NUTRITIONAL REQUIREMENTS AND STORAGE BEHAVIOUR OF APRICOT cv. NEW CASTLE

THESIS

By

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CERTIFICATE - I

This is to certify that the thesis entitled "Nutritions requirements and storage behaviour of apricot cv. New Castle", submitted in partial fulfilment of the requirement for the degree of DOCTOR OF PHILOSOPHY (HORTICULTURE) of Dr. Y. S. Parmar University of Horticulture and Forestry, Solan, is a faithful record of bonafide research work carried out by Sh. Ghan Shyam Sud under my guidance and supervision. No part of the thesis has been submitted for any other degree or diploma.

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

January 23, 1987.

(V.P. Bhutani)

C E R T I F I C A T E II

This is to certify that the thesis entitled 'Nutritional requirements and storage behaviour of New Castle apricot', submitted by Ghan Shyam Sud to the Dr.Y.S.Parmar University of Horticulture and Forestry, Solan, in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY IN HORTICULTURE (Pomology and Fruit Technology) has been approved by the Students' Advisory Committee after an oral examination on the same in collaboration with External Examiner.

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C O N T E N T S

LIST OF TABLES

LIST OF TABLES contd...

LIST OF FIGURES

L I S T O F A P P E N D I C E S

LIST OF APPENDICES contd...

CHAPTER I

INTRODUCTION

I N T R O D U C T I O N

Stone fruits have an important share in the economy of the hilly areas of our country. Mid hills ranging from 1200 to 1500 metres above mean sea level are ideally suited for their cultivation. Apricot (*Prunus armeniaca* L.) is one of the most important and delicious fruits of this region. It is commercially cultivated in Himachal Pradesh, Jammu and Kashmir and hilly areas of Uttar Pradesh and to some extent in the North Eastern parts of the country including Manipur, Arunachal Pradesh, Meghalaya, Mizorum and Nagaland. In Himachal Pradesh, apricot is cultivated extensively in Solan, Shimla, Kullu, Sirmour, Chamba and Kinnaur districts. 'New Castle' is an important cultivar of apricot which has good demand for table purpose. The fruit ripens in the end of May, when no other fruit is available in the market and thus can fetch good returns for the growers.

For successful cultivation, an optimum supply of nutrients to the plant is essential and nitrogen (N) has long been considered a dominating nutritional factor for growth, development and productivity of the fruit plants. The effects of N on the vegetative growth, blossoming, fruit set, yield, maturity and post-harvest physiology have been extensively documented for different horticultural crops. Thus, sufficient N supply, which can better be accomplished through soil and foliar applications, must be ensured. Amongst the N fertilizers urea is eminently suited for foliar sprays. Application of urea through foliage during spring and / or autumn, as a substitute or supplement to soil N dressings have been proved to be an efficient mean for improving fruit set, size and yield of apple (Blasberg, 1953; Van Dam, 1957; Shim et al. 1972). But no such work has been reported in apricot.

Short storage life of apricot is perhaps the single major factor responsible for restricting the apricot cultivation. Apricot can not endure storage after harvest as the fruits are highly perishable at normal atmosphere and ambient temperature. Even at low temperature ($0^{o}C$) its storage life does not exceed 2-3 weeks. Chemical modification of ripening or senescence with a view to increase the shelf life of fruits has engaged the attention of researchers in recent years and assumes added significance with fruits, such as apricot which have extremely short storage life. Growth regulators are known to play an important role in modulating the maturation and ripening processes by effecting changes in fruit firmness brought about by changes in cellular events. Similarly inorganic nutrients are also known to play a part in increasing the firmness and delaying the ripening. N,K, Ca and B have been implicated in many ways in the maintenance of cellular organisation and firmness of the apple fruit (Shear and Faust, 1975), but the information in respect of apricot is lacking.

Keeping the above objectives in view, the present investigations were undertaken to study the influence of soil and foliar applications of urea on the tree production, fruit quality and nutrient status of New Castle apricot. A separate experiment was laid out to study the effect of preharvest application of nutrients and growth regulators on the fruit quality and nutrient status during cold storage in New Castle apricot which is an

CHAPTER II

R E V I E W   O F   L I T E R A T U R E

R E V I E W O F L I T E R A T U R E

The major problem in the production of apricot is the standardisation of N level to obtain satisfactory yield of high quality fruit, which could better be accomplished through its soil application supplemented with foliar feeding. Storage behaviour of apricot in relation to mineral nutrients and growth regulators is another aspect, since apricot fruits are not well adopted to long term storage and softens rapidly during the first few days after harvest. The available relevant literature pertaining to N nutrition and storage bahaviour of stone fruits in relation to nutrients and growth regulators with special emphasis on apricot is reviewed under various appropriate headings.

2.1 Effect of soil and foliar applications of N on the tree productivity, fruit quality and nutrient status

2.1.1. Vegetative growth

2.1.1.1. Soil N applications

That adequate N supply is essential for proper tree growth is accepted by all research workers. Chadha and Bajwa (1966) working with New Castle apricot reported that the tree growth increased significantly with N fertilizers in combination with P and K. Bajwa and Chadha (1968) compared the effects of N, P and K individually and in combinations on apricot. Of the three elements, N exerted the greatest impact on the tree growth. Nijjar et al. (1972) concluded that N application was highly conducive to the plant growth and maximum trunk circumference could be obtained with NPK (396.9 g N, 198.45 g P_2O_5 and 476.28 g K_2O tree^{-1}) in 7-year-old New Castle apricot plants. They further observed that application of P and/or K without N had no effect on the plant growth. Marinov (1982) conducted 4 year field trial in apricot cv. Hungarian and found that best shoot growth was obtained by applying N, P_2O_5 and K_2O at the rate of 300, 160 and 200 kg ha^{-1} respectively. Chandel (1985) applied 4 levels of N and 3 levels of P_2O_5 to apricot plants and found that the tree growth in terms of height, spread, girth and extension growth increased significantly with increased level of N alone or in combination with P. Application of N has been observed to increase the tree growth in peach trees (Ritter, 1956; Degtyar and Krolik, 1972; Tawfic et al. 1974). In case of Sharbati cv. of peach, 120 g N per-year age of plant produced the highest growth rate as compared to two lower levels (Sharma and Singh, 1980). Kanwar and Nijjar (1983) working on Flordasun peach found that 1.50 kg of N $tree^{-1}$ produced significantly higher trunk growth as compared with the lower doses of 0.5 and 1.0 kg of N. Increased tree growth in plum with N applications have been reported by Guseva and Kiltchevskll (1934), Davidescu et al. (1967), Bajwa and Mishra (1970), Bhatia (1982) and Khokhar (1984).

2.1.1.2. Foliar urea sprays

In recent years the practice of urea foliar fertilization have become an increasingly popular means of regulating the N economy of several fruit crops. The efficient utilization of foliar applied urea by apple is well known (Blasberg, 1953; Van Dam, 1957; Pecznik, 1973; Kropp and Ben, 1981; Yogaratnam, 1982). *Prunus* leaves are regarded as less efficient in foliar absorption than apple or citrus leaves (Jones and Steinaker, 1953; Embelton and Jones, 1974; Leece, 1978. Peach, plum and sour cherry trees responded poorly to foliar N applications as measured by leaf N level (Weinberger et al. 1949; Bullock et al. 1952; Norton and Childers, 1954; Walker and Fisher, 1955; Wlodek et al., 1959; Leece and Kenworthy, 1972; Leece and Dirou, 1977). On the other hand, Nortan and Childers (1954) reported a significant response in growth obtained from the urea sprays on peach and opined that peach can absorb N applied as urea to the foliage, but not so efficiently as in case of apple. In addition, Tukey et al. (1952) have shown that not only the leaves but also the bark of the peach tree may actively hydrolize urea though at comparatively a slow rate. Rawat (1974) observed that tree growth of Santa Rosa plum increased with increased N supply through soil and foliar sprays of urea, but when the leaf N raised very high, the growth declined. He observed that leaf N contents of 2.49, 2.58 and 2.72 per cent were critical for shoot growth, leaf area and internodal length respectively. Similar beneficial effects of N, in the form of soil and foliar applied urea on the tree growth of Santa Rosa plum have been reported by Badyal (1980).

The work of Oland (1960, 1963) has indicated the possible value of utilizing urea foliar sprays as a N source when applied shortly before leaf fall. The advantage of applying urea during fall, compared with early in the growing season is that much more leaf surface is present and N is not diverted into unnecessary vegetative growth. This may be very important for additional photosynthesis for root growth and early spring growth, as well as for deposition into the woody parts of the tree for increased winter hardiness. Thus the full application of urea sprays, in addition to supplying the early spring N needs of the trees, may promote the essential activities that would not occur or would occur at a lesser degree. However, the findings of Little et al. (1966) were not in accordance to that of Oland. They observed that trunk growth, flowering or fruit set in apple was not significantly influenced by the autumn sprays. The authors, however, explained that they had used comparatively very less amount of urea in sprays and the experimental trees otherwise had a reasonable N status. Titus (1972) was of the opinion that post harvest urea sprays can supply N to the apple trees. He obtained increased shoot growth in Golden Delicious apple with these sprays as compared to control. Shim et al. (1972) reported similar findings of increased tree growth with autumn urea sprays in comparison to soil applied urea or no urea. However, Quast (1979) applied autumn urea sprays of 5 per cent to Cox and 3, 6 or 9 per cent to Red Boskoop apple cultivars and observed that the higher N reduced the number of flower buds as well as the length of two year old wood. However, comparative data on the absorption rates of apricot leaves are lacking.

2.1.2. Yield

Adequate amounts of N are required to obtain good yields or limit crops. The soils of Himachal Pradesh are, in general, deficient in N. Therefore, proper fertilization of orchards with nitrogenous materials is essential for economic fruit yields.

2.1.2.1. Soil N application

Chadha and Bajwa (1966) reported on the basis of 4-year field trial, that the fruit yield of New Castle apricot, which was not affected during the first 3 years of the trial, increased significantly by all the N containing treatments during the fourth year. Bajwa and Chadha (1968) compared the effects of N, P and K individually and in combinations in New Castle apricot and obtained maximum increases in yield with the combinations NPK, NK and NP. Bajwa and Mishra (1970) observed that 450 g N $tree^{-1}$ was the most appropriate dose which gave the significant increase in fruit yield of New Castle apricot as compared with other treatments. Nijjar et al. (1972) obtained significantly higher yields in New Castle apricot with NPK fertilization in comparison to control and further reported that application of P and/or K without N had no effect on fruit yield. Marinov (1982) obtained the best yield in apricot cv. Hungarian by applying 300, 160 and 200 kg ha^{-1} of N, P_2O_5 and K_2O respectively. Similarly Chandel (1985) also obtained marked yield response from the application of N fertilizers alone or in combination with P_2O_5. Increased yield in peaches with N fertilizers have been reported by various workers (Weinberger, 1949; Ritter, 1956; Degtyar and Krolic, 1972; Krivoruchko, 1979; Sharma and Singh, 1982). On the other hand Rogers (1977) observed no effect of N application on the yield of Giant Elberta peach trees. Studies of Guseva and Kiltchevskll (1934), Davidescu et al. (1967) and Bajwa and Mishra (1970) have revealed that N fertilization exert a great influence on the plum yield, but Chohan and Singh (1976) observed a slight response of plum cvs. Titron, Ladakhi, Zardalu, Alubukhara and Sharbati to nitrogenous fertilizers at 25-100 g N $year^{-1}$ age. However, Ystaas (1966) could not obtain significant increase in the yield of plum with the application of N fertilizers.

2.1.2.2. Foliar urea sprays

Stone fruits have been reported to respond poorly to foliar feeding of urea. Weinberger et al. (1949) demonstrated that foliar urea applications to peach trees were practically ineffective. El-Banna et al. (1981) applied 1 to 4 urea sprays or ammonium sulphate at 225-900 g tree^{-1} to peach trees and observed that urea had little effect on yield even after 4 sprays whereas ammonium sulphate increased the yield considerably. Similar results were reported in plum (White and Glenn, 1967), prune (Wlodek et al. 1959) and Cherry (Walker and Fisher, 1955). However, beneficial effects of soil and foliar applied urea on the yield in Santa Rosa plum were reported by Badyal (1980).

Pre-fall sprays of urea have not been tried earlier in stone fruits to study their influence on tree productivity. Oland (1963) demonstrated that yield increased upto 50 per cent in apple with pre-fall sprays of urea when compared with ground treatment and October sprays were found to be more effective than the September sprays. Oland (1966) confirmed that increased yield in apple could be obtained with 5 per cent urea sprays applied during autumn. Quast (1979) reported that autumn urea sprays increased the set due to prolonged viability of flowers, but increased yields could be obtained when the trees were low in N. Delver (1966) and Shim et al. (1972) observed a maximum set of fruit in apple with autumn urea sprays, but maximum yield was recorded with soil applied N during spring.

2.1.3. <u>Fruit quality</u>

2.1.3.1. <u>Soil N applications</u>

Application of N fertilizers in fruit trees have been found to exert a considerable influence on the fruit size and other quality attributes. Bajwa and Chadha (1968) demonstrated that maximum fruit size in apricot cv. New Castle could be obtained by applying NPK, while other quality attributes varied greatly with different treatments. Bajwa and Mishra (1970) compared 4 levels of N (150, 300, 450 and 600 g tree^{-1}) and noticed that 450 g N could produce the largest apricot fruits and improved the quality. Nijjar et al. (1972) also conducted an N - rate experiment on New Castle apricot. They did not observe any significant influence of N,P and K on the fruit shape, total soluble solids and acid contents of the juice. However, the acidity and TSS:acid ratio in the juice was increased with N application alone. No significant differences in terms of size, TSS, acidity and sugar contents were found with different levels of N in young apricot trees (Chandel, 1985). Increased size in peach fruits with N applications has been reported by Brown and Proebsting (1962), Mowry (1963) and Sharma et al. (1979). However, Ballinger et al. (1963) and Schneider and McClung (1957) did not find increased fruit size in peaches by increasing the rate of N application. Ritter (1961) observed that graded N and P applications increased the total soluble solids, but reduced the flavour in Elberta peaches. Lott (1931) and Proebsting et al. (1957) reported the TSS in peaches to decrease with increased N level. Bajwa and Mishra (1970) found NPK + FYM to substantially improve the quality of Santa Rosa plum in comparison to FYM alone. Bhutani et al. (1983) recorded increased fruit weight, acidity and soluble proteins and decreased sugar content in Santa Rosa plum with increased N application.

2.1.3.2. Foliar urea sprays

The influence of foliar urea sprays on the quality of stone fruits is not well documented and information pertaining to apricot fruits is especially lacking. White and Glenn (1967) found the post blossom sprays of urea to be ineffective in improving the fruit size of Early Laxton plum. Rawat (1974) conducted a field trial on Santa Rosa plum with 2 levels of N (500 and 750 g tree^{-1}), applied through soil alone or a part of it supplied through 3-4 foliar sprays of 0.5 or 1 per cent urea, after petal fall. He observed that fruit quality deteriorated with increased N fertilization through soil or foliage and demonstrated that with every 0.25 per cent rise in leaf N as a result of increased N supply, total sugar content in the fruit decreased by 0.7 per cent, sugar : acid ratio fell by 0.56 per cent and the acidity increased by 0.25 per cent. Badyal (1980) however, observed that fruit size, TSS, sugar and acid content of Santa Rosa plum improved significantly with raised N fertilization through soil or foliage. A dose of 400 g N in the form of 3/4 soil application and 1/4 foliar application has been recommended for plum and apricot in Himachal Pradesh for getting optimum tree produce of better quality (Anonymous, 1984). The effect of late sprays of urea during pre-fall stage on the quality of horticultural crops has not been studied enough and no report is available pertaining to stone fruits. Oland (1966) demonstrated that increased fruit size in apple cvs. Gravenstein and Torstein could be obtained with the autumn sprays of 5 per cent urea.

2.1.4. Tree nutrient status

2.1.4.1. Soil N applications

Evidences are available to suggest that the nutrient status of fruit tree is greatly influenced by the presence of various nutrients in the soil and N fertilizers play a vital role. However, in case of apricot, literature available is quite scanty. Albigo et al. (1966) studied the influence of graded levels of N (0.7, 1.7, 4.4 and 7.7 lbs N $tree^{-1}$ $year^{-1}$) on Royal apricot and observed that different N rates produced differences both in the leaf and fruit N levels. Accumulation of N in the fruit flesh increased steadily until maturity and was faster with increased soil N applications. Chandel (1985) working on the nutrition of New Castle apricot observed that N applications significantly increased the leaf N, Ca, Mg and Fe status, while P and K decreased considerably. However, differences in case of leaf Zn and Mn were not statistically influenced. Most of the fertilizer experiments have shown that with an increase in the rate of N fertilization, N and Mn concentration in the leaves of stone fruits is increased (Ritter, 1956; Stojkovska et al., 1972; Vitanova, 1974, Leece, 1976; Stoilov and Vitanova, 1979; Jangic, 1979; Sharma and Singh, 1982; Khokhar, 1984), while P, K, Fe, Zn, Cu and B decreased (Rogers, 1969; Leece and Barkus, 1974). A positive relation between rate of N fertilization and leaf N status and a negative between N rate and leaf K status was observed by Stembridge et al. (1962) in Dixigem peaches. Vitanova (1981) observed that N fertilization had direct influence on the N level of plum shoots and branches.

2.1.4.2. Foliar urea sprays

No information regarding the influence of foliar urea sprays on the tree nutrient status of apricot is available in the literature. However, information pertaining to different stone fruits, which is also scanty, is reviewed below. Weinberger (1949) did not find urea sprays of much avail in peaches and reported that if any amount of N was utilized by the peach leaves, it was in such a small quantity that did not show significant effects in improving the foliage N. Bullock et al. (1952) however, demonstrated that leaf N of Elberta peach was maximum when a part of N was applied to soil and remainder as urea sprays, over those received all the N either as soil or foliar N alone. Leece and Dirou (1970) suggested a combination of soil and foliar N, as a mean to maximise the tree N status of prunes. Rawat (1974) observed that leaf N increased significantly with increased N rate through soil or with foliar urea sprays. He further noticed that 500 g N in the form of soil and a part of it through 3-4 sprays of 1 per cent urea, resulted in the similar tree N status, as with 750 g N through soil alone. Leaf P decreased with increased N fertilization, but a decrease in leaf Ca+Mg+K contents was associated with urea sprays. Further, he reported that the nutrient status of the shoots remained unchanged, except a slight decrease in P with increased N fertilization. Badyal (1980) noticed that the leaf N, Ca, Mg, S, Mn, Zn and Cu had a direct relation with the N applied, either through soil or foliage, but P, K, Fe and B contents displayed an inverse relation. Ludders and Bunemann (1970) observed that urea sprays applied during August-September or

October-November raised the mineral contents of Cox's apple trees, which did not receive urea in June-July. Differences were large in N, P and Ca and small in K and Mg. Shim et al. (1972) observed that senescing apple leaves, in growth chambers absorbed 80 per cent of the applied urea within 48 hours. The efficiency of N utilization by 5 per cent urea spray was 4 times as great as that of soil application and 5 sprays of 4 per cent urea in October resulted in marked increase in the N contents of overwintering parts. Shim et al. (1973) have shown that during leaf senescence, storage tissues from unsprayed trees increased 1.5 fold in N, while in case of sprayed plants, it was 3.0 fold. Similar observations in apple with 10 per cent urea sprays during October were recorded by O'Kennedy et al. (1975).

2.1.5. Physico-chemical properties of soil

With the high intensity cropping and heavy application of fertilizer, the need for assessment of changes in soil properties is being increasingly realised. Out of N fertilizers, ammonium sulphate (Aquino et al., 1976; Sinha et al., 1983) and ammonium phosphate (Aquino et al., 1976) have been observed to cause a drastic reduction in soil pH as compared to urea, whereas calcium nitrate and sodium nitrate proved ineffective. Bhatia (1982) demonstrated that soil pH and electrical conductivity of Santa Rosa orchard decreased with the application of N fertilizers and were noticed to be higher with increased soil depth. Similar reduction in the soil pH and electrical conductivity in the plum orchards with increased N rates have been reported by Badyal (1980) and Khokhar (1984). However, Chandel (1985) did not find the pH level to be influenced with increased N applications, though increased pH with increased soil depth occurred in apricot orchard. Organic carbon content on the other hand, have been reported to increase with increased N rates (Badyal, 1980, Bhatia, 1982 and Khokhar, 1984) and decreased with increased soil depth (Bhatia, 1982).

