
XX	79	16	19	18
'r' value	-	0.0763	-0.3869	0.2911
Range				
Maximum	84.0	24.0	22.0	26.0
Minimum	43.0	11.0	11.0	10.0
Mean	66.2	17.8	16.6	15.3

Table 10(c) Correlations between Mn status of leaf and flower

Tree No.	Leaf Mn (ppm)	Flower Mn (ppm)	
		PB	FB
I	50	25	25
II	52	22	21
III	80	22	23
IV	82	22	24
V	45	20	22
VI	77	23	20
VII	70	19	17
VIII	67	26	29
IX	71	25	30
X	55	22	21
XI	68	24	19
XII	43	22	23
XIII	58	21	17
XIV	60	18	21
XV	58	21	18
XVI	82	26	26
XVII	65	19	29
XVIII	84	27	21
XIX	78	24	22
XX	79	20	18
'r' value	-	0.2484	0.0649
Range			
Maximum	84.0	27.0	30.0
Minimum	43.0	18.0	18.0
Mean	66.2	22.4	22.3

4.6 CORRELATIONS OF ZINC STATUS

The data concerning the yield and zinc status of different tissues of Patharnakh are tabulated in Table 11 and 12.

The mean, maximum and minimum values of yield and zinc levels of leaf and bark are given in Table 11a. Zinc status of leaf and bark at SI (bud-dormant stage) and SIII (full-bloom stage) was positively correlated with the yield. On the contrary, zinc status of bark at SII (bud-swelling stage) bore a negative correlation with the yield. The data, however, were non-significant.

The data in Table 11b depict a negative correlation between yield and zinc status of spur and flower at all stages.

It is apparent from the data in Tables 11a and 11b that zinc content was maximum in spur at SII stage (99.0 ppm) followed by flower at PB stage (85 ppm). The minimum zinc content was in leaf (27.0 ppm).

The data tabulated in Table 12a depict that there was positive correlation between the zinc status of leaf and zinc status of bark at SII and SIII stages. Negative correlation was observed between zinc status of leaf and zinc status of bark at SI. However, the correlations were non-significant.

A perusal of the data in Table 12b clearly demonstrates that the zinc status of spur at SII and SIII stages was positively correlated with the zinc status of leaf but the correlations were non-significant. On the contrary, zinc status of spur at SI stage depicted negative correlation that of leaf.

Table 11(a) Correlations of yield with Zn status of leaf and bark in Patharnakh

Tree No.	Yield (Kg tree-1)	Leaf Zn (ppm)	Bark Zn (ppm) S I	S II	S III
I	47.0	33	56	41	63
II	44.7	40	62	45	66
III	35.9	42	67	64	54
IV	37.9	27	63	48	40
V	46.0	36	52	42	46
VI	52.6	51	56	44	49
VII	43.7	48	54	47	52
VIII	57.7	37	58	50	54
IX	58.6	35	54	47	56
X	63.4	54	59	61	48
XI	55.6	39	68	40	44
XII	61.3	54	58	43	62
XIII	58.0	50	60	45	62
XIV	50.6	41	54	49	55
XV	36.5	49	48	48	45
XVI	61.4	39	57	41	49
XVII	68.0	35	56	44	52
XVIII	46.0	38	51	47	61
XIX	44.0	52	61	49	57
XX	64.5	50	58	52	63
'r' value	-	0.2220	0.0194	-0.1585	0.2057
Range					
Maximum	68.00	54.0	68.0	64.0	66.0
Minimum	35.90	27.0	48.0	40.0	40.0
Mean	51.67	42.5	57.6	47.3	53.9

Table 11(b) Correlations of yield with Zn status of spur and flower in Patharnakh

Tree No.	Yield	Spur Zn (ppm)			Flower Zn (ppm)	
	(Kg tree-1)	S I	S II	S III	PB	FB
I	47.0	58	86	43	85	61
II	44.7	54	92	40	58	39
III	35.9	51	89	39	75	60
IV	37.9	61	84	41	57	39
V	46.0	62	97	55	62	39
VI	52.6	55	91	62	65	32
VII	43.7	52	68	39	70	38
VIII	57.7	54	74	38	58	44
IX	58.6	56	99	34	62	52
X	63.4	50	85	40	72	48
XI	55.6	58	67	41	60	42
XII	61.3	54	82	33	50	37
XIII	58.0	59	79	35	65	35
XIV	50.6	54	77	32	54	41
XV	36.5	51	80	38	52	44
XVI	61.4	55	68	42	49	38
XVII	68.0	37	62	34	50	41
XVIII	46.0	61	74	36	62	52
XIX	44.0	60	85	46	69	50
XX	64.5	53	81	49	63	44
'r' value	-	-0.3723	-0.3028	-0.1014	-0.2696	-0.2486
Range						
Maximum	68.00	61.0	99.0	62.0	85.0	61.0
Minimum	35.90	50.0	62.0	32.0	49.0	32.0
Mean	51.67	54.7	81.0	40.8	61.9	43.8

Table12(a) Correlations between Zn status of leaf and bark

Tree No.	Leaf Zn (ppm)	Bark Zn (ppm)		
		S I	S II	S III
I	33	56	41	63
II	40	62	45	66
III	42	67	64	54
IV	27	63	48	40
V	36	52	42	46
VI	51	56	44	49
VII	48	54	47	52
VIII	37	58	50	54
IX	35	54	47	56
X	54	59	61	48
XI	39	68	40	44
XII	54	58	43	62
XIII	50	60	45	62
XIV	41	54	49	55
XV	49	48	48	45
XVI	39	57	41	49
XVII	35	56	44	52
XVIII	38	51	47	61
XIX	52	61	49	57
XX	50	58	52	63
'r' value	-	-0.0425	0.2792	0.2174
Range				
Maximum	54.0	68.0	64.0	66.0
Minimum	27.0	48.0	40.0	40.0
Mean	42.5	57.6	47.3	53.9

Table 12(b) Correlations between Zn status of leaf and spur

Tree No.	Leaf Zn (ppm)	Spur Zn (ppm)		
		S I	S II	S III
I	33	58	86	43
II	40	54	92	40
III	42	51	89	39
IV	27	61	84	41
V	36	62	97	55
VI	51	55	91	62
VII	48	52	68	39
VIII	37	54	74	38
IX	35	56	99	34
X	54	50	85	40
XI	39	58	67	41
XII	54	54	82	33
XIII	50	59	79	35
XIV	41	54	77	32
XV	49	51	80	38
XVI	39	55	68	42
XVII	35	37	62	34
XVIII	38	61	74	36
XIX	52	60	85	46
XX	50	53	81	49
'r' value	-	-0.1386	0.0237	0.1379
Range				
Maximum	54.0	61.0	99.0	62.0
Minimum	27.0	50.0	62.0	32.0
Mean	42.5	54.7	81.0	40.8

Table 12(c) Correlations between Zn status of leaf and flower

Tree No.	Leaf Zn (ppm)	Flower Zn (ppm)	
		PB	FB
I	33	85	61
II	40	58	39
III	42	75	60
IV	27	57	39
V	36	62	39
VI	51	65	32
VII	48	70	38
VIII	37	58	44
IX	35	62	52
X	54	72	48
XI	39	60	42
XII	54	50	37
XIII	50	65	35
XIV	41	54	41
XV	49	52	44
XVI	39	49	38
XVII	35	50	41
XVIII	38	62	52
XIX	52	69	50
XX	50	63	44
'r' value	-	0.0848	-0.2282
Range			
Maximum	54.0	85.0	61.0
Minimum	27.0	49.0	32.0
Mean	42.5	61.9	43.8

A reference to the data in Table 12c reveals that zinc status of flower at PB stage bore positive correlation with zinc status of leaf. But the correlation was non-significant. Negative correlation was observed between zinc status of flower at FB stage and that of leaf.

4.7 CORRELATIONS OF COPPER STATUS

The data regarding the yield and copper status of different tissues of Patharnakh are presented in Tables 13 and 14.

An examination of the data in Table 13a indicates mean, maximum and minimum values of yield and copper status of leaf and bark. Positive correlation was observed between yield and copper status of bark at SI (bud-dormant stage). The copper status of leaf and that of bark at SII (bud-swelling stage) and SIII (full-bloom stage) was negatively correlated with yield. The data, however, were non-significant.

A reference to the data in Table 13b clearly demonstrates that positive correlation was observed between yield and copper status of spur at SII and SIII. However the correlations were non-significant. On the contrary copper status of spur at SI and that of flower at PB (pre-bloom stage) and FB (full-bloom stage) depicted a negative correlation.