2.1.6. Nutrient status of soil

N fertilizers have their marked influence on the availability of various nutrients in the soil. Vitanova (1973) and Chandel (1985) noticed that with increased N rates, available N and K raised in the apricot orchard soil in different soil depths, while available P decreased with N fertilization. Bhatia (1982) observed that the amount of N, K, Ca, Mg, Cu, Zn and Mn increased in plum orchard with increased N application and decreased with increased soil depth. Available P and Fe, on the other hand decreased with raised N rate and the soil depth. There is a good evidence that applied N raised the levels of available and reserve soil N (Balo et al., 1982). The decrease of soil K content by N fertilization has been reported by Cumings (1978) and Kepka et al. (1982). Some decrease in soil K might have resulted from NH_4^+ replacing K on the exchange complex with resultant leaching of K. Khokhar (1984) observed that available N, P, Mg, Fe and Zn increased whereas K, Ca and Cu contents decreased with increased N fertilization in plum orchard. Recently, Bhan (1986) reported that N application increased the available N and Mg status, but reduced K and Ca content in plum orchard soil.

2.1.7 Soil microorganisms

Microorganisms living in the surface soil horizone play a vital role both in evaluation of agriculturally useful soil condition and in stimulating the plant growth. Collective fluctuations in soil microorganisms following change in soil environment or soil treatment may have marked effect on agricultural productivity. Information on the effects of N fertilizers on soil microflora in orchard soil is lacking. Application of NPK fertilizers increased the number of soil bacteria and their activities (Prijmak and Suslova, 1958; Koshar et al., 1976) and celluloytic bacteria and cellulose decomposing activity in the soil (Todorova, 1972).

Eiland (1980) studied the microfloral count in the soils unmanured, manured or fertilized since 1893. He observed highest humus content, ATP content and oxygen uptake in fertilized soils, intermediate in manured soils and lowest in unmanured soils. Minenko (1981) observed a general increase in the biological activity of soil by the application of fertilizers at normal rates. Venkata Rao et al. (1972) studied the effect of repeated heavy fertilization on the microbial properties of the red soils of Mysore and observed that increased N generally increased the bacterial and fungal population. Pavlenko (1975) demonstrated that fertilizer applications generally stimulated the fungal development. However, long term applications of N, P and K (180 kg ha^{-1}, each) on dark grey soils under apple crop, decreased the Trichoderma spp. and Mucorales. Rate of mineral fertilizers which stimulated microorganisms also enhanced the apple productivity. Bhutani and Bhatia (1984) observed that increased doses of N had no effect on the bacterial population, but stimulated the actinomycetes and fungi population in plum orchard. Khokhar (1984) also recorded an increase in the microflora, particularly fungi and actinomycetes by the application of N and K in a plum orchard soil.

2.2. Effect of pre-harvest sprays of nutrients and growth regulators on the storage behaviour and nutrient status

2.2.1. Nutrients

Mineral nutrients have been reported to play a vital role in the chemical modification of ripening and senescence of fruits. There are numerous reports of relationship between mineral composition of the fruits and their storage behaviour involving a number of mineral nutrients.

2.2.1.1. Calcium

The Ca concentration in the tissues of many fruits including apricot, is well known to be an important deteriment of fruit quality. Many storage disorders and poor shelf life of fruits have been correlated with inadequate Ca nutrition. In general, low Ca concentration in tissues such as those of fruits result from poor redistribution within the plant, rather than failure of Ca uptake by the plant (Bangerth, 1979; Hanger, 1979, Mason, 1979; Hill, 1980).

Ca has been shown to preserve cellular organisation and at deficiency levels induce disintegration of the cytoplasmic membranes. It is associated with the pectic substances in the middle lamella and may prevent disorders merely by strengthening the structural components of the cell without alleviating the main cause of the cell collapse (Shear and Faust, 1975). According to Faust (1975), Ca maintains the protein synthesis in the cells and protects the membranes from disintegration, which delays but does not prevent senescence.

Abdalla and Childers (1963) reported that when Radhaven peach and stanley prunes were treated with 90, 180, 270 and 400 ppm Ca, the fruits were smaller but more firm in comparison to control. Mehta (1980) reported that $CaCl_2$ (500 ppm) treatment improved the fruit firmness of Santa Rosa plum, but its lower concentration (250 ppm) slightly reduced the fruit acidity. Mishra (1983) recorded the loss of firmness during storage to be lowest with $CaCl_2$ treatment in Santa Rosa plum. Increased Ca in the fruits has been reported to result in increased firmness, slower softening during storage, increased ascorbic acid content, higher acidity and improved yields in apples (Blank, 1974; Mason et al. 1975; Hartman, 1983). Sachdeva (1985) found $CaCl_2$ (1%) to be quite effective in preventing weight loss and softening of apple fruits during storage.

There exists an inverse relation between respiration and the fruit Ca. Fruits high in Ca, have a low respiration rate and longer storage life than does the low Ca fruit (Faust and Shear, 1972). Faust (1975) has shown that Ca can overcome the N induced respiration. Naquash (1986) observed that the rate of respiration was slower in the $CaCl_2$ treated Red Delicious apple fruits and the climactric peak was achieved after 105 days in comparison to 60 days of storage under control.

Schumacher et al. (1981) reported that 3 or 6 sprays of $CaCl_2$(1%) applied to Maigold apple trees, resulted in high (275 mg 100^{-1}g dry weight). Ca content and a low K/Ca ratio in healthy fruits and the trend was reversed in unsprayed fruits. Neilsen et al. (1985) found that 4, weekly sprays of 0.75 and 1.0 per cent of $CaCl_2$, immediately prior to harvest, significantly increased the fruit Ca in Golden Delicious apple.

2.1.1.2. Potassium

Information pertaining to the influence of K applications on the development and storage behaviour of apricot fruit is particularly lacking in the literature. Griffin (1959) observed increase in fruit bud formation, fruit set, size, earliness in maturity and decrease in percentage of soluble solids in peach fruits treated with K. Lilleland et al. (1962) reported a marked enhancement of fruit size associated with an increase in leaf K of peach. Cumings (1965) observed that application of K was related with significant increase in fruit weight and increased production of peaches. The treatment delayed maturity but improved the red colour of the fruits. Increased fruit size in plum with foliar applications of K was recorded by Ystaas (1966). Mehta (1980) found KNo_3 spray, applied at pit-hardening stage to be effective in improving the fruit size in Santa Rosa plum. Rasmussen (1966) reported that the foliar application of K had little effect on the storage quality of fruits. He observed that fruit firmness lowered with increased K level, while leaf and fruit K enhanced. There appears to be a relationship between N and K. Stoilov and Marinov (1979) observed that high K applications increased the accumulation of K in the developing leaves of apricot cv. Hungarian. They further reported that increased K requirement during fruit enlargement and ripening, reduces the leaf K and high K supply reduces leaf Ca and Mg, thus affects the distribution pattern.

2.2.1.3. Boron

Beneficial results of spraying various minor elements including B, in enhancing the yield and quality of plum, have been observed by Rashchinska and Drobotii (1972). Studies indicate that B effect is of stimulating metabolic activity of parenchyma cells of the leaf lamina (Shear and Faust, 1975). Callan et al. (1978) also observed that pre-or postharvest applications of B increased the fruit set of Italian prunes. Chopra et al. (1982) applied H_3Bo_3 to the developing July Elberta peach fruits and observed an increase in shelf life of fruits by about 6 days over control with H_3Bo_3 (2%). Increased size, firmness, sugars and organic acids in mature fruits were also reported by the authors with 0.15 to 0.20 per cent H_3Bo_3 spray. Mehta (1980) also recorded increased accumulation of sugar in Santa Rosa plum fruits when H_3Bo_3 was sprayed at pit-hardening stage. Mishra (1983) observed that acid content and vitamin C declined during storage of Santa Rosa plum and H_3Bo_3 (2%) + Cycocel (1000 ppm) recorded the highest values for both.

Belyaev and Chekan (1978) studied the beneficial effects of foliar nutrition on young plum trees and found that spraying with NPK+B stimulated the tree growth and the accumulation of nutrient elements in the leaves. B has been shown to effect the Ca accumulation in apple fruits when applied through soil (Shear and Faust, 1970) or foliage (Shear and Faust, 1971), and has been reported to help in reducing the Ca related disorders (Heweston, 1966).

2.2.2. Growth regulators

Growth regulators have a pronounced influence on the growth of different plant organs and the accumulation of organic and inorganic materials, and their mobility to different tissues are controlled by them. Hormonal directed transport is important in the normal redistribution of the nutrients from various plant parts to the growing organs.

2.2.2.1. Alar

Considerable experimental evidences have accumulated showing that the maturation of various fruits can be retarded through the use of SADH. Guelfat-Reich and Ben-Arie (1975) applied SADH to canino apricot at 2000 to 4000 ppm concentration at different stages of fruit development and noticed that SADH treated fruits were firmer with greater acid content and had slower softening rate than the control. The authors opined that SADH is probably active soon after its application at the hormonal level and its effect thereafter is expressed according to specific response of each specie to the changed hormonal balance. Hricovsky and Kosova (1980) found alar to be effective in improving the quality of apricot and peach fruits. Pandita (1983) conducted a field trial with New Castle apricot and found that the fruit weight, volume, pulp : stone ratio, sugar and sugar : acid ratio improved considerably with SADH applications during the pit-hardening stage. Improved fruit quality with alar applications has been reported in different stone fruits by various workers (Arora et al., 1973; Sachdeva, 1979; Mehta, 1980; Gorini et al. 1982). Chaplin and Kenworthy (1970) reported that fruits of cherry treated with SADH, prior to harvest were not only firmer at picking, but also showed a slower softening rate during storage also.

Fruit respiration remained unaltered through SADH applications in Windsor Sweet Cherry (Chaplin and Kenworthy, 1970). Blanpied et al. (1967) opined that SADH delayed the onset of respiratory climactric, though it did not affect the post-climactric respiration rate.

Pandita (1983) noticed that the accumulation of P and Ca enhanced, while that of N, Mg, Mn and Cu remained unaffected in the apricot leaves with SADH sprayed at pit-hardening stage. In case of fruits SADH slightly depressed the N content, while that of P, K, Ca, Fe and Zn were improved with its different concentrations. SADH has been reported to increase the Ca accumulation in apple fruits (Ludders, 1978). Himelrick and Pollard (1977) noticed that SADH reduces the N concentration of apple fruits but no significant differences were recorded in case of P, K, Mg, Fe, Mn and Zn. Zika et al. (1983) found an increase in Ca and decrease in K contents of the apple shoots with alar sprays.

2.2.2.2. Gibberellic acid

GA has been reported to improve the set, size, weight, shape and storage life of the fruits. Jackson (1968) found GA concentration in the fruits to be related with cell expansion, but not with cell division in different fruit tissues and reported that its application at pit-hardening stage increased the growth rate of apricot and peach fruits. The presence of GA may increase the activity of a tissue to compete for the metabolites. Sandhu et al. (1970) observed best results in respect of fruit retention, fruit size, weight, volume and flesh thickness in New Castle apricot, when sprayed with GA (250 ppm)+2, 4, 5-T (12.5 ppm) at pit-hardening stage. Sandhoo et al. (1971) also related the increased size in apricot, resulting from GA and/or 2,4,5-T to the greater cell size and not the greater cell number. The authors also reported that increased fruit size due to growth regulator treatment is limited to fruit flesh, while pit size is not affected. GA has been used with varying success in improving the fruit size, weight, volume, firmness and shelf life in different stone fruits (Naubeller and Stosser, 1972; Nyhlen, 1976; Drake et al. 1978 and Thakur, 1984).

Wierszyllowski and Bojar (1976) reported that GA applications increase the N and P contents in sour cherry leaves. Thakur (1984) found that GA applications improved the leaf as well as fruit P and the Mg level in leaves only, while the other nutrients remained unaltered in Santa Rosa plum.

2.2.2.3. Maleic hydrazide

Inhibitory action of MH has been reported to be due to inhibition of cell division, rather than cell enlargement. It does not inhibit or compete with the synthesis of some simple metabolites or hormones and is fairly selective in its action.

Okasa and Crane (1963) applied MH (1000 and 2000 ppm) to Royal apricot and July Elberta peach, early in the May and noticed that no shoot growth occurred for about 5 weeks which suggested a possible diversion of food materials to reproductive organs. Apricot fruit size was not altered by MH, but maturity occurred a week earlier. Crane and Nelson (1970) related the hastening of fruit maturity, following MH application in apricots, with the MH induced seed abortion. Fruits in which the seeds aborted early in the season, grew like those with the seeds, when the competition between fruit growth and the vegetative growth was reduced to a minimum. The authors concluded that seed development and its attendant hormone production do not determine the pattern of fruit growth in apricot. Suranyi (1975) reported that MH retarded the fruit ripening and extended the harvest season of apricot by 3 to 5 days.

CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigations were carried out at Fruit Research Station, Kandaghat and Fruit Nutrition Laboratory of the Department of Pomology and Fruit Technology, Dr.Y.S.Parmar University of Horticulture and Forestry, Solan, during the years 1981-1984. The experimental orchard is situated midway between Solan and Shimla on the National Highway-22, at an elevation of 1500 m above mean sea level. 21-year-old uniform New Castle apricot trees, raised on wild apricot rootstock, spaced 6 x 6 m in a sandy loam, were selected for the present study. The soil status of the orchard, determined prior to laying out the experiment is presented below in Table 1.

Table 1. Mechanical and chemical characteristics of the experimental orchard soil

Particulars	Content	Method used
A. Mechanical analysis		
Sand (%)	46.3	International pipette method (Piper, 1966)
Silt (%)	29.7	
Clay (%)	24.0	
B. Chemical analysis		
pH	7.6	1:2.5 soil water suspension-glass electrode pH meter(Jackson,1967)
Electrical conductivity(m mhos/cm)	0.27	1:2.5 soil water suspension-Systronic conductivity meter (Jackson, 1967)
Organic carbon (%)	2.9	Walkley and Black's rapid titration method (Piper, 1966)
Available N (ppm)	51	Alkaline permanganate method (Subhiah and Asija,1956)
Available P (ppm)	63	Olsen's method of extraction with 0.5 M $NaHCo_3$ at pH 8.5 and development of colour by chlorostannous reduced molybdophosphoric acid(Olsen et al. 1954)
Available K (ppm)	230	Ammonium acetate (1 N) extraction and determination on Perkin Elmer automic absorption spectrophotometer model 2380)

The experimental trees were given uniform cultural, irrigation, insecticidal and fungicidal practices during the course of investigations. The detail of the experiments conducted is given below:

Experiment 1. Effect of soil and foliar applications of urea on tree productivity and nutrient status of New Castle apricot

The experiment was laid out under randomised block design with three levels of N viz. 200, 400 and 600 g $tree^{-1}$, and four modes of its application viz. soil application alone or supplemented with 1, 2 or 3 foliar urea sprays. In all there were 12 treatments replicated quadrately. The half dose of N was applied in the first week of February and the second half in the second week of March. The F.Y.M. (40 kg $tree^{-1}$) and a basal dose of P_2O_5 and K_2O (250 and 600 g $tree^{-1}$ respectively) were applied alongwith the first half dose of N. Each spray contained 5 litres of 1 per cent urea (biuret content less than 0.03%). The first spray was applied on 10th of April, while the others followed at fortnightly intervals.

Experiment 2. Effect of pre-fall urea sprays on the tree productivity and nutrient status of New Castle apricot

The experiment was laid out under randomised block design with two urea concentrations viz. 2.5 and 5.0 per cent and four spray dates viz. September 15, 30, October 15 and 30 alongwith a control (sprayed with tap water). In all there were nine treatments replicated quadrately. Each experimental tree was fertilized with N (400 g $tree^{-1}$), P_2O_5 and K_2O (250 and 600 g $tree^{-1}$, respectively) alongwith FYM (40 kg $tree^{-1}$), as given under experiment 1.

Experiment 3. Effect of pre-harvest sprays of some mineral nutrients and growth regulators on the storage behaviour and nutrient status of New Castle apricot

The experiment comprised of 19 treatments viz:

1. H_3BO_3 (0.2%)
2. $CaCl_2$ (0.5%)
3. KNO_3 (0.5%)
4. GA (50 ppm)
5. MH (1000 ppm)
6. SADH (1000 ppm)
7. H_3BO_3 +GA
8. H_3BO_3 +SADH
9. $CaCl_2$+GA
10. $CaCl_2$ + MH
11. KNO_3 + MH
12. KNO_3 + SADH
13. H_3BO_3 + $CaCl_2$ + GA
14. H_3BO_3 + SADH + GA
15. $CaCl_2$ + GA + MH
16. $CaCl_2$ + KNO_3 + MH
17. KNO_3 + MH + SADH
18. KNO_3 + GA + SADH
19. Control

Each treatment was applied as a pre-harvest spray of 5 litre solution on an individual tree at the onset of pit-hardening stage. The fruits were harvested at appropriate maturity, when the fruits attained colour but were still firm, packed in the wooden boxes of standard size (46.5 x 16.5 x 16.5 cm), and stored at $0^{o}C$ for 0, 10, 20 and 30 days. The trial was replicated thrice under randomised block design.

The procedures adopted for the study are detailed below:

3.1. Tree productivity

3.1.1. Trunk girth:

The trunk circumference was measured with measuring tape 30 cm above the ground level in the last week of October during 1982 and 1983. The results were expressed as per cent increase in girth over the previous year.

3.1.2. Shoot growth:

25 shoots of the current season growth were randomly selected all over the tree periphery and their growth was measured during the last week of October 1982 and 1983. The results were expressed as their mean value.

3.1.3. Fruit set:

300 flower buds were marked around the tree periphery at the pink bud stage. Fruit set was recorded after 15 days of full bloom and expressed as per cent fruit set.

3.1.4. Fruit retention:

200 fruits were tagged on different branches, around the tree after the fruit set, the total number retained till harvest was recorded and the results expressed as per cent fruit retention.

3.1.5. Yield:

The crop loads removed from the trees during each harvesting season of 1981 to 1984, were recorded and expressed as yield in kg $tree^{-1}$.

3.2. Chlorophyll contents and amino-nitrogen in leaves

3.2.1. Chlorophyll contents:

Leaves from all over the tree periphery were collected during first week of June, from middle position of the fresh growth, chopped into small pieces and mixed to make a homogenous mixture. 1 g of mixture was ground with 0.1 g of Na_2Co_3 in a pestle mortar with 80 per cent acetone. The extract was filtered through Whatman No.42 filter paper. The residue was again reground and the procedure repeated twice. All these operations were carried out in dark light. The final volume of the extract was made to 25 ml with acetone (80%) and the absorbance was recorded at 645 and 663 nm on Spectronic 20 colorimeter. The contents of chlorophyll a and b were calculated by the following formulae (Mahadevan and Sridhar, 1982).

Chlorophyll a = 12.7 A 663 - 2.69 A 645.

Chlorophyll b = 22.9 A 645 - 4.68 A 663.

Total chlorophyll = 8.02 A 663 + 20.2 A 645.

3.2.2. Amino-nitrogen:

Ninhydrin method of Moore and Stein (1949) was employed to estimate the amino-nitrogen in the leaves. The details of the procedure are given below:

Reagents:

I. Citrate buffer (pH 5.0):

0.2 M solution of the buffer was prepared from 21 g citric acid dissolved in 200 ml of 1 N NaOH. The volume was made to 500 ml.

II. Ninhydrin reagent:

To 500 ml of citrate buffer at pH 5.0, 0.8 g of hydrated stannous chloride was added and dissolved. The solution was mixed with 20 g ninhydrin dissolved in 500 ml of methyl cellosolve. Fresh reagent was prepared for each determination.

III. Diluent solution:

Equal volume of water and n-propanol was mixed and stored.

Method:

To 1 ml of alcoholic extract of the leaf sample (collected during first week of June from the middle position of the fresh growth and dried), 1 ml of ninhydrin reagent was added. The mixture was thoroughly shaken and heated for 20 minutes on a hot water bath, 5 ml of the diluent solution was added to the cooled mixture and shaken for one minute. The intensity of the colour was read on Spectronic 20 colorimeter at 475 nm. The amino nitrogen was calculated from the standard curve prepared from glutanic acid as reference. The results thus obtained were expressed as per cent of dry weight of leaves.

3.3. Physico-chemical fruit analysis

20 fruits, representing each sample were selected randomly from all around the tree at the time of harvest and subjected to the following physico-chemical analysis.

3.3.1. Fruit weight:

The weight of the fruit was taken on electrical top pan balance and the results were expressed as weight in g fruit^{-1}.

3.3.2. Fruit firmness:

The firmness of the fruits was measured with the help of Effigi FT 011 penetrometer (plunger diameter : 7 mm), on both the cheeks of individual fruit and expressed as Kg.

3.3.3. Total soluble solids (TSS):

The TSS was determined with Erma hand refractometer (0-32^{o} brix) and expressed as per cent of fresh weight of the juice.

3.3.4. Titratable acidity:

25 g of the fruit pulp was thoroughly mixed with distilled water in a waring blender and volume made to 250 ml. The solution was filtered through Whatman No.1 filter paper. 25 ml of this solution was titrated against N/10 NaOH using phenolphthalein as indicator. Total titratable acidity was calculated in terms of malic acid on the basis of 1 ml N/10 NaOH equivalent to 0.0067 g anhydrous malic acid. The results were expressed as per cent titratable acidity on pulp weight basis.

3.3.5. Pulp pH:

The pH of fruit pulp was determined by Eltop digital pH meter after standardising it with buffer solution of 4.0 pH.

3.3.6. Soluble protein:

The soluble protein was estimated as per method suggested by Lowery (1951). Fruit pulp (2 g) was macerated in 10 ml of 0.1M phosphate buffer (pH 6.4) in an ice cold pestle mortar. The extract was then passed through a double layer cheese cloth and centrifuged at 5000 r pm for 30 minutes at $4^{o}C$. To 1 ml of the protein extract, 5 ml of the alkaline solution was added, which was prepared freshly by mixing 50 ml of stock alkaline carbonate solution (20% Na_2Co_3 in 0.1 N NaOH) and 1 ml of copper sulphate sodium potassium tartarate solution (0.05% $CuSo_4$, 2 H_2O in 1 per cent $KNaC_4$ H_4O_6, $4H_2O$). After thorough mixing, it was allowed to stand for 10 minutes at room temperature. Then 0.5 ml of Folin-Ciocalteau reagent was added rapidly with immediate mixing. After 30 minutes, the optical density of the resultant blue coloured solution was recorded at 750 nm using spectronic 20 colorimeter. The amount of protein was calculated from the standard curve prepared from bovine serum albumin (BSA) as a reference protein.

3.3.7. Fruit respiration:

The quantitative measurement of the rate of fruit respiration was done by the gas flow method of Meyer et al. (1966).

Pipetted 25 ml of 0.1 N $Ba(OH)_2$ into the absorption flask. After placing 300 g apricot fruits on the respiration Chamber, all the connections were checked for air tightness and then the apparatus was put on for one hour. Thereafter, 4-6 drops of phenolphthalein indicator were added to the absorption flask and titrated against 0.1 N HCl. A blank with all the reagents was also run and titrated against 0.1 N HCl.

The respiration rate was worked out as mg CO_2 liberated $hour^{-1}$ kg^{-1} of fresh fruits with the following equation:

CO_2 liberated (mg) = V x N x 20 where;

V = difference between blank and experimental titration (ml)

N = Normality of HCl used for titration

3.4. Nutrient estimation

3.4.1. Collection and preparation of leaf, shoot and fruit samples:

Leaf samples were collected from the middle of the terminal shoots on the periphery of the tree as recommended by Kenworthy (1964), during the first week of July, 1982 and 1983. 25 current shoot growths were sampled around each tree, during the last week of October, 1982 and 1983. In case of fruits fresh samples were collected at the time of harvest. Cleaning, drying, grinding and storage of samples were carried out as per procedure suggested by Chapman (1964).

3.4.2. Digestion of the plant material:

Well ground samples of known weight of leaf, shoot and fruit were digested for N estimation using concentrated H_2So_4 and digestion catalyst as described by Jackson (1967). Separate digestion for other nutrient elements was done in di-acid mixture (A.R.grade conc. HNo_3 and $HClo_4$ in the ratio of 4:1) taking all the precautions as suggested by Piper (1966).

Total N was estimated with the help of Technicon auto-analyser. Total P was determined by Vanadomolybdo phosphoric yellow colour method (Jackson, 1967). Total K, Ca, Mg, Fe, Cu, Zn and Mn were estimated on Perkin Elmer atomic absorption Spectrophotometer model 2380.

3.5. Soil analysis

3.5.1. Collection and preparation of soil samples:

Soil samples representing 0-15, 15-30 and 30-60 cm depth were collected with the help of screw type auger, from four sites of each experimental tree basin in second week of August during 1982 and 1983. These were dried in Shade, ground, sieved through 2 mm plastic sieve and stored in cloth bags. The soil analysis for various characters viz. pH, electrical conductivity, organic carbon, available N, P and K were determined as per methods given in Table 1.

3.5.2: Exchangeable Ca and Mg contents of soil were extracted with 1 N ammonium acetate solution and then estimated on Perkin Elmer atomic absorption spectrophotometer model 2380.

3.5.3: Available Fe, Cu, Zn and Mn were extracted with DTPA (diethylene triamine penta acetic acid) solution, containing DTPA, 0.005 M, $CaCl_2$ 0.01 M and triethanol amine 0.01 M buffered at 7.3 pH (Lindsay and Norvell, 1969). The DTPA extractable micronutrients were analysed on Perkin Elmer atomic absorption Spectrophotometer Model 2380.

3.5.4. Microbial studies:

Microbial studies were conducted during 1983 and 1984 on the plots where different rates of N were applied through soil. Six random samples were drawn from 0-15 cm depth, from the drip area of each tree at fortnightly interval upto 75 days of N application. These were then mixed throughly and such a composite sample was air dried, screened (20 mesh) and analysed for microbial status. Population counts on bacteria, actinomycetes and fungi were made by dilution plate technique employing soil extract agar medium, ken knight agar medium and Martin's rose bengal agar medium respectively as suggested by Rangaswamy (1966).

3.6. Statistical analysis:

Observations recorded in the study were subjected to statistical analysis by the method described by Cochran and Cox (1963). Levels of significance used for 'F' and 't' were compared at $p = 0.05$. Wherever error variances were found to be homogenous, the data were pooled with a view to arriving at valid conclusions.

CHAPTER-IV

EXPERIMENTAL RESULTS

E X P E R I M E N T A L   R E S U L T S

4.1. Effect of soil and foliar applications of urea on tree productivity and nutrient status of New Castle apricot

Pooled data pertaining to the influence of different rates of nitrogen and foliar sprays on the tree growth and yield are presented in Table 2 and the year wise data appears in Fig. 1 and appendix 1 respectively.

4.1.1. Tree productivity

4.1.1.1. Trunk girth

A perusal of data given in Table 2 and Fig.1 indicates that with each increment of the N dose, the percentage of trunk girth increased significantly and was maximum (5.1%) with the highest dose of N. Similarly increased number of foliar sprays resulted in increased trunk growth and was maximum with two foliar sprays and further increase in the number of sprays did not influence it significantly. A study of interactions between the N levels and the modes of application reveal that the maximum increase in trunk girth (5.3%) could be obtained when 600 g N was soil applied supplemented with two or three foliar urea sprays.

4.1.1.2. Shoot growth:

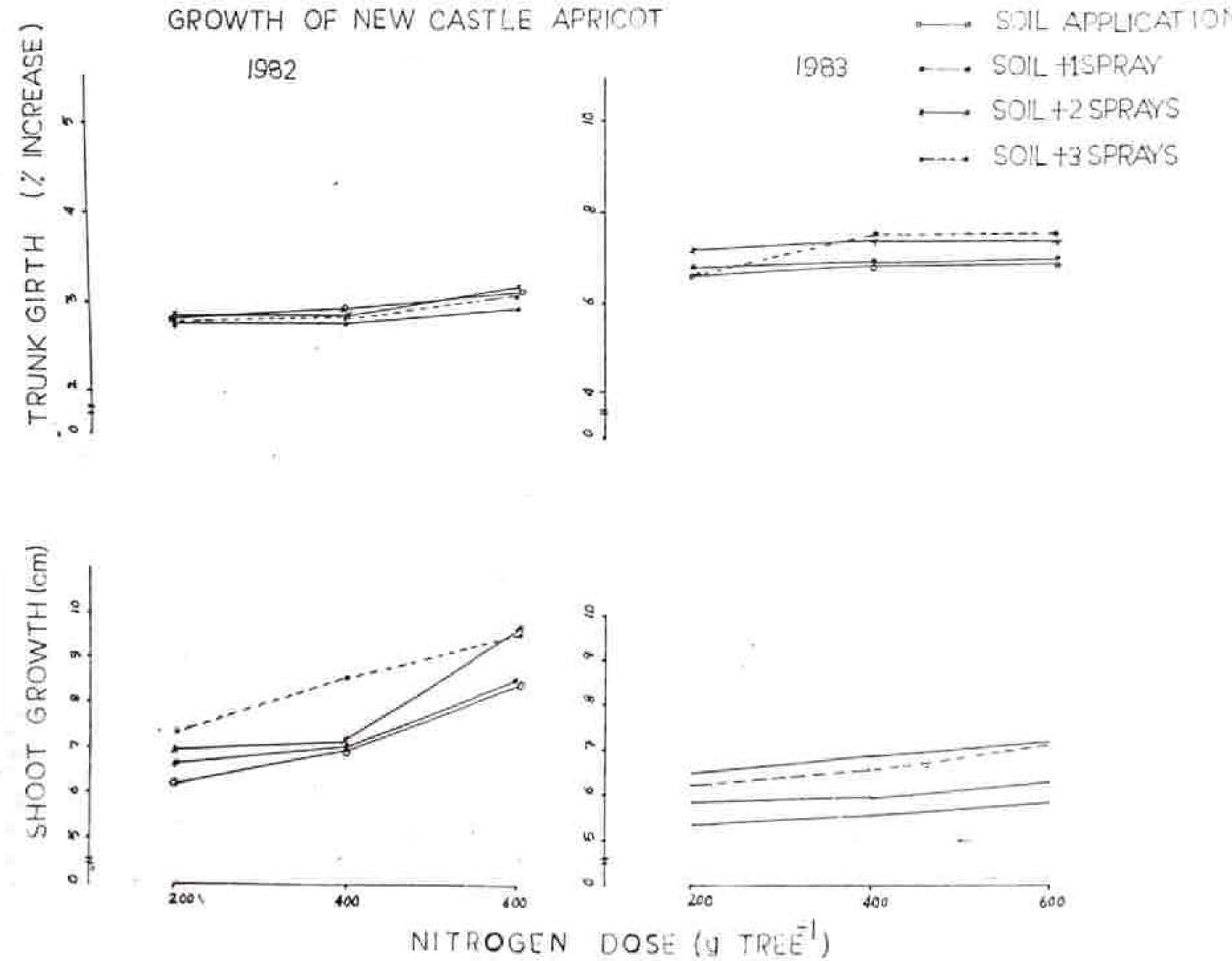
A direct relationship was observed between N rate and shoot growth. The highest shoot growth was observed in trees receiving 600 g N. Foliar sprays of urea also enhanced the shoot growth. Maximum shoot growth was observed with three sprays, though no significant difference occurred between two and three sprays. Interaction effects due to N levels and their

Table 2. Effect of soil and foliar applications of urea on the tree productivity of apricot cv. New Castle (pooled mean for 2 years

Treatment	Annual vegetative growth		
	Trunk girth (% increase)	Shoot growth (cm)	Yield* (kg tree^{-1})
N dose (g tree^{-1})			
200 (N_1)	4.8	6.4	47.3
400 (N_2)	5.0	6.8	57.1
600 (N_3)	5.1	7.8	58.5
L.S.D. (p = 0.05)	0.1	0.3	5.3
Mode of application			
Soil (M_1)	4.8	6.4	48.0
Soil + 1 spray (M_2)	4.9	6.7	52.6
Soil + 2 sprays (M_3)	5.1	7.4	58.0
Soil + 3 sprays (M_4)	5.0	7.5	58.6
L.S.D. (p = 0.05)	0.1	0.4	6.0
N dose x Mode			
N_1 M_1	4.7	5.8	42.9
N_1 M_2	4.8	6.2	45.7
N_1 M_3	5.0	6.7	50.3
N_1 M_4	4.7	6.8	50.3
N_2 M_1	4.8	6.3	49.6
N_2 M_2	4.8	6.5	54.7
N_2 M_3	5.1	7.0	61.3
N_2 M_4	5.1	7.5	63.0
N_3 M_1	4.9	7.1	51.7
N_3 M_2	5.0	7.4	57.3
N_3 M_3	5.3	8.4	62.4
N_3 M_4	5.3	8.3	62.4
L.S.D. (p = 0.05)	0.2	N.S.	N.S.

* Pooled mean for 4 years

FIG. 1. EFFECT OF NITROGEN ON THE TRUNK GIRTH AND SHOOT GROWTH OF NEW CASTLE APRICOT



modes of application were found to be non-significant.

4.1.1.3. Yield

The highest yield (58.5 Kg $tree^{-1}$) was obtained from the the trees fertilised with 600 g N which was at par with 400 g, but superior to that of 200 g N. Similarly foliar sprays of urea were found to be effective in improving the fruit yield. Maximum yield was observed with three foliar sprays, though it did not differ statistically from two sprays, but was superior to soil application alone or when supplemented with a single urea spray. Interaction due to different N rates and modes of application was found to be non-significant.

4.1.2. Chlorophyll and amino-nitrogen in leaves

Pooled data pertaining to the influence of soil and foliar applications of urea on the chlorophyll contents and the amino-nitrogen level are presented in Table 3 and the year wise data exists in Appendix 2.

4.1.2.1. Total chlorophyll:

The highest dose of 600 g N resulted in maximum chlorophyll content in leaves which was superior to the two lower doses. Similarly each urea spray increased the total chlorophyll and the maximum number of sprays had the greatest influence, though it was at par with two foliar sprays. Interaction due to N rates and the number of sprays was observed to be non-significant.

4.1.2.2. Chlorophyll 'a':

Chlorophyll 'a' increased in the foliage with increased contents in New Castle apricot leaves (pooled mean for two years)

Treatment	Total chlorophyll (mg g^{-1} fresh wt.)	Chlorophyll 'a' (mg g^{-1} fresh wt.)	Chlorophyll 'b' (mg g^{-1} fresh wt.)	Amino nitrogen (% dry wt.)
N dose (g $tree^{-1}$)				
200 (N_1)	34.2	17.9	16.3	1.3
400 (N_2)	36.1	19.0	17.0	1.6
600 (N_3)	38.9	20.4	18.6	1.7
L.S.D. ($p = 0.05$)	2.5	1.7	1.1	0.1
Mode of application				
Soil (M_1)	34.4	18.9	15.6	1.3
Soil + 1 spray (M_2)	35.7	18.8	16.9	1.5
Soil + 2 sprays (M_3)	36.7	19.1	17.7	1.7
Soil + 3 sprays (M_4)	38.7	19.7	19.1	1.6
L.S.D. ($p = 0.05$)	2.9	N.S.	1.3	0.1
N dose x mode				
N_1 M_1	32.2	17.3	14.9	1.3
N_1 M_2	33.7	17.7	16.0	1.5
N_1 M_3	34.5	17.3	17.2	1.5
N_1 M_4	36.4	19.3	17.1	1.2
N_2 M_1	34.5	19.3	15.2	1.3
N_2 M_2	35.3	18.8	16.6	1.6
N_2 M_3	36.3	19.3	17.0	1.7
N_2 M_4	38.1	18.8	19.4	1.8
N_3 M_1	36.7	20.1	16.6	1.4
N_3 M_2	38.0	20.0	18.0	1.7
N_3 M_3	39.4	20.6	18.8	1.8
N_3 M_4	41.5	21.0	20.7	1.9
L.S.D. ($p = 0.05$)	N.S.	N.S.	N.S.	0.2

dose of N, though the higher doses of 400 and 600 g N remained at par. Different modes of application did not show their individuality. The interaction effects were also found to be non-significant.

4.1.2.3. Chlorophyll 'b':

The application of N raised the chlorophyll 'b' in the leaves and maximum level of 18.6 mg g^{-1} was estimated with the highest dose. Similarly each spray enhanced its quantity and was found to be maximum with three foliar sprays. Interaction effects, were however, found to be non-significant.

4.1.2.4. Amino-nitrogen:

As with chlorophyll, the percentage of amino N in foliage enhanced significantly with each increment of N rate. Similarly foliar sprays of urea upto two in number raised its level considerably, while the third spray did not differ statistically from the second one. The interaction was found to be significant and the maximum percentage of amino-N obtained with 600 g N coupled with three foliar sprays.

4.1.3. Fruit quality:

Pooled data pertaining to the effect of N fertilization on the quality of apricot fruits are presented in Table 4 and the year wise data in Appendix 3.

4.1.3.1. Fruit firmness:

Fruit firmness increased significantly with N applications through soil or foliage. The highest dose was most effective in enhancing the fruit firmness in comparison

Treatment	Fruit firmness (kg)	Weight (g)	T.S.S. (%)	Acidity (%)	Pulp pH*	Soluble protein* (mg g^{-1})
N dose (g $tree^{-1}$)						
200 (N_1)	6.0	18.0	13.5	0.63	3.9	4.5
400 (N_2)	6.1	18.4	13.9	0.71	3.9	6.0
600 (N_3)	6.3	19.5	14.8	0.74	3.8	4.8
L.S.D. ($p = 0.05$)	0.2	0.8	0.4	0.08	N.S.	0.5
Mode of application						
Soil (M_1)	5.9	17.7	13.2	0.61	3.9	4.5
Soil +1 spray (M_2)	6.1	18.4	14.0	0.67	3.9	4.8
Soil +2 sprays (M_3)	6.3	18.9	14.4	0.72	3.8	5.4
Soil +3 sprays (M_4)	6.3	19.6	14.7	0.78	3.8	5.9
L.S.D. ($p = 0.05$)	0.3	1.0	0.4	0.10	N.S.	0.6
N dose x mode						
N_1 M_1	5.7	17.0	13.0	0.57	3.9	4.1
N_1 M_2	5.9	17.8	13.4	0.62	3.9	4.1
N_1 M_3	6.1	18.2	13.8	0.64	3.9	4.7
N_1 M_4	6.2	18.9	13.9	0.68	3.8	5.3
N_2 M_1	5.9	17.7	13.0	0.63	3.9	5.0
N_2 M_2	6.1	18.3	13.9	0.66	3.9	5.6
N_2 M_3	6.3	18.6	14.4	0.73	3.8	6.3
N_2 M_4	6.2	19.1	14.4	0.87	3.8	7.3
N_3 M_1	6.0	18.3	13.7	0.64	3.9	4.4
N_3 M_2	6.3	19.0	14.7	0.72	3.8	4.8
N_3 M_3	6.4	20.0	15.1	0.80	3.8	5.1
N_3 M_4	6.5	20.4	15.8	0.79	3.8	5.1
L.S.D. ($p = 0.05$)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

*Pooled mean for 2 years

to rest of two doses. Two or three sprays did not differ among themselves, but improved the firmness when compared with the soil application alone. Interaction effects due to doses and modes of N application failed to exhibit their superiority in improving the fruit firmness.

4.1.3.2. Fruit weight:

600 g N was most effective in producing the heaviest fruits (19.58 g) and the lower two doses remained at par with each other. Foliar urea applications also increased the fruit weight and was maximum with three sprays though it did not differ statistically from that of two sprays. Interaction between doses and modes remained non-significant.

4.1.3.3. Total soluble solids:

N application greatly influenced the total soluble solids in the fruits and the effects were more pronounced when supplemented with foliar urea sprays. Each increment in the N dose stimulated the TSS percentage significantly, maximum being 14.8 with the highest dose. Similarly, foliar applications also increased the TSS and it was maximum with three sprays which was at par with 2 sprays. Interaction due to doses and modes of application was observed to be non-significant.

4.1.3.4. Titratable acidity:

Titratable acid content of the fruits increased with N applications. The maximum acid content (0.74%) was observed with 600 g N which was at par with 400 g N. Supplemented urea sprays also enhanced the acid level, but the effect of two or three sprays remained at par. The interaction was found to be non-significant.

4.1.3.5. Pulp pH:

The pH of pulp did not alter significantly as a result of different N rates or its modes of application.

4.1.3.6. Soluble protein:

The highest soluble protein content was recorded at 400 g N in comparison to 200 and 600 g N which were at par. Foliar sprays of urea were effective in enhancing the protein level, but the maximum amount of 5.9 mg g^{-1} protein, obtained with three sprays was not statistically superior to that of two sprays. Interaction due to doses and modes was found to be ineffective.

4.1.4. Nutrient status:

The pooled data regarding the nutrient status of leaves, shoots and fruits as influenced by different levels and modes of application of N are presented in Tables 5 and 6 and the year wise data are shown in Figs. 2 and 3, respectively.