It is clear from the data given in Tables 13a and 13b that the mean copper content was observed in spur was 46.3 to 98.5 ppm followed by flower (43.8 to 51.9 ppm). The lowest mean of copper content was observed in leaf (21.0 ppm). Maximum copper content was registered in spur at SII stage (119.0 ppm) followed by that in the same tissue at SIII (79.0 ppm). Minimum copper content was recorded in bark at SI stage (11.0 ppm).

Table 13(a) Correlations of yield with Cu status of leaf and bark in Patharnakh

Tree No.	Yield (Kg tree-1)	Leaf Cu (ppm)	Bark Cu (ppm)		
			S I	S II	S III
I	47.0	29	13	19	23
II	44.7	26	18	28	13
III	35.9	28	22	37	25
IV	37.9	18	11	32	37
V	46.0	29	12	22	37
VI	52.6	23	15	37	28
VII	43.7	21	14	28	31
VIII	57.7	19	17	37	29
IX	58.6	25	15	28	25
X	63.4	20	13	26	31
XI	55.6	16	16	21	23
XII	61.3	20	28	14	20
XIII	58.0	22	30	31	19
XIV	50.6	17	15	24	30
XV	36.5	13	21	20	25
XVI	61.4	15	12	26	27
XVII	68.0	21	22	30	20
XVIII	46.0	19	17	26	26
XIX	44.0	18	29	22	33
XX	64.5	22	23	19	30
'r' value	-	-0.1254	0.1891	-0.1097	-0.1609
Range					
Maximum	68.00	29.0	29.0	37.0	34.0
Minimum	35.90	13.0	11.0	14.0	13.0
Mean	51.67	21.0	18.1	26.0	26.3

Table 13(b) Correlations of yield with Cu status of spur and flower in Patharnakh

Tree No.	Yield (Kg tree-1)	Spur Cu (ppm)			Flower Cu (ppm)	
		S I	S II	S III	PB	FB
I	47.0	69	81	33	61	74
II	44.7	52	94	49	39	60
III	35.9	38	105	54	60	52
IV	37.9	48	112	73	39	55
V	46.0	46	115	39	39	57
VI	52.6	65	80	57	32	50
VII	43.7	46	92	65	38	48
VIII	57.7	55	96	68	44	42
IX	58.6	52	82	79	52	61
X	63.4	47	116	64	48	39
XI	55.6	48	91	48	42	50
XII	61.3	39	89	50	37	36
XIII	58.0	36	96	47	35	42
XIV	50.6	45	105	46	41	48
XV	36.5	42	72	56	44	54
XVI	61.4	37	119	58	38	42
XVII	68.0	33	116	70	41	49
XVIII	46.0	50	98	48	52	72
XIX	44.0	41	107	43	50	38
XX	64.5	43	96	51	44	70
'r' value	-	-0.2018	0.2249	0.2009	-0.2486	-0.2890
Range						
Maximum	68.00	69.0	119	79.0	61.0	74.0
Minimum	35.90	33.0	72.0	33.0	32.0	36.0
Mean	51.67	46.3	98.5	54.9	43.8	51.9

A perusal of data in Table 14a indicates that positive correlation was observed between copper status of leaf and bark at SII stage. On the other hand a negative correlation was recorded between copper content of leaf and that of bark at SI and SIII stages.

The data tabulated in Table 14b show that copper status of spur at SI was positively correlated with leaf copper status but the correlation was non-significant. Negative correlations were observed between copper status of leaf and that of spur at SII and SIII stages.

An examination of the data in Table 14c indicates that there were positive correlations between copper status of leaf and that of flower at PB and FB stages. However, the correlations were non-significant.

5.1 PHYSICO-CHEMICAL CHARACTERS OF FRUIT

The data pertaining to the length, breadth, weight, total soluble solids, acidity and TSS/acid ratio of fruit from the experimental tree are presented in Table 15.

Fruit length ranged from 5.75 to 7.0 cm. However the mean fruit length was 6.19 cm. Maximum fruit breadth was 6.62 cm and minimum was 5.5 cm. The mean fruit breadth was 5.83 cm. The data indicate that the fruit weight ranged from 97.0 to 120.5 g. However, the mean fruit weight of 111.0 g was recorded.