4.1.4.1. Nitrogen:

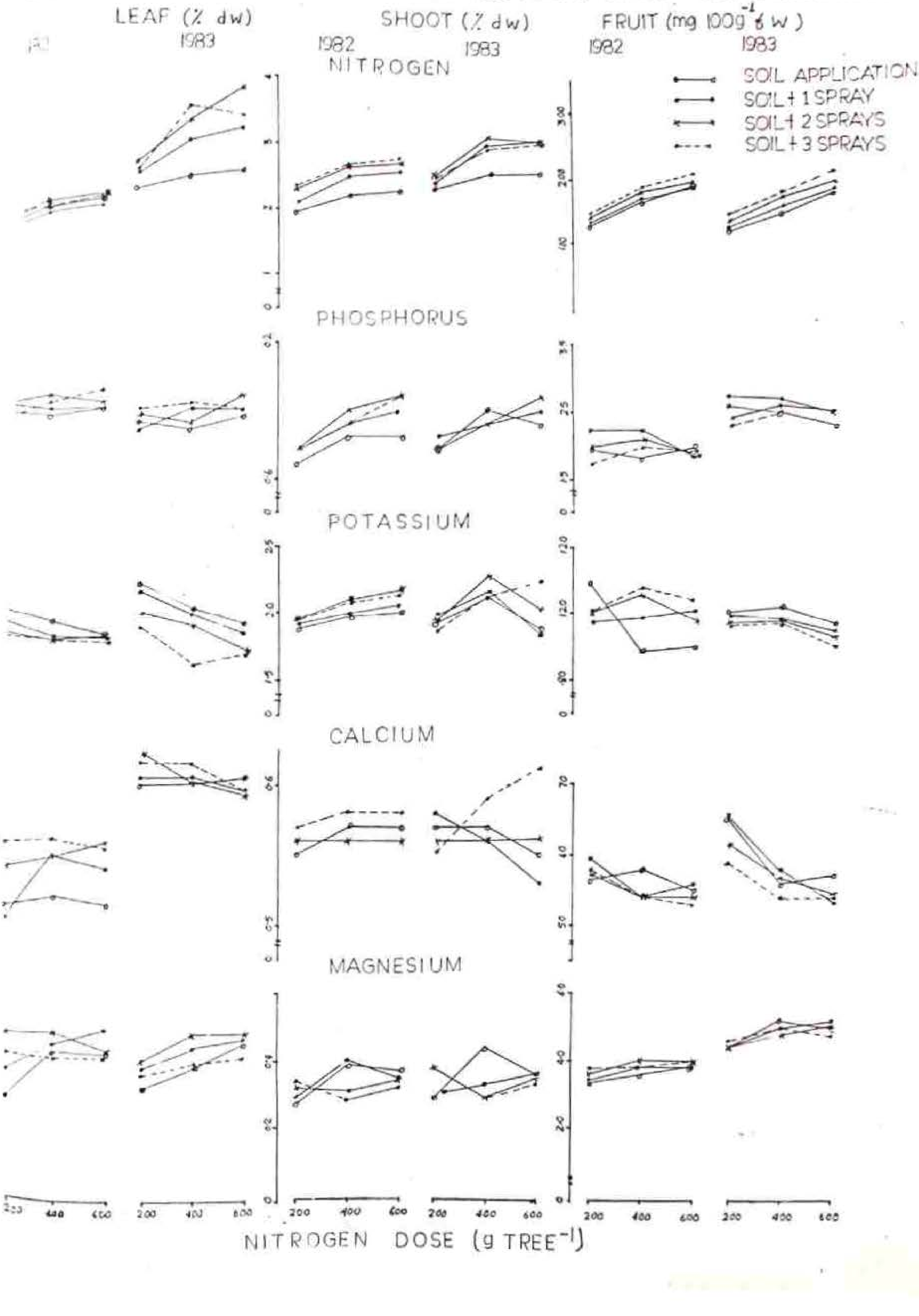
Different doses of N and its modes of applications exerted a considerable influence on the N status of leaves, shoots and fruits. A perusal of table 5 and Fig.2 shows that N applications improved the N content in all the plant tissues analysed, however, no significant differences were obtained between 400 and 600 g N doses in case of leaves and shoots. Foliar urea sprays numbering two or three did not differ from each other, but improved the N content of leaves in comparison to soil application. In case of apricot shoots, foliar sprays (1 to 3) remained at par but raised the N content sufficiently in comparison to soil application. Similarly, in case of fruits two foliar sprays enhanced the N content in comparison to soil application, though it remained at par with one or three number

Table 5. Effect of soil and foliar applications of urea on the macronutrient content of leaf, shoot and fruit of New Castle apricot (pooled mean for 2 years)

Treatment	Nitrogen			Phosphorus			Potassium			Calcium			Magnesium		
	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit
N dose (g tree^{-1})															
200 (N_1)	2.19	2.31	134.4	0.19	0.12	22.3	2.98	1.91	98.8	3.47	0.56	60.2	0.78	0.32	39.9
400 (N_2)	2.58	2.71	169.6	0.20	0.14	22.9	2.84	2.09	98.3	3.47	0.57	55.6	0.83	0.34	44.0
600 (N_3)	2.70	2.77	194.2	0.21	0.15	21.4	2.78	2.02	94.9	3.41	0.56	54.7	0.84	0.35	44.5
L.S.D.(p=0.05)	0.15	0.10	11.6	N.S.	0.01	N.S.	0.05	0.09	N.S.	N.S.	N.S.	2.6	0.03	0.02	2.4
Mode of application															
Soil (M_1)	2.19	2.32	154.6	0.19	0.13	21.8	2.97	1.94	96.7	3.43	0.56	57.9	0.78	0.35	42.2
Soil + 1 spray(M_2)	2.45	2.62	160.1	0.20	0.14	23.6	2.91	1.97	97.1	3.44	0.56	57.6	0.83	0.34	42.7
Soil + 2sprays(M_3)	2.68	2.73	169.8	0.20	0.14	22.3	2.83	2.06	97.5	3.48	0.56	56.4	0.86	0.33	43.0
Soil + 3sprays(M_4)	2.64	2.72	180.0	0.21	0.14	21.1	2.75	2.05	98.2	3.47	0.58	55.3	0.80	0.33	43.3
L.S.D. (p=0.05)	0.18	0.12	13.4	N.S.	N.S.	N.S.	0.05	N.S.	N.S.	N.S.	N.S.	N.S.	0.04	N.S.	N.S.
N dose x mode															
N_1 M_1	2.03	2.13	124.4	0.19	0.12	22.6	3.11	1.88	103.9	3.41	0.56	60.6	0.71	0.28	38.7
N_1 M_2	2.16	2.26	129.5	0.19	0.13	24.7	3.04	1.93	97.4	3.39	0.57	62.5	0.78	0.29	39.0
N_1 M_3	2.29	2.74	137.1	0.20	0.12	21.7	2.91	1.93	97.2	3.57	0.56	59.4	0.84	0.35	40.0
N_1 M_4	2.29	2.41	146.7	0.19	0.13	20.0	2.86	1.90	96.9	3.64	0.56	58.2	0.79	0.36	42.0
N_2 M_1	2.21	2.37	155.9	0.18	0.14	21.5	2.94	2.03	94.0	3.45	0.57	57.0	0.80	0.41	44.0
N_2 M_2	2.52	2.75	163.4	0.20	0.14	24.5	2.88	2.06	97.5	3.50	0.56	55.9	0.85	0.36	44.0
N_2 M_3	2.74	2.87	176.0	0.20	0.15	23.4	2.83	2.17	100.2	3.43	0.56	55.4	0.89	0.30	44.0
N_2 M_4	2.84	2.84	183.4	0.21	0.14	22.2	2.69	2.10	101.6	3.52	0.58	54.0	0.80	0.29	44.0
N_3 M_1	2.33	2.44	183.5	0.19	0.14	21.2	2.86	1.92	92.2	3.41	0.56	56.1	0.84	0.36	44.0
N_3 M_2	2.68	2.85	187.4	0.20	0.15	21.5	2.81	1.93	96.5	3.42	0.54	54.5	0.88	0.35	45.0
N_3 M_3	3.02	2.90	196.2	0.21	0.16	21.7	2.75	2.08	95.0	3.44	0.56	54.5	0.86	0.34	45.0
N_3 M_4	2.78	2.90	209.9	0.21	0.16	21.0	2.71	2.16	96.0	3.37	0.60	53.6	0.81	0.33	44.0
L.S.D. (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.09	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.04	N.S.

Leaf and shoot: % dry weight, Fruit: mg 100 g^{-1} fresh weight.

EFFECT OF NITROGEN ON THE MACRONUTRIENT STATUS NEW CASTLE APRICOT



of sprays. Interaction effect due to doses and modes of application was observed to be non-significant.

4.1.4.2. Phosphorus

Application of urea could not affect significantly the P level in leaves and fruits as is evident from Table 5 and Fig.2. However, in case of shoots, increased dose of N fertilizer enhanced it considerably. Different modes of application did not exhibit their superiority in improving the P level of leaves, shoots or fruits. Interaction due to doses and modes of application was non-significant.

4.1.4.3. Potassium:

In general, K content in leaves decreased significantly with increased N applied through soil alone or coupled with foliar sprays. Interaction due to doses and modes was significant in case of leaves. Maximum level of leaf K (3.11%) was observed with the lowest N dose applied through soil alone. Application of N beyond 400 g tree^{-1} resulted in decreased shoot K, though the difference between 400 and 600 g N doses was not significant. Different modes of application and interaction were however, ineffective in improving the shoot K. Different levels of N as well as foliar sprays could not influence the K content of the fruits.

4.1.4.4. Calcium:

Ca content in leaves and shoots was not affected by different treatments of urea. However, in case of fruits, it decreased with enhanced fertilizer rate, though the difference between 400 and 600 g N was observed to be non-significant. The effect of foliar applications and interaction between N rates and modes of application on the Ca content was found to be non-significant in all the tissues studied.

4.1.4.5. Magnesium:

The amount of magnesium in the leaves, shoots and fruits increased with increased N dose, though the difference between 400 and 600 g N was observed to be non-significant. A single or two foliar sprays remained at par, but improved leaf Mg in comparison to soil application while the third spray affected it adversely. Urea sprays did not influence the amount of K in shoots and fruits. Interaction due to doses and modes was found to be significant in case of shoots only. The maximum shoot Mg (0.41%) was recorded with 400 g N applied through soil alone.

4.1.4.6. Iron:

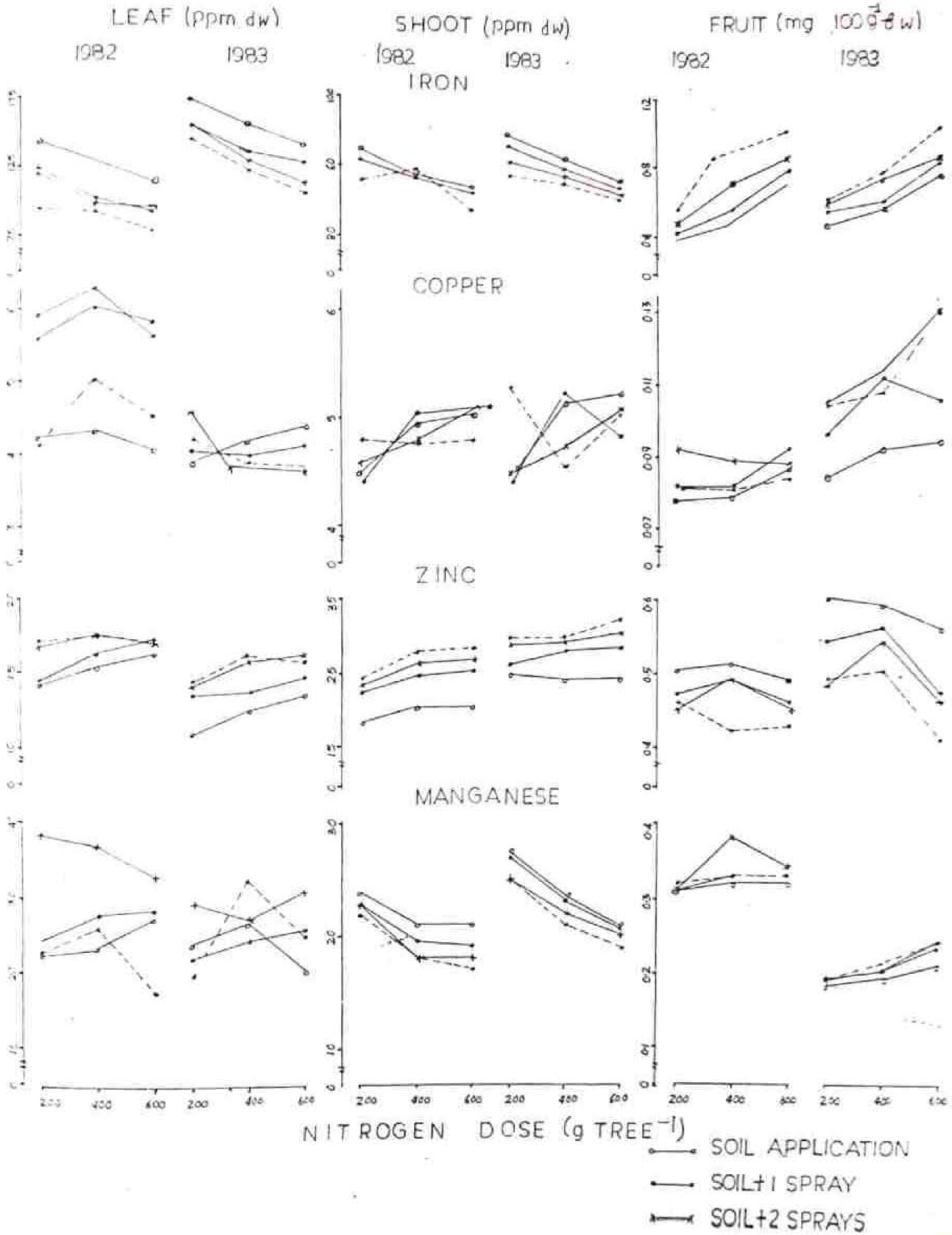
Application of N through soil as well as foliage reduced significantly the accumulation of Fe in the leaves as well as shoots, while in case of fruits it increased the Fe content considerably (Table 6, Fig.3). Interaction effects due to doses and modes of application were significant in case of apricot shoots and fruits. While in case of leaves, it proved to be ineffective. Maximum level of Fe in leaves (155.5 ppm) and shoots (73.5 ppm) was noticed with the lowest N dose of 200 g N applied through soil alone and the minimum (90.5 and 35.5 ppm respectively) with the highest dose of 600 g N supplemented with two foliar urea sprays. Exactly reverse trend was

Table 6. Effect of soil and foliar applications of urea on the micronutrient content of leaf, shoot and fruit of New Castle apricot (pooled mean for 2 years)

Treatment	Iron			Copper			Zinc			Manganese		
	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit
N dose (g tree^{-1})												
200 (N_1)	136.0	62.5	0.52	4.5	4.6	0.09	14.4	24.5	0.50	25.2	24.5	0.25
400 (N_2)	117.5	56.4	0.67	4.7	4.9	0.10	15.5	26.5	0.51	28.3	20.7	0.27
600 (N_3)	106.1	42.7	0.85	4.5	5.0	0.10	15.9	25.9	0.47	25.7	19.4	0.28
L.S.D. (p=0.05)	9.9	3.7	0.04	0.1	0.2	N.S.	0.2	1.2	0.02	N.S.	1.4	0.01
Mode of application												
Soil (M_1)	139.7	61.2	0.56	4.2	4.9	0.09	13.7	21.8	0.54	24.2	23.0	0.26
Soil + 1 spray(M_2)	119.8	56.3	0.63	4.9	4.8	0.10	14.9	25.5	0.50	25.3	22.0	0.26
Soil +2 sprays(M_3)	115.7	51.2	0.71	5.0	4.8	0.10	16.2	27.1	0.48	32.3	21.0	0.28
Soil +3 sprays(M_4)	104.3	47.0	0.81	4.2	4.9	0.10	16.3	28.5	0.45	23.9	20.3	0.27
L.S.D.(p=0.05)	11.4	4.2	0.05	0.2	N.S.	N.S.	0.3	1.3	0.02	3.3	1.7	0.01
N dose x mode												
N_1 M_1	155.5	73.5	0.44	4.0	4.5	0.08	12.5	21.0	0.55	22.9	25.8	0.25
N_1 M_2	136.0	67.0	0.50	4.8	4.4	0.09	13.9	24.6	0.50	23.0	25.0	0.25
N_1 M_3	135.0	57.5	0.54	5.2	4.5	0.10	15.4	25.7	0.47	33.9	24.0	0.25
N_1 M_4	117.0	52.5	0.59	4.1	5.1	0.09	15.7	26.9	0.48	21.1	23.5	0.25
N_2 M_1	139.0	60.0	0.53	4.2	5.1	0.09	13.9	22.2	0.55	25.7	22.2	0.25
N_2 M_2	115.5	56.0	0.59	5.0	5.2	0.10	14.9	26.3	0.53	26.1	21.3	0.26
N_2 M_3	110.5	56.5	0.73	5.0	4.8	0.10	16.6	28.1	0.51	32.1	20.0	0.29
N_2 M_4	105.5	53.0	0.82	4.4	4.7	0.10	16.8	29.9	0.46	29.3	19.5	0.27
N_3 M_1	124.5	50.0	0.72	4.2	5.2	0.09	14.8	22.1	0.52	23.9	20.9	0.27
N_3 M_2	108.0	46.0	0.81	5.0	5.0	0.10	16.0	22.6	0.47	26.8	19.8	0.28
N_3 M_3	101.5	39.5	0.87	4.7	5.1	0.11	16.5	27.1	0.46	30.9	19.0	0.29
N_3 M_4	90.5	35.5	1.00	4.2	4.9	0.11	16.4	28.9	0.42	21.4	18.0	0.29
L.S.D.(p=0.05)	N.S.	7.4	0.08	0.3	0.3	N.S.	0.5	N.S.	N.S.	N.S.	N.S.	N.S.

Leaf and shoot: ppm dry weight, Fruit: mg 100 $^{-1}$g fresh weight.

FIG. 3. EFFECT OF NITROGEN ON THE MICRONUTRIENT STATUS OF NEW CASTLE APRICOT



notice in case of fruits.

4.1.4.7. Copper

Increased N rate upto 400 g N, raised the leaf Cu considerably, but it declined significantly with the highest N dose. In case of shoots, increased N rate upto 600 g enhanced the Cu content though it did not differ significantly from 400 g. However, in case of fruits, N applications did not influence the Cu level significantly. Foliar sprays upto two in number were effective in enhancing the Cu level in case of leaves, though it did not differ significantly from a single spray, while the third spray had an adverse effect. Foliar urea sprays were however, ineffective in changing the Cu content in case of shoots or fruits. Interaction was found significant in case of leaves and shoots only. Maximum level of Cu in leaves (5.2 ppm) was noticed under 200 g N supplemented with 2 foliar sprays while in case of shoots it was with 400 g N coupled with a single spray.

4.1.4.8. Zinc:

Zn level in the apricot leaves increased with the increased fertilizer dose and was maximum (15.9 ppm) with 600 g N. In case of shoots, application of N upto 400 g improved the Zn content. Further increase in N dose resulted in decreased Zn content though the difference between 400 and 600 g N was not significant. However, in case of fruits, increased N dose upto 400 g slightly raised its Zn content, but with the highest dose it declined considerably. Foliar feeding of urea enhanced the Zn content both in leaves as well as shoots, though no significant difference could be observed betweentwo and three sprays. In case of shoots, however, a sharp increase was evident upto three urea sprays. Each spray reduced the Zn content significantly in fruits and the minimum (0.45 mg 100 g^{-1}) was recorded with three sprays. Interaction between doses and modes of application was significant in case of leaves only. The maximum (16.8 ppm) and minimum (12.5 ppm) Zn contents were recorded in N_2M_4 and N_1M_1 treatments respectively.

4.1.4.9. Manganese:

Graded levels of N could not bring any statistical change in the leaf Mn. In case of shoots, its level declined significantly with each increment of N rate. A reverse trend was observed in case of fruits. Foliar sprays of urea upto two in number enhanced the Mn status considerably in case of leaves and fruits, but further spraying had adverse effects. In case of shoots, foliar sprays resulted in decreased Mn content, though no significant difference was noticed between two and three sprays. Interaction effects were found to be non-significant in case of leaves, shoots as well as fruits.

4.1.5. <u>Soil properties</u>

The pooled mean for two years regarding the influence of N on various soil properties viz., soil pH, organic carbon, nutrient status and the microbial population are presented in Tables 7,8 and 9 and the year wise data have been given in Appendices 4-5 and Fig.4.

4.1.5.1. Soil pH:

It is evident from the data (Table 7) that all the

Table 7. Effect of nitrogen on the pH level and organic carbon content of soil (pooled mean for 2 years)

Treatment	pH	Organic carbon (%)
N dose (g $tree^{-1}$)		
200 (N_1)	7.47	2.25
400 (N_2)	7.39	2.40
600 (N_3)	7.35	2.42
L.S.D. (p = 0.05)	0.08	0.09
Soil depth (cm)		
0 - 15 (D_1)	7.25	2.90
15 - 30 (D_2)	7.33	2.27
30 - 60 (D_3)	7.63	1.90
L.S.D. (p = 0.05)	0.08	0.09
N dose x depth		
N_1 D_1	7.30	2.77
N_1 D_2	7.40	2.13
N_1 D_3	7.71	1.87
N_2 D_1	7.24	2.95
N_2 D_2	7.32	2.32
N_2 D_3	7.61	1.92
N_3 D_1	7.21	2.98
N_3 D_2	7.26	2.36
N_3 D_3	7.59	1.93
L.S.D. (p = 0.05)	N.S.	N.S.

levels of N reduced the soil pH, although the difference between N_2 and N_3 was not significant. Soil pH varied greatly with depth. The pH at the surface (0-15 cm) was lower as compared to the other two lower depths. Interaction due to N rates and soil depths was observed to be non-significant.

4.1.5.2. Organic carbon:

In general, the organic C content increased with the increase in N dose, however, the difference between N_2 and N_3 was observed to be non-significant. The organic carbon decreased with the soil depth throughout the period of investigations. Interaction due to doses and depths failed to exert its influence on the percentage of soil organic carbon.

4.1.5.3. Available nitrogen:

Data presented in Table 8 and Fig.4 indicate that the available N increased significantly with increase in N dose and decreased with increase in soil depth. Interaction effect between N rates and soil depth was also found to be significant. In general, the available N in different depths increased with the increase in N rates. The available N was found to be maximum (122 ppm) at surface layer (0-15 cm) when 600 g N was applied (N_3D_1) and the minimum (33.2 ppm) under N_1D_3 treatment.

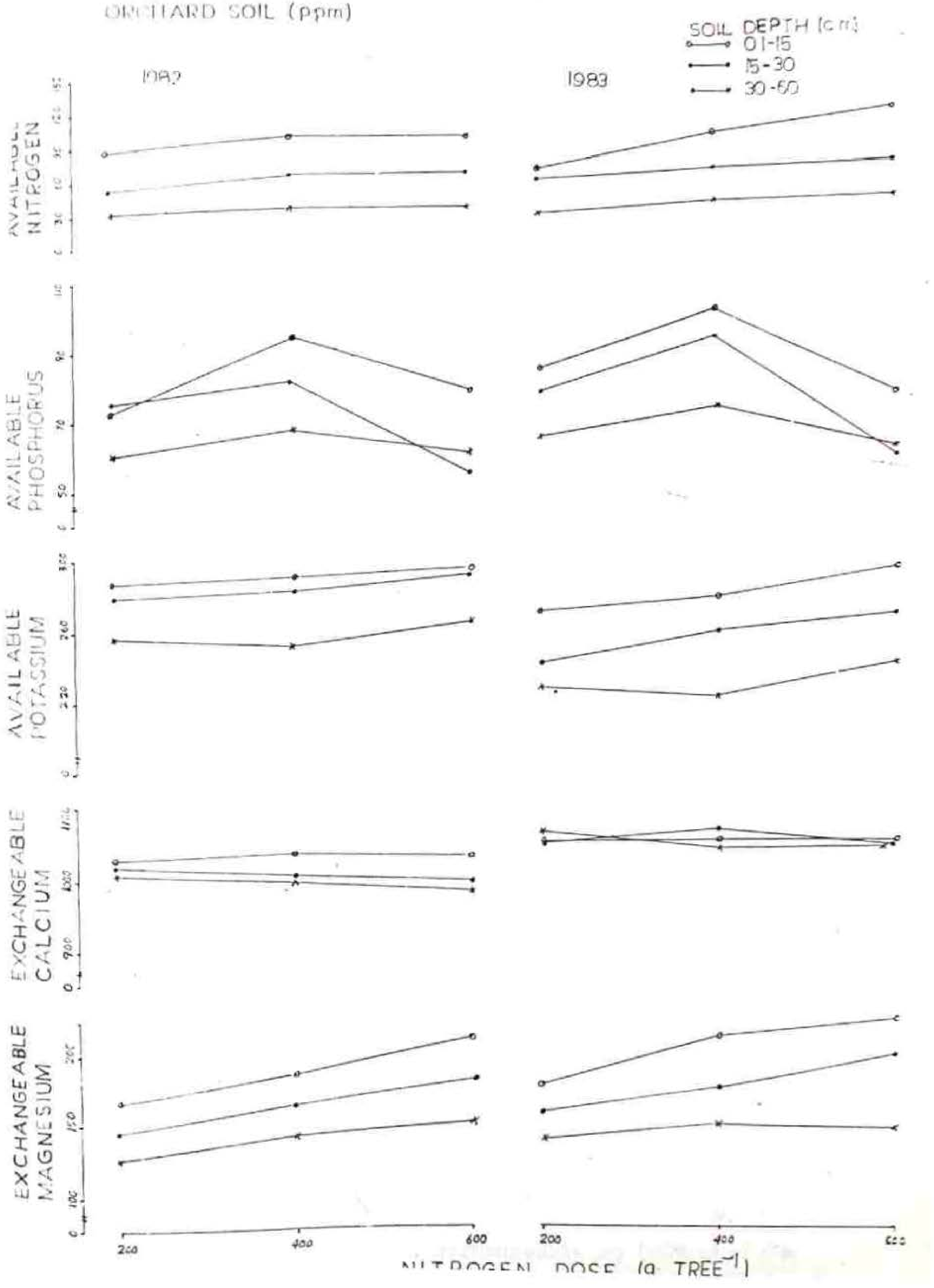
4.1.5.4. Available phosphorus:

An increased rate of fertilizer N from 200 to 400 g increased significantly the available P content of the soil and further higher dose reduced its level considerably. Data also reveal that P content varied greatly in different soil depths. Its concentration was found to be maximum in the top layer of

Table 8. Effect of nitrogen on the available nutrient status (ppm) of soil at different depth (pooled mean for 2 years)

Treatment	N	P	K	Ca	Mg	Fe	Cu	Zn	Mn
N dose (g $tree^{-1}$)									
200 (N_1)	61.2	72.2	259.3	1033.0	149.7	62.0	7.2	1.9	42.1
400 (N_2)	74.5	84.5	264.8	1030.5	168.2	62.1	8.2	3.1	54.6
600 (N_3)	81.6	66.3	276.3	1023.2	187.3	64.2	7.8	3.8	48.7
L.S.D. (p = 0.05)	3.9	3.5	10.2	N.S.	9.7	N.S.	0.3	0.1	3.2
Soil depth (cm)									
0 - 15 (D_1)	107.2	85.2	287.4	1038.3	198.8	96.4	7.5	3.8	68.2
15 - 30 (D_2)	69.5	72.7	270.0	1028.2	167.8	49.8	8.0	3.0	47.8
30 - 60 (D_3)	40.6	65.1	242.9	1020.2	138.5	42.0	7.8	1.9	29.3
L.S.D. (p = 0.05)	3.9	3.5	10.2	12.0	9.7	3.1	0.3	0.1	3.2
N dose x depth									
N_1 D_1	90.8	76.6	278.0	1034.0	170.0	96.4	6.7	2.6	60.0
N_1 D_2	59.7	77.0	259.1	1031.0	149.0	50.1	7.2	1.6	43.5
N_1 D_3	33.2	63.0	240.7	1034.0	130.0	39.4	7.5	1.5	22.7
N_2 D_1	108.5	99.4	288.6	1041.0	197.5	96.5	8.0	4.1	82.5
N_2 D_2	72.3	83.6	270.5	1034.0	167.0	48.8	8.7	3.4	49.5
N_2 D_3	42.4	70.5	235.3	1016.5	140.0	40.9	8.0	1.7	32.0
N_3 D_1	122.0	79.5	295.6	1040.0	229.0	96.5	7.7	4.6	62.3
N_3 D_2	76.6	57.5	280.3	1019.5	187.5	50.5	8.1	4.1	50.5
N_3 D_3	46.2	61.8	252.7	1010.0	145.5	45.6	7.8	2.5	33.2
L.S.D. (p = 0.05)	6.8	6.0	N.S.	N.S.	16.7	N.S.	N.S.	0.2	5.5

FIG.4. EFFECT OF NITROGEN ON THE NUTRIENT STATUS OF APRICOT ORCHARD SOIL (ppm)



of 0-15 cm and decreased significantly with increased soil depth. The interaction between N rates and the soil depths was also observed to be significant. P level was maximum (99.4 ppm) in N_2D_1 and minimum (57.5 ppm) in N_3D_1 treatment.

4.1.5.5. Available potassium:

Graded levels of N increased the available soil K, though the difference between 200 and 400 g N was observed to be non-significant. Availability of K, however, decreased with increased soil depth. Significantly higher K was recorded in the surface layer (287.4 ppm) compared to lower depths. The interaction due to N doses and depths was observed to be non-significant.

4.1.5.6. Exchangeable calcium:

Data presented in Table 8 and Fig.4 indicate that different N doses did not affect the exchangeable Ca significantly, though it decreased with increased soil depth. Maximum Ca content was recorded in the surface layer (0-15 cm), however, it did not differ from 15-30 cm depth. The interaction between N rates and the soil depths was observed to be non-significant.

4.1.5.7. Exchangeable magnesium:

A perusal of data in Table 8 and Fig.4 reveal that the exchangeable Mg content of soil was greatly influenced both by N levels and soil depths. An increase in exchangeable soil Mg was recorded with increased N in the soil. On the other hand, the exchangeable Mg content decreased with increase in depth. The interaction between N doses and soil depths was observed to be significant. Maximum exchangeable Mg (229 ppm) was recorded in N_3D_1 and the minimum (130 ppm) in N_1D_3 treatment.

4.1.5.8. Available iron:

The difference in DTPA extractable Fe due to N levels was observed to be non-significant. A decrease in the Fe content with the increase in soil depth was, however, observed. Interaction due to N doses and soil depths failed to exert its influence on the availability of Fe in the soil.

4.1.5.9. Available copper:

400 g N increased the DTPA extractable Cu content in comparison to other two doses of N. A further increase in N, however, lead to a significant decrease in the Cu content of the soil. Significantly higher DTPA extractable Cu was recorded in 15-30 cm depth compared to surface layer (0-15 cm), however, the difference between 0-15 and 30-60 cm depths was not significant. The interaction between N doses and soil depths was found to be ineffective in altering the Cu status of the soil.

4.1.5.10. Available zinc:

The amount of available Zn in the soil increased significantly due to N application. However, its availability decreased markedly with increased soil depth. The interaction effect between N doses and soil depths was also noticed to be significant. Zn level was maximum (4.6 ppm) in N_3D_1 and minimum (1.5 ppm) in N_1D_3 treatment.

4.1.5.11. Available manganese:

Mn content increased significantly when the N rate was raised to 400 g and reduction in Mn content was recorded with the further increase in N dose. The DTPA extractable Mn content declined markedly with increased soil depth. Interaction due to N doses and soil depths was also observed to be significant. Maximum amount of available Mn (82.5 ppm) was recorded with N_2D_1 and the minimum (22.7 ppm) with N_1D_3 treatment.

4.1.5.12. Soil micro-organisms:

4.1.5.12.I. Bacteria:

Increased dose of urea N increased the bacterial population significantly and was maximum with the highest dose (Table 9, Fig.5). Bacterial population also increased periodically upto 45 days (D_3) and thereafter declined till the last sampling date. Interaction due to doses and days of observations was significant. Maximum population (84×10^7) occurred under N_3D_3 and the minimum (30×10^7) under N_1D_1.

4.1.5.12.2. Actinomycetes:

Increased rate of urea N raised the population of actinomycetes significantly though the higher doses of 400 and 600 g remained at par. Actinomycetes population was maximum (68×10^4) after 15 days of N application, after which it declined significantly till the last date of sampling. The interaction between N doses and the sampling dates was significant. Maximum population of actinomycetes (78×10^4) was recorded with N_2D_1 and minimum (13×10^4) with N_1D_5 treatment.

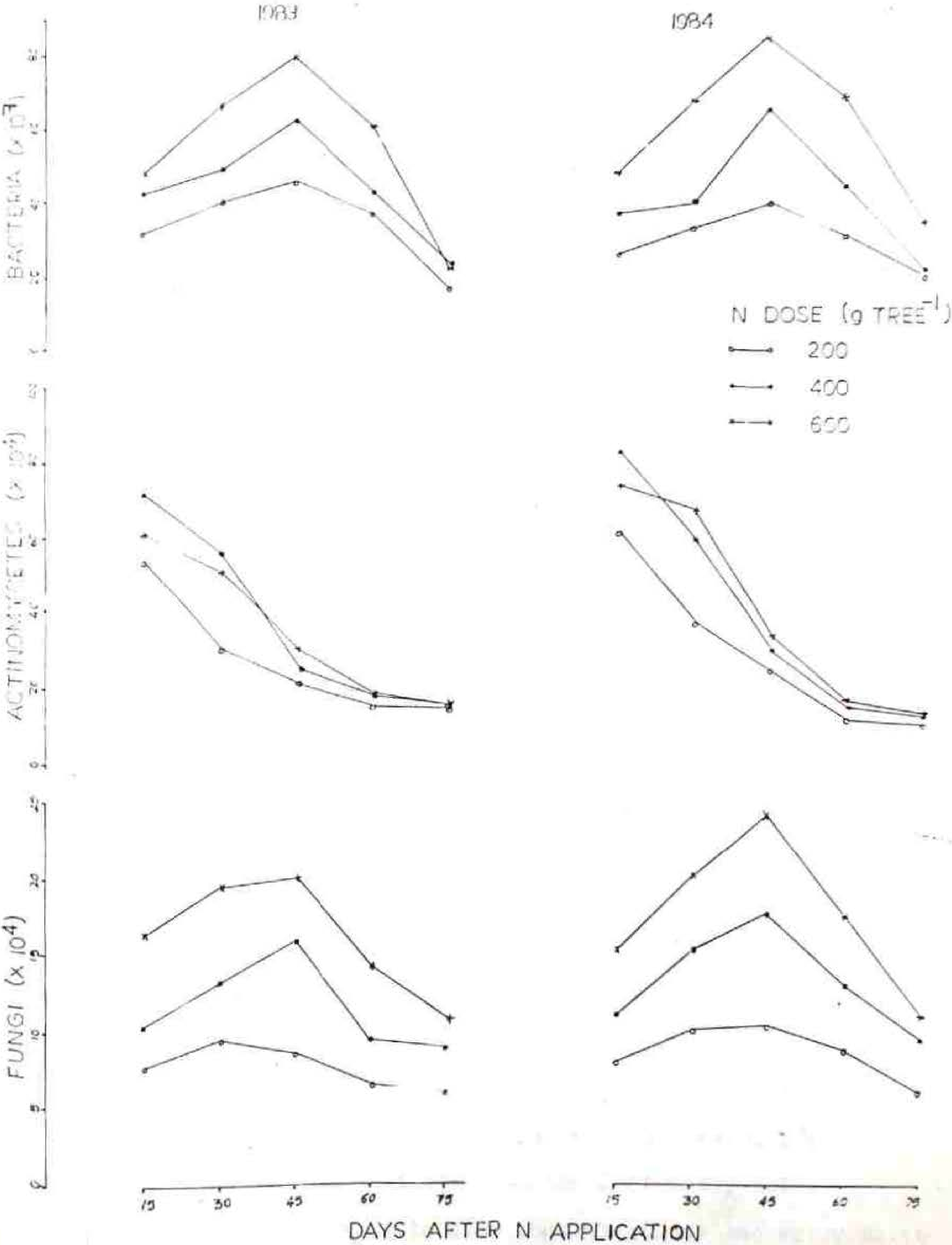
4.1.5.12.3. Fungi:

Urea application had a positive influence on the fungi population. Fungi population, worked out to be 8×10^4 under N_1 raised to 17×10^4 with N_3. Periodical observations reveal that it increased significantly upto 45 days of N application, after which it declined sharply till the last sampling date.

Table 9. Effect of different rates of nitrogen on the microbial population of the soil

Treatment	Bacteria ($\times 10^7$)	Actinomycetes ($\times 10^4$)	Fungi ($\times 10^4$)
<u>N dose</u> (g tree^{-1})			
200 (N_1)	34	29	8
400 (N_2)	45	39	12
600 (N_3)	60	38	17
L.S.D. ($p = 0.05$)	2.9	2.0	0.9
<u>Days after N application</u>			
15 (D_1)	40	68	11
30 (D_2)	51	51	15
45 (D_3)	65	28	16
60 (D_4)	49	16	12
75 (D_5)	25	14	9
L.S.D. ($p = 0.05$)	5.8	2.6	1.1
<u>N dose x days</u>			
N_1 D_1	30	58	8
N_1 D_2	38	34	10
N_1 D_3	44	23	10
N_1 D_4	36	14	8
N_1 D_5	21	13	6
N_2 D_1	41	78	11
N_2 D_2	46	58	14
N_2 D_3	66	28	17
N_2 D_4	45	17	11
N_2 D_5	25	15	9
N_3 D_1	49	68	16
N_3 D_2	69	60	20
N_3 D_3	84	33	23
N_3 D_4	67	18	16
N_3 D_5	31	16	11
L.S.D. ($p = 0.05$)	6.6	4.6	1.9

FIG. 5. EFFECT OF UREA ON THE MICROBIAL POPULATION IN THE APRICOT ORCHARD SOIL



interaction effects were found to be significant and maximum population (23 x 10^4) was observed with N_3D_3 and the minimum (6 x 10^4) with N_1D_5.

4.2. Effect of pre-fall urea sprays on the tree productivity, quality and nutrient status of New Castle apricot

4.2.1. Fruit set, retention, yield and quality:

The pooled means pertaining to the influence of pre-fall sprays of urea on the percentage of fruit set, retained till harvest, yield and quality are presented in Table 10 and the year wise data in Appendix 6.

4.2.1.1. Fruit set:

Urea sprays applied at the pre-fall stage improved significantly the fruit set compared to control. The lower urea concentration was more effective than the higher one. In general, the fruit set increased significantly with delayed urea sprays. The maximum fruit set of 45.0 per cent was recorded when the trees were sprayed on 30 October, though it did not differ statistically from that of its earlier spray (15 October). The interaction between urea concentrations and dates of spray was not significant.

3.2.1.2. Fruit retention:

Pre-fall sprays of urea were effective in retaining a higher percentage of fruits till harvest in comparison to control. The lower urea concentration retained a higher percentage of fruits. Delayed sprays upto October 15, increased it markedly which was at par with the last spray date. Interaction effects due to urea concentrations and spray dates

Table 10. Effect of pre-fall urea sprays on the fruit characters of New Castle apricot (pooled mean for 2 years)

Treatment	Fruit set (%)	Fruit retention (%)	Yield (kg)	Weight (g)	Firmness (kg)	Total soluble solids(%)	Acidity (%)	Pulp pH
Urea concentration (%)								
2.5 (C_1)	42.0	24.8	70.7	15.7	6.2	13.0	0.79	3.7
5.0 (C_2)	37.0	22.5	58.0	14.6	5.8	12.9	0.72	3.8
Mean	39.5	23.7	64.4	15.2	6.0	13.0	0.76	3.8
Control	30.2	19.3	52.4	14.0	6.0	12.2	0.74	4.0
L.S.D.(p=0.05)								
Control vs spray	2.3	1.4	4.6	N.S.	N.S.	N.S.	N.S.	N.S.
Urea concentration	2.4	1.5	4.9	N.S.	N.S.	N.S.	0.04	N.S.
Date of spray								
15 Sept. (D_1)	32.6	23.2	58.5	14.9	5.6	12.5	0.72	3.8
30 Sept. (D_2)	37.3	21.8	62.1	15.5	6.0	13.3	0.78	3.8
15 Oct. (D_3)	43.1	24.8	71.1	15.3	6.0	13.2	0.78	3.7
30 Oct. (D_4)	45.0	24.8	65.7	15.1	6.3	12.8	0.74	3.7
L.S.D. (p=0.05)	3.5	2.1	6.9	N.S.	N.S.	N.S.	N.S.	N.S.
Concentration x date of spray								
C_1 D_1	35.2	23.9	60.0	15.6	5.7	12.8	0.74	3.8
C_1 D_2	39.2	22.6	68.2	16.0	6.1	13.5	0.82	3.8
C_1 D_3	46.0	26.7	85.8	16.0	6.2	13.0	0.82	3.7
C_1 D_4	47.5	26.1	69.0	15.4	6.6	12.9	0.78	3.7
C_2 D_1	30.0	22.4	57.0	14.2	5.4	12.2	0.70	3.8
C_2 D_2	35.4	21.0	56.0	14.9	5.9	13.1	0.74	3.8
C_2 D_3	40.2	23.0	55.5	14.7	5.8	13.4	0.74	3.8
C_2 D_4	42.5	23.5	62.4	14.8	6.0	12.8	0.70	3.8
L.S.D. (p = 0.05)	N.S.	N.S.	9.8	N.S.	N.S.	N.S.	N.S.	N.S.

were observed to be non-significant.

4.2.1.3. Yield:

Fruit yield increased significantly with urea sprays applied at pre-fall stage (64.4 Kg) when compared with control. The lower concentration of 2.5 per cent urea was more effective. Delayed spraying upto October 15, enhanced the yield significantly which was at par with that of the last spray. The interaction between urea concentrations and spray dates was found to be significant. The maximum yield (85.8 Kg) was obtained with 2.5 per cent urea spray applied on 15 October and the minimum (57.0 Kg) with the higher concentration on 15 September.

4.2.1.4. Fruit quality:

Two concentrations of urea applied on four different dates during pre-fall stage had practically no influence on the fruit weight, firmness and total soluble solids. The amount of total titratable acid in fruits of urea sprayed trees was also at par with control, however, the difference between the two concentrations of urea was significant. Pulp pH decreased but not significantly with urea sprays applied prior to leaf fall, and the two concentrations failed to exert their individual superiority. The interaction effect due to urea concentrations and the dates of application was observed to be non-significant in any of the quality attributes studied.