Table 14(a) Correlations between Cu status of leaf and bark

Tree No.	Leaf Cu (ppm)	Bark Cu(ppm)		
		S I	S II	S III
I	29	13	19	23
II	26	18	28	13
III	28	22	34	25
IV	18	11	32	34
V	29	12	22	34
VI	23	15	34	28
VII	21	14	28	31
VIII	19	17	37	29
IX	25	15	28	25
X	20	13	26	31
XI	16	16	21	23
XII	20	28	14	20
XIII	22	30	31	19
XIV	17	15	24	30
XV	13	21	20	25
XVI	15	12	36	27
XVII	21	22	30	20
XVIII	19	17	26	26
XIX	18	29	22	33
XX	22	23	19	20
'r' value	-	-0.0794	0.0080	-0.1762
Range				
Maximum	29.0	29.0	37.0	34.0
Minimum	13.0	11.0	14.0	13.0
Mean	21.0	18.1	26.0	26.3

Table 14(b) Correlations between Cu status of leaf and spur

Tree No.	Leaf Cu (ppm)	Spur Cu(ppm)		
		S I	S II	S III
I	29	69	81	33
II	26	52	94	49
III	28	38	105	54
IV	18	48	112	73
V	29	46	115	39
VI	23	65	88	57
VII	21	46	92	65
VIII	19	55	96	68
IX	25	52	82	79
X	20	47	116	64
XI	16	48	91	48
XII	20	39	89	50
XIII	22	36	96	47
XIV	17	45	105	46
XV	13	42	72	56
XVI	15	37	119	58
XVII	21	33	116	70
XVIII	19	50	98	48
XIX	18	41	107	43
XX	22	43	96	51
'r' value	-	0.3500	-0.0392	-0.2351
Range				
Maximum	29.0	69.0	119.0	79.0
Minimum	13.0	33.0	72.0	33.0
Mean	21.0	46.6	98.5	54.9

Table 14(c) Correlations between Cu status of leaf and flower

Tree No.	Leaf Cu (ppm)	Flower Cu (ppm)	
		PB	FB
I	29	61	74
II	26	39	60
III	28	60	52
IV	18	39	55
V	29	39	57
VI	23	32	50
VII	21	38	48
VIII	19	44	42
IX	25	52	61
X	20	48	39
XI	16	42	50
XII	20	37	36
XIII	22	35	42
XIV	17	41	48
XV	13	44	54
XVI	15	38	42
XVII	21	41	49
XVIII	19	52	72
XIX	18	50	38
XX	22	44	70
'r' value	-	0.3310	0.4236
Range			
Maximum	29.0	61.0	74.0
Minimum	13.0	32.0	36.0
Mean	21.0	43.8	51.9

Table15 Physico-chemical characters of fruit of experimental trees of Patharnakh

Tree No.	Fruit Length (cm)	Fruit Breadth (cm)	Fruit Weight (g)	TSS (%)	Acidity (%)	TSS/Acid ratio
I	5.87	5.62	100.0	10.0	0.30	33.33
II	5.87	5.80	105.0	12.0	0.23	52.17
III	6.25	5.75	110.5	10.0	0.30	33.33
IV	6.12	5.62	110.0	11.0	0.26	42.30
V	6.25	5.25	112.0	11.5	0.26	44.23
VI	6.50	6.00	115.0	10.0	0.23	43.47
VII	6.00	5.50	108.0	10.0	0.34	29.41
VIII	7.00	6.62	123.5	09.0	0.30	30.00
IX	6.25	6.12	114.5	10.0	0.33	30.30
X	6.50	6.12	117.5	11.0	0.26	42.30
XI	6.00	5.87	112.5	09.0	0.30	30.30
XII	6.00	5.50	108.0	10.0	0.33	30.30
XIII	6.50	6.12	117.5	09.0	0.33	27.27
XIV	6.00	5.87	112.5	12.0	0.26	46.15
XV	6.12	5.75	111.5	11.0	0.26	42.30
XVI	6.62	6.25	120.5	11.0	0.26	42.30
XVII	6.50	6.00	115.0	10.0	0.30	33.33
XVIII	5.75	5.62	097.0	11.5	0.26	44.23
XIX	5.87	5.50	098.0	10.5	0.30	35.00
XX	6.00	5.87	112.2	10.0	0.30	33.33
Mean	6.19	5.83	111.0	10.42	0.28	37.26
Maximum	7.00	6.62	120.5	12.00	0.34	52.17
Minimum	5.75	5.50	097.0	09.00	0.23	27.27

There was marked difference in total soluble solids of fruits from different experimental trees. The maximum TSS was 12.0 per cent and minimum was 9.0 per cent and mean TSS was 10.42 per cent. Similarly, the acidity of fruit ranged from 0.23 to 0.34 per cent and mean acidity was 0.28 per cent. TSS/acid ratio ranged from 27.27 to 52.17 and mean TSS/acid ratio of 37.26 was recorded.