4.2.2. Chlorophyll contents and amino-nitrogen in leaves

The pooled means pertaining to the influence of pre-fall sprays of urea on the chlorophyll and amino-nitrogen content of apricot leaves are presented in Table 11 and the year wise data in Appendix 7.

4.2.2.1. Chlorophyll content:

A perusal of data indicates that total chlorophyll, chlorophyll 'a' and chlorophyll 'b' were enhanced significantly in the apricot leaves with pre-fall sprays of urea. However, different concentrations of urea, dates of application and their interaction did not alter the chlorophyll content of the leaves significantly.

4.2.2.2. Amino nitrogen:

Urea sprays applied at the pre-fall stage, increased significantly the amino nitrogen content in leaves. However, no significant difference between the two concentrations of urea was noticed. The first spray applied on 15 September, resulted in the lowest amino nitrogen and the later three sprays, which were at par, enhanced significantly the amount of amino N in the leaves. Interaction due to dates and concentrations was observed to be non-significant.

4.2.3. Nutrient status:

Data pertaining to the nutrient status of leaves, shoots and fruits as influenced by urea sprays applied prior to leaf fall are presented in Tables 12 and 13 (pooled mean for two years) and the year wise data for 1982 and 1983 in Appendices 8, 9 and 10.

4.2.3.1. Nitrogen:

Pre-fall sprays of urea enhanced the N level in leaves and shoots, but no significant improvement was recorded in case of fruits. Delayed urea sprays upto October 15, increased the leaf N composition, which was at par with the last spray date.

Table 11. Effect of pre-fall urea sprays on the chlorophyll and amino nitrogen contents of apricot leaves (pooled mean for 2 years)

Treatment	Total chlorophyll (mg g^{-1} fresh wt.)	Chlorophyll 'a' (mg g^{-1} fresh wt.)	Chlorophyll 'b' (mg g^{-1} fresh wt.)	Amino nitrogen (% dry wt.)
Urea concentration (%)				
2.5 (C_1)	35.5	18.9	16.6	1.8
5.0 (C_2)	36.0	19.1	16.9	1.8
Mean	35.7	19.0	16.8	1.8
Control	32.0	17.1	14.9	1.6
L.S.D.(p=0.05)				
Control vs spray	1.1	0.4	0.4	0.1
Urea concentration	N.S.	N.S.	N.S.	N.S.
Date of spray				
15 Sept. (D_1)	35.8	19.1	16.7	1.6
30 Sept. (D_2)	36.1	19.1	16.9	1.9
15 Oct. (D_3)	35.7	18.9	16.8	1.9
30 Oct. (D_4)	35.5	18.8	16.7	1.9
L.S.D.(p = 0.05)	N.S.	N.S.	N.S.	0.1
Concentration x date of spray				
C_1 D_1	35.5	18.9	16.5	1.5
C_1 D_2	36.0	19.1	16.9	2.0
C_1 D_3	35.2	18.6	16.5	1.9
C_1 D_4	35.4	18.8	16.6	1.9
C_2 D_1	36.2	19.2	16.9	1.6
C_2 D_2	36.1	19.2	16.9	1.9
C_2 D_3	36.2	19.2	17.1	1.9
C_2 D_4	35.6	18.9	16.7	1.8
L.S.D.(p=0.05)	N.S.	N.S.	N.S.	N.S.

Table 12. Effect of pre-fall urea sprays on the macronutrient content of leaf, shoot and fruit of New Castle apricot (pooled mean for 2 years)

Treatment	Nitrogen			Phosphorus			Potassium			Calcium			Magnesium		
	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit
Urea concentration (%)															
2.5 (C_1)	2.10	2.28	184.2	0.21	0.14	24.7	2.23	1.83	102.5	2.93	0.69	65.5	0.87	0.42	48.9
5.0 (C_2)	2.17	2.37	192.4	0.21	0.15	23.3	1.98	1.81	97.1	3.05	0.71	67.6	0.83	0.44	46.7
Mean	2.13	2.32	188.3	0.21	0.14	24.0	2.11	1.82	99.8	2.99	0.70	66.5	0.85	0.43	47.8
Control	1.67	2.10	184.2	0.21	0.14	25.0	2.50	1.71	123.9	2.76	0.68	66.2	0.75	0.42	51.0
L.S.D.(p=0.05)															
Control vs spray	0.14	0.13	N.S.	N.S.	N.S.	N.S.	0.05	0.06	4.6	0.09	N.S.	N.S.	0.02	N.S.	N.S.
Urea concentration	N.S.	N.S.	N.S.	N.S.	N.S.	1.3	0.05	N.S.	4.9	0.10	0.01	1.2	0.03	N.S.	N.S.
Date of spray															
15 Sept. (D_1)	1.99	2.27	184.6	0.21	0.13	22.5	2.33	1.95	96 .7	2.92	0.69	66.9	0.82	0.45	49.7
30 Sept. (D_2)	2.06	2.31	186.1	0.21	0.14	25.0	2.19	1.81	101.2	3.15	0.72	67.2	0.86	0.48	49.1
15 Oct. (D_3)	2.25	2.33	191.4	0.21	0.15	24.9	1.98	1.79	98.0	3.13	0.73	66.4	0.88	0.42	48.5
30 Oct. (D_4)	2.24	2.37	191.1	0.21	0.16	23.6	1.93	1.73	103.2	2.77	0.65	65.6	0.82	0.37	44.0
L.S.D.(p=0.05)	0.21	N.S.	N.S.	N.S.	0.01	1.8	0.07	0.09	N.S.	0.14	0.02	N.S.	0.04	0.04	3.1
Concentration x date of spray															
C_1 D_1	1.97	2.24	183.4	0.21	0.12	23.5	2.44	1.97	93.5	2.87	0.64	65.5	0.84	0.44	51.4
C_1 D_2	2.08	2.28	182.0	0.21	0.15	27.0	2.32	1.81	101.4	3.01	0.70	66.4	0.88	0.47	51.2
C_1 D_3	2.09	2.30	185.6	0.21	0.15	25.1	2.05	1.80	102.5	3.18	0.76	65.5	0.87	0.42	50.0
C_1 D_4	2.27	2.29	185.7	0.20	0.15	23.1	2.11	1.75	112.5	2.66	0.65	64.5	0.87	0.37	43.0
C_2 D_1	2.01	2.30	185.7	0.22	0.13	21.5	2.22	1.94	100.0	2.97	0.75	68.2	0.80	0.47	48.0
C_2 D_2	2.05	2.35	190.2	0.20	0.14	23.0	2.05	1.81	101.0	3.29	0.73	68.1	0.84	0.49	47.0
C_2 D_3	2.40	2.36	197.1	0.21	0.15	24.6	1.92	1.77	93.5	3.07	0.70	67.2	0.89	0.42	47.0
C_2 D_4	2.21	2.45	196.5	0.21	0.16	24.1	1.74	1.72	94.0	2.89	0.65	66.6	0.77	0.38	45.0
L.S.D. (p=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	3.6	0.10	N.S.	13.9	0.19	0.03	N.S.	0.05	N.S.	N.S.

Leaf and shoot: % dry weight, Fruit: mg 100^{-1}g fresh weight

Different spray dates did not affect the N level in other two tissues analysed. Different concentrations of urea and its interaction with dates failed to exert their influence on N uptake in any of the three tissues studied.

4.2.3.2. Phosphorus:

Urea sprays applied prior to leaf-fall had no influence on the P level in leaves, shoots or fruits when compared with control. Urea concentrations did not differ in case of leaves and shoots but the lower concentration raised the fruit P significantly. Different spray dates failed to influence the P content of leaves, but delayed sprays upto October 30, enhanced its level in shoots. In case of fruits, significant improvement in P content was noticed with the second date only, though the difference between second and third spray was non-significant. The interaction due to concentrations and spray dates was observed to be effective in case of fruits only. Maximum fruit P (27.0 mg 100 g^{-1}) was recorded with lower urea concentration, sprayed on 30 September and the minimum with the higher concentration sprayed on 15 September.

4.2.3.3. Potassium:

The level of K in leaves and fruits decreased and in case of shoots increased considerably with the urea sprays applied at pre-fall stage. The lower urea concentration resulted in higher amount of K in the leaves and fruits, while in case of shoots, the difference was not significant. Delayed spraying reduced the accumulation of K in leaves and shoots, though the difference between the last two dates was not significant. In case of fruits, spray dates had no significant effect. The interaction due to dates and spray concentrations was significant in case of leaves and fruits. The lower concentration of urea sprayed on the first date resulted in the maximum leaf K (2.44%), and when sprayed on the last date resulted in the highest level in fruits (112.5 mg 100 g^{-1}).

4.2.3.4. Calcium:

Leaf Ca content enhanced significantly as a result of pre- fall urea sprays. However, in case of shoots and fruits, differences were not significant. The higher urea concentration was more effective in maintaining the higher level of Ca in all the three tissues studied. Time of sprays exerted significant influence in case of leaves and shoots. Urea sprays applied on September 30 and October 15, respectively, accumulated higher amount of Ca in these two tissues, though these two dates did not differ significantly with each other. The interactions were also found to be significant in leaves and shoots only. The highest percentage of leaf Ca (3.29%) was recorded when 5.0 per cent urea was sprayed on September 30, while in case of shoots, it was maximum (0.76%) with 2.5 per cent urea sprayed on October 15.

4.2.3.5. Magnesium:

Mg level increased significantly with pre-fall urea sprays in apricot leaves. However, in case of shoots and fruits, differences were not statistically significant. The lower concentration of urea showed its superiority in case of leaves, while in case of shoots and fruits, differences due to urea concentrations were not significant. Delayed sprays upto October 15 increased the leaf Mg, after which it declined considerably. In case of shoots its level declined markedly with delayed sprays of October 15 and 30, while in case of fruits, a significant decrease was noticed with the last spray. The differences among the first three dates of spray were observed to be non-significant in case of fruits.

4.2.3.6. Iron:

A decrease in the Fe content, due to pre-fall urea sprays was recorded in leaves, shoots as well as fruits. The higher urea concentration maintained a higher level of Fe in comparison to lower concentration in the shoots and fruits, while in case of leaves the difference was non-significant. Delayed sprays lowered the Fe content in leaves as well as shoots, while in case of fruits a reverse trend was recorded. Interaction effects were found to be non-significant in all the three tissues under study,

4.2.3.7. Copper:

Cu content increased significantly in the leaves with pre-fall sprays of urea, but the differences in case of shoots and fruits were not significant. The lower concentration of urea was more effective in improving the Cu content of leaves and the higher one in the fruits. The Cu content due to two concentrations, however, did not differ in case of shoots. Delayed spraying reduced the amount of Cu in leaves, though the last two dates did not differ significantly. Different spray dates did not affect the Cu status of shoots or fruits. The interaction effect was significant in case of shoots only. Maximum level of Cu in shoots (4.2 ppm) was found when 5.0 per cent urea was applied on the first spray date or when the lower mean for 2 years)

Treatment	Iron			Copper			Zinc			Manganese		
	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit	Leaf	Shoot	Fruit
Urea concentration												
2.5 (C_1)	152.0	85.2	0.61	5.0	4.0	0.08	17.7	31.3	0.32	18.7	57.2	0.28
5.0 (C_2)	158.2	96.1	0.93	4.6	3.9	0.10	18.0	31.7	0.35	19.9	53.0	0.27
Mean	155.1	90.7	0.77	4.8	4.0	0.09	17.8	31.5	0.34	19.3	55.1	0.28
Control	201.5	111.5	1.37	3.8	3.8	0.08	11.9	30.1	0.23	21.5	56.0	0.27
L.S.D.(p=0.05)												
Control vs spray	9.5	2.6	0.06	0.4	N.S.	N.S.	0.5	N.S.	0.01	N.S.	N.S.	N.S.
Urea concentration	N.S.	2.8	0.06	0.4	N.S.	0.01	N.S.	N.S.	0.01	N.S.	2.4	N.S.
Date of spray												
15 Sept. (D_1)	163.7	95.5	0.60	5.3	4.0	0.09	17.0	30.5	0.28	17.8	54.0	0.26
30 Sept. (D_2)	158.0	91.7	0.69	4.9	4.0	0.09	19.2	31.0	0.35	20.6	60.0	0.27
15 Oct. (D_3)	154.0	89.2	0.83	4.5	4.0	0.09	18.9	34.9	0.36	21.9	57.4	0.28
30 Oct. (D_4)	144.7	86.2	0.97	4.4	3.9	0.09	16.4	29.6	0.35	16.7	48.9	0.29
L.S.D. (p = 0.05)	N.S.	3.9	0.09	0.5	N.S.	N.S.	0.8	1.4	0.02	2.2	3.4	0.01
Concentration x date of spray												
C_1 D_1	170.0	92.0	0.48	5.6	3.8	0.08	15.7	29.9	0.27	16.3	56.8	0.26
C_1 D_2	151.0	85.5	0.55	5.0	3.9	0.08	19.3	30.3	0.35	19.3	63.9	0.27
C_1 D_3	147.0	83.5	0.63	4.7	4.2	0.08	18.9	36.1	0.34	23.0	55.3	0.28
C_1 D_4	140.0	80.0	0.80	4.7	4.1	0.09	16.8	29.2	0.34	16.1	53.0	0.29
C_2 D_1	157.5	99.0	0.71	5.1	4.2	0.10	18.3	31.1	0.30	19.3	51.2	0.27
C_2 D_2	165.0	98.0	0.84	4.9	4.1	0.10	19.1	31.9	0.35	21.9	56.2	0.27
C_2 D_3	161.0	95.0	1.03	4.3	3.8	0.10	18.8	33.8	0.38	20.9	59.6	0.28
C_2 D_4	149.5	92.5	1.14	4.1	3.7	0.10	16.0	30.1	0.37	17.4	44.9	0.28
L.S.D.(p=0.05)	N.S.	N.S.	N.S.	N.S.	0.3	N.S.	1.1	1.9	N.S.	N.S.	4.8	N.S.

Leaf and shoot: ppm dry weight; Fruit: mg 100^{-1}g fresh weight concentration was applied on the third spray date.

4.2.3.8. Zinc:

Zn level improved in the apricot leaves and fruits with the pre-fall sprays of urea, but difference was not significant in case of shoots. The higher concentration of urea improved the Zn level in all the three tissues, but significant results were obtained in case of fruits only. The maximum Zn level (19.2 ppm) was recorded with the second spray date. Further delay in spraying, however, decreased the Zn content of the leaves. In case of shoots, the delayed sprays raised the Zn content, but the last date showed a sharp decline. Almost similar findings were recorded in case of fruits, though the last three dates did not differ significantly. Interactions were found effective in case of leaves and shoots only. The highest Zn content (19.3 ppm) occurred in leaves with the lower urea concentration sprayed on the second date, while in case of shoots, it was recorded to be 36.1 ppm when the same concentration applied on the third spray date.

4.2.3.9. Manganese:

Mn content did not alter significantly in any of the plant tissue studied with pre-fall urea sprays. The lower concentration of urea maintained its superiority in shoots, while in the other two tissues the differences were not statistically significant. Mn content increased in the leaves with sprays applied upto October 15, though it was at par with the earlier spray date. A further delay in the urea spray reduced the Mn content in leaves significantly. In case of shoots, the second date of spray was most effective, after which it declined. In apricot fruits, Mn level improved even upto the last spray date, though the last two dates did not differ significantly. The interaction was significant in case of shoots only where maximum Mn (63.9 ppm) was recorded when 2.5 per cent urea was sprayed on 30 September.

4.3. Effect of pre-harvest sprays of mineral nutrients and growth regulators on the storage behaviour and nutrient status of New Castle apricot

4.3.1. Fruit characters:

Pooled means for two years pertaining to the periodical changes in various quality characters recorded at 10 days interval from the date of harvest (D_0) to 30 days of cold storage (D_3) are presented in Tables 14 and 15. The year wise data for 1982 and 1983 are given in Appendices 11,12 and 13.

4.3.1.1. Fruit respiration:

Rate of respiration was influenced greatly by different treatments applied. Fruits treated with T_{10}($CaCl_2$ + MH) resulted in the lowest rate (3.8 mg CO_2 kg^{-1} h^{-1}) of respiration followed by T_2, T_{16} and T_5. On the other hand, fruits respired heavily when treated with T_1, T_3, T_7, T_{14} and T_{18}. It was observed that treatments resulting in the lower respiration rate at the time of harvest, maintained it throughout the storage period. A perusal of Table 14 also reveals that there was a sudden decline in the respiration rate when the fruits were stored for the first 10 days in comparison to the freshly harvested fruits. Thereafter with subsequent storage, it rose and was maximum (5.6 mg CO_2 kg^{-1} h^{-1}) on the last sampling date.

Table 14. Effect of nutrients and growth regulators on the rate of respiration and firmness of New Castle apricot fruits stored at 0°C

Treatment No.	Treatment	Respiration (mg CO_2 $kg^{-1}h^{-1}$)					Fruit firmness (kg)				
		Days after storage									
		0	10	20	30	Mean	0	10	20	30	Mean
T_1	H_3BO_3 (0.2%)	5.9	3.3	5.5	5.9	5.1	8.4	5.7	4.7	3.6	5.6
T_2	$CaCl_2$ (0.5%)	4.2	2.8	4.0	4.5	3.9	10.0	8.0	6.9	5.6	7.6
T_3	KNO_3 (0.5%)	5.7	3.2	5.5	5.9	5.1	8.8	7.2	6.0	3.5	6.4
T_4	GA (50 ppm)	5.3	3.2	5.2	5.7	4.9	8.9	6.9	5.7	4.0	6.4
T_5	MH (1000 ppm)	4.4	2.9	4.3	5.1	4.2	9.9	8.4	6.7	4.5	7.4
T_6	SADH(1000 ppm)	5.4	3.7	4.9	5.7	4.9	9.0	7.4	6.2	4.4	6.7
T_7	H_3BO_3+GA	5.6	3.3	5.5	6.0	5.1	8.9	7.3	6.4	4.3	6.7
T_8	H_3BO_3+SADH	5.5	3.2	5.4	5.9	5.0	8.8	7.3	6.0	4.3	6.6
T_9	$CaCl_2$+GA	5.4	3.2	4.3	5.8	4.7	9.0	7.8	6.4	4.9	7.0
T_{10}	$CaCl_2$+MH	4.1	2.4	3.9	4.8	3.8	10.3	8.7	8.0	6.1	8.3
T_{11}	KNO_3+MH	4.5	3.2	5.3	5.7	4.7	9.3	7.8	6.6	4.3	7.0
T_{12}	KNO_3+SADH	5.4	3.2	5.4	5.9	5.0	8.8	7.3	5.3	3.6	6.2
T_{13}	H_3BO_3+$CaCl_2$+GA	5.7	3.3	5.3	5.8	5.0	8.9	7.8	6.6	3.9	6.8
T_{14}	H_3BO_3+SADH+GA	5.5	3.3	5.5	6.0	5.1	8.7	7.8	5.7	4.3	6.6
T_{15}	$CaCl_2$ +GA+MH	4.9	3.1	5.1	5.6	4.7	9.4	7.6	6.5	4.6	7.0
T_{16}	$CaCl_2$+KNO_3+MH	4.2	2.5	4.2	5.0	4.0	9.7	8.2	7.8	4.5	7.4
T_{17}	KNO_3+MH+SADH	5.1	3.2	5.3	5.8	4.8	9.5	7.4	6.0	3.5	6.6
T_{18}	KNO_3+GA+SADH	5.5	3.4	5.5	6.1	5.1	[illegible]	7.2	5.8	4.6	6.7
T_{19}	Control	5.5	3.3	5.4	5.7	5.0	7.6	6.5	4.7	3.3	5.5
	Mean	5.1	3.1	5.0	5.6	-	9.1	7.5	6.2	4.3	-

L.S.D. (p=0.05)

	Respiration	Fruit firmness
1. Treatment	0.37	0.44
2. Storage date	0.17	0.20
3. Treatment x date	-	0.88

4.3.1.2. Firmness:

Data presented in Table 14 shows that all the treatments improved the fruit firmness during storage, except that of T_1 (H_3BO_3) which was at par with that of control. Firmness was observed to be maximum (8.3 Kg) with T_{10} ($CaCl_2$ + MH) which was significantly superior to all other treatments. There was a sharp decline in the firmness from the first sampling date (4.3 Kg). Interaction due to treatments and storage dates was noticed to be significant. Maximum fruit pressure (10.2Kg) was recorded with T_{10} or T_2 on the date of harvest and the minimum under control on the last sampling date.

4.3.1.3. Total soluble solids:

Different treatments of mineral nutrients and growth regulators had no visible effect on the percentage of TSS in fruits (Table 15). During storage, however, it increased significantly, though the last three dates (10-30 days of storage) did not differ statistically from each other. Interaction effects were found to be non-significant.