It is apparent from the data that generally the fruits with less weight had more TSS. Similarly, fruits with more TSS had less acidity. The weight of fruits also had influence on TSS/acid ratio. Generally the fruits with less weight had higher TSS/acid ratio.

CHAPTER V

DISCUSSION

In pear, the leaf has so far been considered a standard sampling tissue for nutrient analysis. However, the technique has its own disadvantages. Any recommendation carried out on the basis of leaf analysis does not benefit the current crop. The present study aims at to evaluate the nutritional status of Patharnakh at an earlier stage by determining the nutrients present in plant parts such as bark, spur and flower. The results are discussed in the light of present knowledge in this chapter.

5.1 CORRELATIONS OF NITROGEN STATUS

From the data in Table 1a it is clear that nitrogen status of leaf ranged between 1.60 to 2.20 per cent. Similar observation was recorded by Kamboj *et al.* (1987) who found that mid-shoot leaves of Patharnakh registered 2.14 per cent of mean value of nitrogen.

Leaf nitrogen level is associated with optimum growth. Hosoi *et al.* (1963) found that leaf nitrogen level as associated with optimum growth and fruiting varied between 2.0 to and 2.20 per cent of dry matter in pear.

The studies showed that there was negative correlation between yield and nitrogen status of leaf (Table 1(a). This may be due to the fact that higher yield would more severely exhaust the nitrogen content of leaf. The findings of Sanchez and Silva (1994) in pear support the present investigation. They found that high yield of pear corresponded with less amount of nitrogen content in leaf. Similar observations was

recorded in peach by Stoilov *et al.* (1990). They stated that N/K ratio in the leaves play an important role in productivity because maximum yields were obtained at lower value of N/P and N/K ratio.

There were negative correlations between yield and nitrogen status of leaf, bark at SII (bud-swelling stage), spur at SII and SIII (full-bloom stage) and flower at FB (full-bloom stage)(Tables 1a and 1b). A positive correlation was depicted between leaf nitrogen status and bark nitrogen status (Table 2a). Probably there is possibility of using bark at SII stage for establishing the N status of Patharnakh. However technique will have to be refined by taking more number of samples from different locations and including a larger number of trees depicting a greater variation in yield and N status.

A significant positive correlation (r=0.4934) was depicted between nitrogen present in flower at PB (pre-bloom stage)and leaf (Table 2c). Similar positive correlation was found between nitrogen status of flower and leaf of pear (*Pyrus communis*) as reported by Sanz *et al.* (1994). They advocated that there is possibility of using flower as sampling tissue for early prediction of N status in *Pyrus communis*. Similarly, nitrogen status of flower at FB had positive correlation with nitrogen status of leaf of Patharnakh.

The nitrogen status of bark and spur was lower than that of leaf and flower (Tables 1a and 1b). It can be due to the fact that nitrogen present in spur and bark would have been utilised by the plant during growth cycle which may lead to decrease in nitrogen content in these tissues at the time of sampling. Also the leaves are metabolically active sites and flowers are the strong sink. Hence, a larger concentration of nutrients may be expected in flowers. The bark contains phloem and xylem which are the conducting tissues. The difference in nutrient status of leaf, bark, spur and flower could also be due to different time of sampling of different tissues.

5.2 CORRELATIONS OF PHOSPHORUS STATUS

It is evident from the data in Table 3a that phosphorus status of leaf ranged between 0.05 to 0.13 per cent. Similarly Kamboj *et al.* (1987) suggested the optimum level for P in leaves of Patharnakh as 0.13 per cent.

It is clear from the data in Table 3a that there was positive correlation between yield and phosphorus status of leaf. Similar results were given by Stoilov *et al* (1990), who found that maximum yields were obtained at lower values of N/P ratio in peach. There was significant positive correlation (r=0.5149) between yield and phosphorus status of spur at SI (bud-dormant stage) (Table 3b).

A significant positive correlation (r=0.6678) was depicted between phosphorus status of leaf and that of bark at SIII (full-bloom stage) (Table 4a).

The study showed that flower contained greater quantities of phosphorus content than leaf thereby indicating that flower acts as a major sink for nutrient utilisation. Similar results were given by Sanz *et al.* (1994) in *Pyrus communis*. They found that phosphorus content ranged from 0.396 to 0.712 per cent in flowers and 0.106 to 0.306 per cent in leaves.

5.3 CORRELATIONS OF K STATUS

The total potassium in pear leaf ranged from 1.06 to 1.56 per cent (Table 5a). Kamboj *et al.* (1987) also reported that the mean value of potassium in pear leaves was 1.44 per cent.

A significant positive correlation (r=0.4501) was depicted between yield and potassium status of bark at SIII (fill-bloom stage) (Table 5a). A positive correlation was also depicted between yield and potassium status of leaf. Stoilov *et al.* (1990) also

reported similar observations in peach. According to them maximum yields were obtained at lower values of N/K ratio in leaf of peach.

It is clear from the data in Table 5a and 5b that leaves contained less potassium content than flowers but more than bark and spur. Flowers contained the greatest quantities of potassium. Similar reports were given by Sanz *et al.* (1994) in *Pyrus communis*. It may be due to the fact that flowers are the major sink for many nutrients.

5.4 CORRELATIONS OF IRON STATUS

The perusal of data in Table 7a indicate that the Fe content of leaves of Patharnakh ranged from 135 to 298 ppm. The results of Sanz *et al.* (1994) in *Pyrus communis* ranged from 42.8 ppm to 300 ppm.

There was no significant correlation between yield and iron status of leaf (Table 7a). Sanchez and Silva (1994) reported the similar results who investigated that with the exception of boron, there was no significant correlation between yield and nutrient concentration. The data in Table 7b indicate a negative significant correlation ($r=-0.5395$) between yield and iron status of spur at SII (bus-swelling stage). It may be due to the super optimal range of iron in spur which could adversely affect the yield.

There were positive correlations between iron status of leaf and flower at PB and FB stages. Therefore, the flower iron may be estimated to judge the iron status of Patharnakh. Sanz *et al.* (1994) suggested the possibility of using flower for early detection of iron deficiency in *Pyrus communis*. There was also positive correlation between iron status of leaf and iron status of spur at SI and SIII.

Iron was found in greater quantities in flower as compared to leaf (Tables 7a and 7b). Similar findings were given by Sanz *et al.* (1994) in *Pyrus communis*. They

observed that mean value of iron was 198.35 ppm for flowers and 126.88 ppm for leaves of pear trees.

5.5 CORRELATIONS OF MANGANESE STATUS

The data in Table 9a indicate that manganese content in leaves of Patharnakh ranged from 43.0 to 84.0 ppm. The ranges described by Shear and Faust (1980) supported the present observations. They found that manganese content of leaves of pear (*Pyrus communis*) varied from 20 to 170 ppm.

It is clear from the data Tables 9a and 9b that there were no significant correlations between yield and manganese status of leaf, bark, spur and flower. However, there was negative significant correlation (r=-0.4708) between manganese status of leaf and that of bark at SI. The leaf is a metabolically active tissue and the bark is mainly the conducting tissue. Hence, such a correlation is evidently possible.

Leaves contained greater quantities of manganese than flower (Tables 9a and 9b). the work of Sanz *et al.* (1994) in *Pyrus communis* supported the above investigation. They found that manganese content ranged from 13.6 to 125.40 ppm in leaves as compared to 14.40 to 52.20 ppm in flower of pear trees.

5.6 CORRELATIONS OF ZINC STATUS

It is evident from the data given in Table 11a that zinc content in leaves ranged from 27.0 to 54.0 ppm. The results of Shear and Faust (1980) support the above observations. They found that zinc content in leaves of *Pyrus communis* ranged from 20 to 60 ppm.

There was no significant correlation between yield and zinc status of leaf, bark, spur and flower. Similarly there was no significant correlation between zinc status of leaf and other tissues.

However, the flower at FB stage had similar quantities of zinc as in leaf. Similar findings were given by Sanz *et al.* (1994) in *Pyrus communis*. They observed that mean value of zinc was 48.99 ppm for flower and 58.72 ppm for leaf.

5.7 CORRELATIONS OF COPPER STATUS IN PATHARNAKH

The mean value of copper content in leaves was 21.0 ppm (Table 13a). The results of Sanz *et al.* (1994) support the above investigation. They found mean value of copper in leaves of *Pyrus communis* was 24.44 ppm. No significant correlation was found between yield and copper status of leaf, bark, spur and flower. The copper status of flower at both PB and FB stages was positively correlated with copper status of leaf.