4.3.1.4. Titratable acidity:

SADH (T_6) treated fruits exhibited the highest amount of titratable acid (0.68%) which did not differ statistically from T_1, T_4, T_7, T_9 and T_{16}. Acid content of the fruits declined sharply with each sampling date during storage. Interaction effects due to treatments and storage dates were found to be significant. The maximum acid content (0.90%) occurred in the fruits treated with GA (T_4) on the date of harvest and the minimum (0.59%) with T_{11}(KNO_3 + MH) on the last sampling date.

Table 15. Effect of nutrients and growth regulators on the quality attributes of New Castle apricot fruits stored at 0°C

Treatment No.	Treatment	Total soluble solids (%)					Acidity (%)					Pulp pH				
		Days after storage														
		0	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	Mean
T_1	H_3BO_3 (0.2%)	10.9	11.5	12.7	13.2	12.1	0.79	0.68	0.62	0.57	0.67	3.5	3.7	3.7	3.8	3.7
T_2	$CaCl_2$ (0.5%)	10.2	10.8	11.2	11.3	10.9	0.82	0.65	0.60	0.51	0.64	3.5	3.7	3.8	3.9	3.7
T_3	KNO_3 (0.5%)	11.8	12.2	12.4	12.0	12.1	0.80	0.60	0.58	0.54	0.63	3.6	3.7	3.8	3.9	3.7
T_4	GA (50 ppm)	10.5	11.2	12.2	12.3	11.6	0.90	0.63	0.60	0.57	0.67	3.6	3.7	3.7	3.9	3.7
T_5	MH (1000 ppm)	11.3	11.9	13.0	13.1	12.3	0.64	0.61	0.60	0.59	0.61	3.5	3.6	3.7	3.8	3.6
T_6	SADH (1000 ppm)	11.7	12.4	13.0	13.4	12.6	0.88	0.72	0.63	0.51	0.69	3.6	3.7	3.8	3.9	3.7
T_7	H_3BO_3 + GA	10.2	10.6	11.5	11.3	10.9	0.76	0.71	0.66	0.53	0.67	3.5	3.7	3.7	3.8	3.7
T_8	H_3BO_3+SADH	11.0	11.8	12.2	12.1	11.7	0.82	0.59	0.59	0.56	0.64	3.6	3.7	3.7	3.8	3.7
T_9	$CaCl_2$+GA	10.4	11.7	12.6	13.0	11.9	0.78	0.69	0.60	0.58	0.66	3.6	3.7	3.8	3.9	3.8
T_{10}	$CaCl_2$+MH	10.1	11.0	11.3	11.5	10.9	0.75	0.61	0.58	0.51	0.61	3.5	3.6	3.7	3.8	3.7
T_{11}	KNO_3+MH	11.3	11.7	12.7	13.0	12.2	0.74	0.61	0.57	0.46	0.59	3.6	3.7	3.8	3.8	3.7
T_{12}	KNO_3+SADH	11.4	12.2	13.2	13.5	12.6	0.75	0.71	0.60	0.49	0.64	3.5	3.6	3.6	3.7	3.6
T_{13}	H_3BO_3+$CaCl_2$+GA	10.9	11.5	12.2	12.3	11.7	0.72	0.68	0.60	0.57	0.64	3.4	3.5	3.7	3.8	3.6
T_{14}	H_3BO_3+SADH+GA	9.8	10.5	11.1	11.4	10.7	0.73	0.64	0.62	0.60	0.65	3.5	3.7	3.7	3.9	3.7
T_{15}	$CaCl_2$+GA+MH	10.9	12.0	11.6	11.5	11.5	0.67	0.64	0.61	0.54	0.62	3.6	3.7	3.9	3.9	3.8
T_{16}	$CaCl_2$+KNO_3+MH	10.2	10.7	11.7	11.4	11.0	0.87	0.65	0.61	0.50	0.66	3.5	3.6	3.7	3.8	3.7
T_{17}	KNO_3+MH+SADH	10.7	11.3	11.7	12.4	11.5	0.79	0.68	0.62	0.51	0.65	3.6	3.6	3.9	4.0	3.8
T_{18}	KNO_3+GA+SADH	10.1	10.7	11.7	11.5	11.0	0.82	0.63	0.60	0.56	0.65	3.5	3.6	3.6	3.7	3.6
T_{19}	Control	9.6	11.6	12.6	13.0	11.7	0.82	0.57	0.52	0.50	0.60	3.4	3.6	3.7	3.9	3.6
	Mean	10.7	11.4	12.1	12.3	-	0.78	0.65	0.60	0.54	-	3.5	3.6	3.7	3.8	-

L.S.D. ($p=0.05$)	Total soluble solids	Acidity	Pulp pH
Treatment	N.S.	0.02	0.06
Storage date	1.2	0.01	0.03
Treatment x date	N.S.	0.05	N.S.

4.3.1.5. Pulp pH:

Different treatments of mineral nutrients and growth regulators had distinct influence on the pulp pH. It was maximum (3.8) under T_{17}, T_{15}, T_{12}, T_{13} and T_{19}. The pH level of fruits rose significantly with enhanced storage period, and was maximum on the last sampling date. The interaction between treatments and storage dates was found to be non-significant.

4.3.2. Nutrient status:

4.3.2.1. Fruit nutrient status:

Apricot fruits treated with different nutrients and growth regulators at the pit hardening stage, were analysed for different nutrients at harvest and after 30 days of cold storage at 0^oC. The pooled means for two years are presented in Tables 16 and 17 and the year wise data given in Appendices 14, 15 and 16.

4.3.2.1.1. Nitrogen:

Different treatments showed their distinct influence on the level of N in the fruits. Maximum amount (215.2 mg 100 g^{-1}) occurred in the fruits treated with $CaCl_2$ (T_2) which was significantly superior to all other treatments. The lowest N (131.0 mg 100 g^{-1}) was noticed under T_{18} (KNO_3+GA+SADH), though the other treatments T_{19}, T_1, T_{11}, T_{17}, T_{16} and T_{15} did not differ significantly from it. Fruit N increased significantly during storage from 140.3 to 176.4 mg 100 g^{-1} of fresh fruit. Interaction effects were found to be significant. Maximum N occurred 220.8 mg 100 g^{-1} with T_2($CaCl_2$) on the date of harvest and the minimum (113.3 mg 100 g^{-1}) under control, also at harvest.

Table 16. *Effect of nutrients and growth regulators on the micronutrient status of New Castle apricot fruits stored at 0°C (mg 100 g^{-1} fresh weight)*

Treatment No.	Treatment	Nitrogen			Phosphorus			Potassium			Calcium			Magnesium		
		Days after storage														
		0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean
T_1	H_3BO_3(0.2%)	133.3	136.2	134.7	29.0	30.5	29.8	119.2	113.5	116.3	43.0	58.0	50.5	53.3	68.0	60.7
T_2	$CaCl_2$(0.5%)	220.8	209.6	215.2	29.3	30.8	30.1	112.8	133.5	123.2	48.7	54.0	51.3	57.2	76.2	66.7
T_3	KNO_3 (0.5%)	130.3	177.6	154.0	30.0	30.8	30.4	125.7	122.2	123.9	46.0	49.0	47.5	48.0	77.8	62.9
T_4	GA (50 ppm)	142.8	183.0	162.9	30.0	34.7	32.3	113.7	112.2	112.9	47.0	47.0	47.0	57.5	64.0	60.7
T_5	MH (1000 ppm)	123.0	196.2	159.6	28.3	27.7	28.0	97.5	115.3	106.4	51.0	50.0	50.5	61.2	62.0	61.6
T_6	SADH(1000 ppm)	158.8	173.8	166.3	23.5	26.0	24.7	121.3	133.7	127.5	48.0	44.0	46.0	50.5	59.8	55.2
T_7	H_3BO_3+GA	142.2	171.2	156.7	29.0	34.2	31.6	110.2	113.2	111.7	49.0	55.0	52.0	52.0	67.5	59.7
T_8	H_3BO_3+SADH	119.8	182.6	151.2	23.3	29.0	26.2	107.0	124.0	115.5	43.0	47.0	45.0	52.3	67.5	59.9
T_9	$CaCl_2$+GA	143.7	183.7	151.8	28.8	30.0	29.4	138.3	131.8	135.1	51.0	55.0	53.0	54.2	63.0	58.6
T_{10}	$CaCl_2$+MH	142.2	208.7	175.4	27.7	28.3	28.0	98.0	115.0	106.5	44.0	47.0	45.5	50.7	64.5	57.6
T_{11}	KNO_3+MH	116.0	162.7	139.3	30.0	29.5	29.7	98.5	108.3	103.4	49.0	48.0	48.5	56.2	62.8	59.5
T_{12}	KNO_3+SADH	145.7	190.5	168.1	30.5	33.0	31.7	100.3	118.2	109.2	48.0	43.0	45.5	52.5	60.2	56.3
T_{13}	H_3BO_3+$CaCl_2$+GA	145.0	191.8	168.4	29.8	33.3	31.6	108.0	120.0	114.0	49.0	48.0	48.5	57.7	67.0	62.3
T_{14}	H_3BO_3+SADH+GA	171.0	210.5	190.7	30.5	33.3	31.9	108.5	122.2	117.8	46.0	51.0	48.5	53.8	60.0	56.9
T_{15}	$CaCl_2$+GA+MH	123.5	170.0	146.7	33.0	29.0	31.0	104.2	110.5	104.8	48.0	53.0	50.5	48.8	64.0	56.4
T_{16}	$CaCl_2$+KNO_3+MH	143.0	183.0	163.0	27.5	25.7	26.6	94.0	130.3	112.2	47.0	48.0	47.5	56.3	69.2	62.7
T_{17}	KNO_3+MH+SADH	131.7	153.7	142.7	28.5	28.2	28.3	101.5	116.5	109.0	48.0	53.0	50.5	49.3	61.2	55.2
T_{18}	KNO_3+GA+SADH	119.0	143.0	131.0	30.0	31.6	30.8	99.0	121.0	110.0	43.0	54.0	48.5	53.5	61.2	57.3
T_{19}	Control	113.3	151.3	132.7	25.2	25.5	25.3	98.0	129.5	113.7	47.0	51.0	49.0	51.0	56.2	53.6
	Mean	140.3	176.4	-	28.6	29.2	-	108.2	120.6	-	46.0	50.0	-	53.5	64.8	-

L.S.D. (p=0.05)	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
Treatment	19.5	N.S.	9.7	N.S.	3.7
Storage date	6.3	N.S.	3.1	1.5	1.2
Treatment x date	27.6	N.S.	13.7	N.S.	5.3

4.3.2.1.2. Phosphorus:

Different chemical treatments as well as the storage dates failed to exert their influence on the level of P in the fruits. The interaction between treatments and storage dates was also observed to be non significant.

4.3.2.1.3. Potassium:

T_9 ($CaCl_2$+GA) was most effective in enhancing the K level of the fruits during storage (135.1 mg 100 g^{-1}), which was at par with T_6(SADH). The lowest level occurred with T_{11} (KNO_3+SADH) which did not differ significantly from T_{10}, T_{15}, T_5, T_{10}, T_{17}, T_{12}, T_8, T_7, T_{16} and T_{14} and these were markedly inferior to control. Rest all the treatments were at par with control. Data in Table 17 indicate that K level in fruits increased significantly during 30 days of storage. Interaction between treatments and storage dates was found to be significant. Maximum K in fruits was estimated (138.3 mg 100 g^{-1}) with T_9 ($CaCl_2$+GA) on the date of harvest and the minimum (98 mg 100 g^{-1}) with T_{10} ($CaCl_2$+MH) or control.

4.3.2.1.4. Calcium:

Data presented in Table 17 demonstrates that different treatments could not influence the accumulation of Ca in the fruits when compared with control. However, Ca content increased significantly during fruit storage. Interaction between treatments and storage periods was also found to be non-significant.

4.3.2.1.5. Magnesium:

Maximum accumulation of Mg (66.7 mg 100 g^{-1}) occurred in the fruits with T_2($CaCl_2$), which was significantly superior to all the other treatments and the minimum (53.6 mg 100 g^{-1})

was under control, which was at par with T_{17}, T_6, T_{12}, T_{15}, T_{14} and T_{18}. Mg level was noticed to increase considerably during storage. Interaction between treatments and the storage dates was found to be significant. Maximum level of fruit Mg (77.8 mg 100 g^{-1}) was recorded with T_3 (KNO_3) after 30 days of storage and the minimum (48 mg 100 g^{-1}) with the same treatment on the date of harvest.

4.3.2.1.6. Iron:

Application of $CaCl_2$(T_2) was the most effective in maintaining the maximum accumulation (0.82 mg 100 g^{-1}) of Fe, followed closely by T_1 and T_3, The lowest amount was noticed in the fruits treated with T_{18} (KNO_3+GA+SADH), followed by T_{14}, T_5, T_6, T_4, T_{19} and T_{16} which were at par with it. A sharp increase from 0.40 to 0.86 mg 100 g^{-1} of Fe occurred in the fruits when stored for 30 days at 0^oC. Interaction due to treatments and storage dates was found to be significant. Maximum concentration of Fe (1.07 mg 100 g^{-1}) was estimated with T_3 (KNO_3) after 30 days of storage and the minimum (0.33 mg 100 g^{-1}) with T_{14} (H_3BO_3+SADH+GA) on the date of harvest.

4.3.2.1.7. Copper:

$CaCl_2$ (T_2) treated fruits resulted in maximum accumulation of Cu (0.11 mg 100 g^{-1} followed closely by T_1, T_7, T_8, T_{10} and T_{18}. Minimum Cu (0.08 mg 100 g^{-1}) was estimated under T_{12} (KNO_3+SADH) and T_{15} ($CaCl_2$+GA+MH) which did not differ significantly from T_{12}, T_{13} and T_{19}. A considerable increase in the Cu component occurred when the fruits were stored for 30 days. The interaction was observed to be significant. Maximum amount of Cu was estimated (0.13 mg 100 g^{-1}) with T_2 and T_{11}

Table 17. Effect of nutrients and growth regulators on the micronutrient status of New Castle apricot fruits stored at $0^{o}C$ (mg 100^{-1} g fresh weight)

Treatment No.	Treatment	Iron			Copper			Zinc			Manganese		
		Days after storage											
		0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean
T_1	H_3BO_3(0.2%)	0.47	1.05	0.76	0.08	0.12	0.10	0.40	0.53	0.46	0.26	0.38	0.32
T_2	$CaCl_2$(0.5%)	0.67	0.97	0.82	0.08	0.13	0.11	0.31	0.49	0.40	0.26	0.40	0.33
T_3	KNO_3(0.5%)	0.44	1.07	0.76	0.07	0.11	0.09	0.34	0.43	0.39	0.26	0.37	0.31
T_4	GA (50 ppm)	0.39	0.73	0.56	0.08	0.11	0.09	0.43	0.54	0.48	0.26	0.38	0.32
T_5	MH (1000 ppm)	0.36	0.73	0.55	0.08	0.11	0.09	0.37	0.54	0.45	0.24	0.40	0.32
T_6	SADH(1000 ppm)	0.34	0.78	0.56	0.07	0.11	0.09	0.40	0.52	0.46	0.24	0.36	0.30
T_7	H_3BO_3+GA	0.40	0.79	0.60	0.09	0.11	0.10	0.47	0.48	0.39	0.25	0.36	0.30
T_8	H_3BO_3+SADH	0.35	0.89	0.62	0.08	0.13	0.10	0.39	0.53	0.46	0.24	0.37	0.30
T_9	$CaCl_2$+GA	0.50	0.76	0.63	0.08	0.12	0.09	0.34	0.42	0.38	0.27	0.41	0.34
T_{10}	$CaCl_2$+MH	0.38	0.91	0.65	0.08	0.12	0.10	0.43	0.54	0.48	0.23	0.35	0.29
T_{11}	KNO_3+MH	0.47	0.91	0.69	0.07	0.13	0.09	0.44	0.54	0.49	0.24	0.34	0.29
T_{12}	KNO_3+SADH	0.39	1.03	0.71	0.07	0.10	0.08	0.38	0.54	0.46	0.25	0.37	0.31
T_{13}	H_3BO_3+$CaCl_2$+GA	0.40	0.80	0.60	0.07	0.11	0.09	0.38	0.50	0.44	0.24	0.37	0.31
T_{14}	H_3BO_3+SADH+GA	0.33	0.74	0.53	0.08	0.11	0.09	0.37	0.45	0.41	0.23	0.36	0.30
T_{15}	$CaCl_2$+GA+MH	0.37	0.95	0.66	0.08	0.09	0.08	0.36	0.45	0.41	0.25	0.40	0.32
T_{16}	$CaCl_2$+KNO_3+MH	0.32	0.82	0.57	0.08	0.10	0.09	0.34	0.40	0.37	0.24	0.40	0.32
T_{17}	KNO_3+MH+SADH	0.73	0.87	0.62	0.08	0.10	0.09	0.38	0.44	0.41	0.23	0.38	0.31
T_{18}	KNO_3+GA+SADH	0.65	0.69	0.51	0.08	0.11	0.10	0.36	0.42	0.39	0.24	0.37	0.31
T_{19}	Control	0.37	0.77	0.57	0.07	0.11	0.09	0.25	0.38	0.31	0.22	0.34	0.28
	Mean	0.40	0.86	-	0.08	0.11	-	0.37	0.48	-	0.24	0.37	-
	L.S.D. (p=0.05)												
	1. Treatment		0.07			.005			0.02			0.02	
	2. Storage date		0.02			.002			0.01			0.01	
	3. Treatment x date		0.10			.008			0.03			N.S.	

after 30 days of storage and the minimum under T_3, T_{10}, T_{11}, T_{12} T_{13} and T_{19} on the harvest date.

4.3.2.1.8. Zinc:

All the treatments were effective in improving the Zn content of the fruits in comparison to control. Maximum accumulation (0.49 mg 100 g^{-1}) occurred with T_{11} (KNo_3+MH) which was at par with T_{10} and T_4. Zn level enhanced significantly from 0.37 to 0.48 mg 100 g^{-1} in fruits during storage. Interaction due to treatments and storage dates was also found to be significant. Zn accumulation was maximum (0.54 mg 100 g^{-1}) in the fruits under T_4, T_5, T_{10}, T_{11} and T_{12} after 30 days of storage, while the minimum (0.25 mg 100 g^{-1}) resulted under control on the date of harvest.

4.3.2.1.9. Manganese:

Different treatments of nutrients and growth regulators improved the Mn content of fruits in comparison to control, though T_{11} and T_{10} did not differ from it significantly. T_9 ($CaCl_2$+GA) was most effective in maintaining the Mn level followed closely by T_2 ($CaCl_2$). Interaction due to treatments and storage dates was, however, found to be non-significant.

4.3.2.2. Leaf nutrient status:

The data pertaining to the influence of nutrients and growth regulators on the leaf nutrient status are presented in Table 18. The year wise data figures in Appendix 17.

4.3.2.2.1. Nitrogen:

Out of 19 treatments, only T_{11} (KNO_3+MH) could raise the

Table 18. Effect of nutrients and growth regulators on the leaf nutrient status of New Castle apricot

Treatment No.	Treatment	N(%)	P(%)	K(%)	Ca(%)	Mg(%)	Fe(ppm)	Cu(ppm)	Zn(ppm)	Mn(ppm)
T_1	H_3BO_3(0.2%)	1.88	0.29	3.03	3.32	0.69	217.0	5.5	12.6	15.2
T_2	$CaCl_2$(0.5%)	1.65	0.26	3.50	3.04	0.76	293.0	6.1	14.4	22.4
T_3	KNO_3(0.5%)	1.73	0.25	3.12	3.31	0.70	234.5	6.0	14.7	22.5
T_4	GA (50 ppm)	1.65	0.34	3.42	3.42	0.68	219.5	5.6	15.9	20.4
T_5	MH (1000 ppm)	1.80	0.25	2.68	3.26	0.74	181.0	6.7	11.8	13.7
T_6	SADH(1000 ppm)	1.57	0.29	3.44	3.07	0.70	190.5	6.6	13.2	17.8
T_7	H_3BO_3+GA	1.71	0.29	3.63	2.72	0.70	250.0	6.8	15.3	20.3
T_8	H_3BO_3+SADH	1.70	0.26	3.05	3.44	0.74	226.5	7.1	13.9	20.1
T_9	$CaCl_2$+GA	1.68	0.27	3.08	2.76	0.65	268.0	5.4	14.8	21.3
T_{10}	$CaCl_2$+MH	1.56	0.27	2.71	3.13	0.77	269.5	7.0	14.6	23.8
T_{11}	KNO_3+MH	2.15	0.27	2.68	2.46	0.74	161.0	7.2	13.8	21.3
T_{12}	KNO_3+SADH	1.58	0.28	2.83	2.82	0.71	233.0	7.4	11.4	15.1
T_{13}	H_3BO_3+$CaCl_2$+GA	1.89	0.27	3.37	3.48	0.71	268.0	6.5	13.8	15.6
T_{14}	H_3BO_3+SADH+GA	1.62	0.26	3.41	3.28	0.74	190.5	7.7	12.5	13.7
T_{15}	$CaCl_2$+GA+MH	1.60	0.25	3.04	2.66	0.66	220.5	5.6	12.8	15.2
T_{16}	$CaCl_2$+KNO_3+MH	1.61	0.26	2.72	3.00	0.78	209.5	5.9	13.1	18.5
T_{17}	KNO_3+MH+SADH	1.41	0.25	3.26	2.56	0.71	205.0	8.7	12.2	14.7
T_{18}	KNO_3+GA+SADH	1.81	0.28	3.53	2.92	0.85	202.5	5.4	16.3	24.4
T_{19}	Control	1.92	0.19	2.62	2.98	0.79	238.0	6.5	16.8	33.0
	L.S.D.(p=0.05)	0.15	0.02	0.28	0.27	0.07	31.6	0.5	1.0	5.0

leaf N significantly (2.15%) in comparison to control (1.92%). The other treatments proved inferior and had adverse effect on the leaf N composition. The minimum N level (1.41%) was noticed with T_{17} (KNO_3+MH+SADH).