The flower contained greater quantities of copper than leaf. Similar observations were recorded by Sanz *et al.* (1994)in *Pyrus communis* They observed that mean value of copper was 111.05 ppm for flower and 24.44 ppm for leaf.

5.8 PHYSICO-CHEMICAL CHARACTERS OF FRUIT

The data in Table 15 indicate that fruit with less weight had more TSS and less acidity. TSS/acid ratio was also more in case of fruit with less weight. Fruits with more TSS had less acidity. The factors favouring greater fruit size could delay the maturity of fruit. Hence, lower TSS and more acidity would accompany the bigger fruit.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The present investigations on the early prediction of nutritional status of Patharnakh pear (*Pyrus pyrifolia* (Burm) Nakai) were undertaken at the college orchard of Department of Horticulture, Punjab Agricultural University, Ludhiana, during year 1996. Thirty-year-old rejuvenated plants were selected for the study. The leaf, bark, spur and flower samples were analysed for nitrogen, phosphorus, potassium, zinc, iron, copper and manganese. The coefficients of correlation were worked out between the nutritional status of bark, spur and flowers with that of leaf and yield. The salient findings of the study are given hereunder:

— There were no significant correlations between the nitrogen status of leaf , bark, spur and flower with that of yield. The mean nitrogen content in flower was 2.74 to 2.92 per cent followed by leaf (1.91 per cent). Maximum nitrogen content was observed in flower at full-bloom stage (3.16 per cent).

— There was significant correlation (r=0.4934) existed between nitrogen status of flower at pre-bloom stage and that of leaf.

— The phosphorus status of spur at SI (bud-dormant stage) depicted a significant correlation (r=0.5149) with the yield. The mean phosphorous content in flower was 0.135 to 0.143 per cent followed by that of leaf (0.088 per cent). Maximum phosphorus content was observed in flower at FB (full-bloom stage) (0.20 per cent).

— A significant correlation (r=0.6678) was observed between phosphorus status of bark at SIII (full-bloom stage) and that of leaf.

— There was significant correlation (r=0.4501) between potassium status of bark at full-bloom stage and yield. The mean potassium content was observed in flower (2.19 to 2.47 per cent) followed by that of leaf (1.29 per cent). Maximum potassium content was observed in flower at full-bloom stage (2.93 per cent).

— No significant correlations were observed between potassium status of bark, spur and flower with that of leaf.

— A negative significant correlation (r = -0.5395) was observed between iron status of spur at SII (bud-swelling stage) and yield. A fluctuation in the iron content was observed in different tissues at various stages of observation. However, it was maximum in bark at SII (358.0 ppm) followed by that at SI (355.0 ppm).

— No significant correlations were depicted between the status of bark, spur and flower with that of leaf.

— There were no significant correlations were depicted between yield and manganese status of leaf, bark, spur and flower. Mean manganese content was highest in leaf (66.2 ppm) followed by flower (22.3 to 22.4 ppm).

— There was negative significant correlation (r = -0.4708) between manganese status of leaf and manganese status of bark at SI (bud-dormant stage).

— No significant correlation was observed between yield and zinc status of leaf, bark and flower. A fluctuation in the zinc content was observed in different tissues at various stages. However, it was maximum in spur at SII (99.0 ppm).

— Non-significant correlations were observed between zinc status of leaf and zinc status of bark, spur and flower.

— The copper status of bark, spur and flower did not have significant correlation with yield. The mean copper content observed in spur was 46.3 to 98.5 ppm followed by flower 43.8 to 51.9 ppm.

— Copper status of leaf was not significantly correlated with the copper status of bark, spur and flower.

— The fruits with smaller size had more TSS and more TSS/acid ratio.

The present studies indicate that there is possibility to predict the nutritional status of Patharnakh tree at an earlier stage by evaluating the nutrients present in spur, bark and flower. However, further studies are needed by including more number of trees in different orchards and locations to arrive at definite conclusion. The studies also suggested that separate tissue may be used to predict the status of different nutrients in Patharnakh; i.e. for instance flower in case of N, spur and bark in case of P, bark in case of K and Mn and spur in case of Fe have given significant correlations with the respective

nutrient status of leaf and yield. Ultimately the new standards will have to be worked out if a tissue other than the leaf is to be used for early prediction of nutritional status of Patharnakh.

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* Original not seen.