4.3.2.2.2. Phosphorus:

All the treatments proved significantly superior to control in improving the leaf P. The minimum P (0.19%) was estimated under control and the maximum (0.34%) under T_4(GA), which was significantly higher than all other treatments.

4.3.2.2.3. Potassium:

K level in the apricot leaves increased with all the treatments, but T_{11}, T_5, T_{10}, T_{16} and T_{12} did not differ significantly from that of control. The highest level of K (3.63%) resulted with T_7 (H_3BO_3+GA) followed by T_{18}, T_2, T_6, T_4, T_{13} and T_{14}.

4.3.2.2.4. Calcium:

Leaf Ca was minimum (2.46%) with T_{11}(KNo_3+MH) which was at par with T_{17}, T_{15} and T_7. The maximum value (3.48%) was recorded with T_{13}(H_3BO_3+$CaCl_2$+GA) being at par with T_8, T_4, T_1 T_3, T_{14} and T_5 and significantly superior to rest of the treatments.

4.3.2.2.5. Magnesium:

Different treatments of nutrients and growth regulators reduced the level of leaf Mg. A slightly higher value (0.85%) estimated under T_{18}, did not differ statistically from control. The lowest Mg (0.65%) was recorded under T_9 ($CaCl_2$+GA) which remained at par with T_{15}, T_4, T_1, T_7, T_6, T_3, T_{17}, T_{13} and T_{12}.

4.3.2.2.6. Iron:

The maximum level of leaf Fe (293 ppm) was recorded under T_2 ($CaCl_2$) which was at par with T_{10}, T_9 and T_{13}. Rest of all the treatments lowered the leaf Fe in comparison to control, but T_7 had slightly but not significantly higher values.

4.3.2.2.7. Copper:

The highest level of leaf Cu (8.7 ppm) was found with T_{17} (KNO_3+MH+SADH) which was significantly superior to all the other treatments. T_{14}, T_{12}, T_{11} and T_8 were also effective in raising the leaf Cu in comparison to control. The lowest concentration (5.4 ppm) was, however, estimated under T_9 or T_{18} followed by T_1, T_4, T_{15}, T_{16} and T_3 which were significantly inferior to control.

4.3.2.2.8. Zinc:

Zn level in apricot leaves decreased with different treatments applied. The lowest level (11.4 ppm) was recorded with T_{12}(KNO_3 + SADH) which was at par with T_5 and T_{17} and the highest (16.8 ppm) under control.

4.3.2.2.9. Manganese:

A reduction in Mn level due to application of nutrients and growth regulators was noticed. The maximum level (33.0 ppm) recorded under control was statistically superior to all the treatments. The lowest value of leaf Mn (13.7 ppm) was recorded with T_{14} and T_5 which was at par with T_{17}, T_{12}, T_{15}, T_1 and T_6.

CHAPTER V

DISCUSSION

DISCUSSION

Optimum nutrition is the most important factor governing growth and fruitfulness of the plants. Amongst the nutrients, N is the most vital and is involved in all the processes associated with protoplasmic and nuclear activities, enzymic reactions and photosynthesis, since it is a constituent of amino acids, proteins, nucleic acid, enzymes and chlorophyll. Thus, sufficient N supply which can better be accomplished through soil and foliar feeding, must be ensured. Urea is eminently suited for foliar feeding. Thus, the first object of the present studies was to standardise the basic dose of N, supplemented with foliar urea sprays during spring or at pre-fall stage, for full bearing apricot plants, so that enough yield and tree nutrient status is maintained. Since fruits have an entirely different pattern of nutrient uptake and distinctly different requirements of essential nutrients and metabolites, which are mediated by hormone directed transport, the study on the pre-harvest sprays of some mineral nutrients and growth regulators, to see their influence on the storage behaviour of apricot cv. New Castle was taken up, which otherwise is not well adopted even for short term storage. The results thus obtained on different aspects are discussed below:

5.1. Effect of soil and foliar application of urea on the tree productivity and nutrient status

5.1.1. Tree productivity

Increased N application through soil and foliar urea sprays during spring increased the annual trunk girth, shoot growth and yield of apricot trees. It seems appropriate to discuss the influence of N on the tree productivity and to differentiate between source sink and morphological aspects of the problem. The source capacity of the plant is primarily determined by leaf area, rate of photosynthesis, respiration and amino acid synthesis (Novoa and Loomis, 1981). Leaf area is the main factor in biomass formation and it varies with nutrient supply. The amount of foliage has been reported to increase with N fertilization (Ritter, 1956; Soloveva, 1968). The rate of photosynthesis is also influenced by N nutrition. Lysenko et al. (1974) observed enhanced rate of photosynthesis in trees receiving NPK. Hewitt and Smith (1975) opined that the limitation of cell division and expansion under conditions of deficient N supply and consequent reduction in size of morphological parts are the result of decreased protein and RNA synthesis, and it also decreases the net assimilation rate. There are conflicting reports in the literature regarding the relative efficiency of soil and/or foliar N for promoting tree growth and yield. Increased tree growth and yield in Santa Rosa plum with soil and foliar applied urea during spring have been reported by Badyal (1980). Similar beneficial effects of foliar urea sprays with soil applications were observed by Rawat (1974), but opined that when the leaf N content raised very high as a result of such fertilization, the tree growth declined. He concluded that the leaf N percentages of 2.49, 2.58 and 2.72 were critical for shoot growth, leaf area and internodal length respectively in Santa Rosa plum. Fisher and Cook (1950) indicated equal effectiveness of foliar and soil N dressings. Later Fisher (1952) reported that spring urea sprays resulted in smaller increases in trunk girth than did soil N dressings. Similar were the observations of Forshey (1963). Fisher (1952) related this to a decrease in leaf N during summer in foliar treated trees and demonstrated that urea sprays had only a temporary effect on leaf N status. From the results of Fisher (1952) and Forshey (1963), general conclusion emerges that spring urea sprays might not be adequate to maintain tree vigour unless the tree have sufficient N reserves, or the soil can provide some of the treés N needs. Fruit set retention and yield were markedly enhanced with pre-fall urea sprays in the present study. Oland (1960) recognised the normal autumnal migration of leaf N to storage tissues in the tree. He suggested that N might be efficiently introduced into the tree by post-harvest sprays and he found that higher concentrations of urea were readily absorbed by apple leaves. Titus and Kang (1982) opined that pre-fall urea sprays increased the N reserves in the plant, due to absorption and storage of N, which influences the tree growth and development during early spring under temperate zone orchards and increases the percentage of flowers that set fruit. Quast (1979) was of the opinion that enhanced yield in apple could be obtained with post-harvest urea sprays, when the trees were low in N.

5.1.2. Chlorophyll and amino N in leaves

N applications through soil as well as foliage raised the chlorophyll and amino N contents of the apricot leaves. Similar beneficial effects were also obtained with the pre-fall spray of urea. This could be attributed to increased N absorption, that forms a basic constituent of both chlorophyll and amino N. Though no report is available about the influence of N fertilization on the amino N content in different temperate fruits, the findings get support from Ritter (1956) who observed better development of peach leaves with more intense green colour as a result of increased N applications. Increased chlorophyll contents in apple leaves have been reported with N fertilizers (Weissenborn, 1961; Kovalenko, 1973; Lysenko et al. 1974 and Salman, 1975).

5.1.3. Fruit quality

Fruit quality in general, improved through N application though soil or with supplemented urea sprays applied during spring. On the other hand pre-fall sprays of urea were found to be ineffective in improving the general fruit quality.

Fruit weight, firmness, soluble solids, acid content and soluble protein increased while the pulp pH remained unaltered with enhanced N fertilization through soil and urea sprays of spring. N is extremely mobile and developing apricot fruit being a strong metabolic sink, can accumulate various organic and inorganic assimilates more efficiently (Smith, 1962), thus increased size and soluble solids are expected. Sharma et al. (1979) also reported an increased fruit size in peaches with increased level of N application, whereas Schneider and McClung (1957) and Ballinger et al. (1963) could not observe increase in peach fruit size with the increasing N dose. Increased firmness and acid content may be the result of slightly delayed maturity through N supply. Vang Petersen et al. (1977) reported that urea applications delayed maturity and increased the number of green fruits at harvest. Increased acidity with increased level of N is also understandable due to increased synthesis of amino acids, proteins and other metabolites, and their consequent translocation to the fruits. These results are in agreement with those of Bhutani et al. (1983) and Chandel (1985) who reported an increase in fruit acidity with N applications in plum and apricot. Increased amount of soluble protein with increased N rate have been reported in plum (Bhutani et al. 1983), and through foliar urea sprays in apple (Dhuria, 1967). Increased fruit protein with N applications is attributed to increased N supply to the fruit which accelerates protein synthesis. Improved quality of fruits with enhanced N rates has been reported by Ritter (1961), Bajwa and Mishra (1970), Rawat (1974) and Bhatia (1982) in peach, apricot and plum fruits. Badyal (1980) observed that better fruit quality could be obtained in Santa Rosa plum, when a part of full N dose was applied through foliar urea sprays during springs. Failure of the pre-fall sprays to influence the fruit quality could be attributed to the following facts. Leaf N is re-absorbed by the trees before abscission and this N is stored in different overwintering parts of the tree, which is recycled and utilised at the on-set of bud burst and developments thereafter during spring growth (Titus and Kang, 1982), when the conditions for the root uptake are mostly not optimal and the synthetic surface is not available in the temperate/sub-temperate zone orchards. Since the stored N is utilised during this early stage, fruit quality may not be affected, since its development continues till harvest and many factors start operating in between. However, no published work is available pertaining to this aspect in stone fruits.

5.1.4. Tree nutrient status

The present studies have shown that N level in leaves, shoots and fruits increased with increased soil and foliar N supply during spring. Pre-fall sprays of urea also raised the N status of the leaves and shoots. The increase in N in different tissues was expected because of increase in the N level of the soil of root zone. The foliage of the apricot may absorb good amount of urea from an aqueous solution, which in turn may increase the N status of the tree measurably. Significant increase in leaf N with increased N supply has been reported by Albigo et al. (1966) and Chandel (1985) in apricot. Significantly enhanced leaf N in plum through soil and foliar N applications has been reported by Abedlal and ElTomi (1965), Rawat (1974), Badyal (1980) and Bhatia (1982). Leece and Dirou (1979) suggested a combination of soil and foliar N as a means to maximise the tree N status of prunes. Vitanova (1981) concluded that N application had a direct influence on the contents of plum shoots and branches. Increased level of N in leaves and storage tissues through post harvest urea sprays during September-October were reported for the first time in apple by Oland (1966) and similar observations were recorded by Ludders and Bunemann (1972). O'Kennedy et al. (1975) and Swietlik and Slowik (1981) in apple, pear and cherry.

A reduction in the P content of the leaves with the application of N fertilizers has been reported by various workers in stone fruits (Zvara, 1967; Stoilov and Vitanova, 1979; Rawat, 1974; Badyal, 1980; Khokhar, 1984 and Chandel, 1985). However, in the present study, it remained unaltered with soil or foliar urea applications in case of apricot leaves and fruits, Though its status was increased in shoots. Pre-fall urea sprays had practically no influence on the P level in any of the 3 tissues studied. This finds support from Leece (1976) and Janjic (1979) who reported similar findings in peach leaves with soil and foliar applications of urea during spring. Similar was the report of Wendt (1971) in case of apple leaves and shoots. Urea sprays on senescing leaves have also been reported to increase the mineral contents of the woody parts of apple (Ludders and Bunemann, 1970). Increased P level in the shoots might be due to the increased back flow of the nutrient from the leaves to the storage organs during cessation of growth and onset of senescence alongwith the selective accumulation of the nutrients.

Trees receiving low level of N had the highest leaf K. Fruit K remained unaffected with soil or foliar applications during spring, but pre-fall sprays reduced it considerably. In case of shoot, raised N applications above 400 g through soil or with foliage at spring reduced the K content considerably. However, pre-fall sprays of urea were effective in enhancing the shoot K in apricot. The existance of antagonism between N and K could account for depressed K level in the leaf or fruit (Ballinger et al. 1966). Ritter (1956) concluded that in peach leaves, high N and high K contents are never possible together because of the antagonistic relation. Similar were the results of Zvara (1967), Leece (1976), Badyal (1980), Khokhar (1984) and Chandel (1985) in leaves of different stone fruits. It seems that an optimum N supply during spring is needed for maintaining the K content of the shoots and its excess would prove antagonistic. Wendt (1971) demonstrated that increased N supply reduced the K level of all the perinnial apple organs. An increased level of shoot K due to pre-fall sprays may be due to increased back flow of the nutrient during senescence after the cessation of vegetative growth. Increased level of shoot K with urea sprays applied during August-September or October-November, in apple has been reported by Ludders and Bunemann (1970).

There was no particular trend of leaf and shoot Ca for any of the soil treatments. However, in fruits it decreased with enhanced N rate. Foliar applications of urea during spring proved ineffective in raising Ca level in any of the three plant tissues studied, but pre-fall sprays could enhance its level in leaves. Failure of N applications to raise the Ca level in leaves and shoots may be related to the slow mobility of Ca in plant tissues (Norton and Wittwer, 1963) and its reduced amount in the fruits may be the result of increased fruit size coupled with lesser mobility of the element. Rawat (1974) demonstrated that the total sum of Ca + Mg + K decreased in the plum leaves with increased N supply, specially with foliar urea sprays. However, Khokhar (1984) found an increased amount of Ca in plum leaves and fruits with enhanced N rates. Pre-fall sprays of urea might have increased the Ca mobility sufficiently during senescence, thus increasing its Ca level later on.

Mg level increased in different plant tissues with increased N applications through soil or spring sprays but the third spray resulted in reduced Mg level. However, urea sprays applied on the senescing leaves were effective in case of leaves only. A positive relation between soil N and Mg content of plum leaves has been reported by Stoilov and Vitanova (1979). Khokhar (1984) and Chandel (1985) reported similar results in plum and apricot. The failure of the third spring spray could be the result of dilution factor due to increased leaf size, since this spray was applied when the fruits were sufficiently, large and mature at this stage and utilization of added foliar N for leaf development was possible. Increased leaf N due to pre-fall sprays, might have raised the mobility of Mg also, thus increasing its amount in the leaves during the next season.

Accumulation of Fe in leaves and shoots decreased, but in fruits it increased with increased N supply through soil and foliage sprays during spring. However, with pre-fall sprays, it declined in all the three tissues studied. Reduction of Fe in the present studies could be attributed to enhanced vegetative growth due to raised N. Increased Fe in the fruits, with increased N supply during springs, may be due to increased sink value and selective accumulation of minerals. Bhatia (1982) reported similar results in plum leaves with increased N rate. Jancic (1979) reported that Fe level remained unaffected in peach leaves and similar were the findings of Wendt (1971) in apple shoots. Khokhar (1984) observed similar findings in plum fruits, with raised N applications.

Cu level increased in the leaves with increased N dose upto 400 g coupled with two spring sprays, but the higher applications had a deterimental effect, which could be attributed to the increased vegetative growth, thus the dilution factor might have been operative. Leece (1976) observed increased uptake of Cu in leaves with increased N supply. In case of shoots Cu accumulation increased with increased N fertilization. Ohme and Ludders (1983) opined that N applications had a marked influence on the mineral contents of apple shoots. Cu accumulation in fruits was not influenced with N fertilization through soil or foliage. Pre-fall sprays of urea could raise the leaf Cu, but were ineffective in case of shoots or fruits. Mobility of Cu might have been increased in leaves due to increased N reserves in the overwintering organs and then its recycling as a result of pre - winter sprays. Increased accumulation of Cu in different plant tissues as a result of increased N rate , could be related to the acid forming property of the N fertilizer, thus enhancing the availability of Cu.

The concentration of Zn in apricot leaves increased with increased N fertilization and foliar urea sprays applied during spring or at pre-fall stage which could also be associated with the lowered soil pH due to N. This also finds support from the observations of Leece (1976) in peach and Badyal (1980) in plum. In case of shoots, increased N supply through soil or spring sprays raised its Zn content, but differences due to pre-fall urea sprays were not significant. Wendt (1971) noticed that N applications raised the Zn level in all the perinnial organs as well as leaves of apple. However, in apricot fruits, Zn accumulation decreased with raised N applications through soil or spring sprays, though the pre-fall sprays could raise it significantly. Lowered Zn in fruits with spring applications could be related to the dilution effect due to the increased fruit size as a result of higher N rates. Khokhar (1984) recorded similar observations in plum with N fertilization. Pre-fall urea sprays might have increased the accumulation of Zn in the storage organs, which later on enhanced its mobilization to the fruits in the coming season.

Mn content of apricot leaves was not much affected with increased N rates, but the highest number of spring foliar sprays, lowered its accumulation, which suggests that excessive spraying resulted in increased foliar growth, thus resulted in its dilution. In case of apricot shoots, Mn component declined with enhanced N supply during spring through soil or foliage, which could also be due to the increased vegetative growth. However, in case of fruits, increased N through soil or foliage in spring improved the Mn accumulation. Khokhar (1984) observed similar results in plum fruits with increased N fertilization. Mn accumulation did not alter significantly in different tissues studied, with urea sprays applied on the senescing leaves.

3.1.5. Soil properties

Soil pH was lowest in the surface soil and it increased with increased soil depth. This could be due to the increased acidification of the surface soil resulting from the conversion of NH_4^+ released during ammonification to nitrate N, which releases the H^+ ions. On the other hand soil organic C and the availability of different nutrients was maximum on the surface soil (0-15 cm) which decreased with increased soil depth. Several workers have reported it (Chawla, 1969; Sankhyan, 1972, Ganai et al. 1982, Bhatia, 1982), possibly due to less weathering in deeper soil segments and decreased pH of the surface soil due to increased N supply, which tend to enhance the availability of various nutrients.

The application of N fertilizers reduced the pH of the soil due to release of H^+ ions during nitrification as discussed earlier. Similar reduction in the soil pH due to urea fertilizer has also been reported by Venkata Rao et al. (1972), Lekhova (1975), Bhatia (1982) and Khokhar (1984).

A marked increase in the organic C content of the soil was recorded with increased N supply. It is due to the fact that N fertilizer stimulated the activity of microorganisms resulting in rapid decomposition of organic residues, thereby increasing the organic C content of the soil. The increase in leaf size and number, due to N application yielded heavy turn over of the biomass during leaf fall, which on decomposition add to the organic matter of the soil. Similar were the findings of Bhatia (1982), Khokhar (1984) and Chandel (1985).

Available N in the soil increased with increased level of N supply possibly as a result of direct contribution by the fertilizer and due to stimulation in the decomposition of nitrogenous materials, with enhanced microbial activity. The present findings are in agreement with Vitanova (1973), Bhatia (1982), Khokhar (1984) and Chandel (1985) who observed that N fertilizers caused appreciable increase in the N available to plants.

Available P in the soil increased with increased N dose upto 400 g only. The highest dose of 600 g decreased the P availability considerably. The reduction of P with the highest dose may be due to its fixation by Fe and Al (Sharma et al. 1956) which becomes more effective with increased soil acidification due to higher N rates. Chandel (1985) reported that available P in the apricot orchard soil decreased with N fertilization. Bhatia (1982) observed the soil P to remain unaffected due to N fertilization. However, Khokhar (1984) noticed the availability of P to increase with increased N supply on Santa Rosa plum orchard.

Urea application in general, increased the available K and exchangeable Mg while Ca remained almost unchanged. More acidic soil reaction due to urea application might have favoured solubilization of K, Mg and other cations (Kanwar, 1976). Cumings (1965) have shown that availability of Mg increases with the availability of K, Naik and Balal (1968) reported that increased N supply increased the soil K availability. Similar observations have been reported by Badyal (1980), Bhatia (1982) and Chandel (1985). Neilson et al. (1982) was of the opinion that the soils with lower pH resulted in lower exchangeable Ca. Khokhar (1984) reported similar observations regarding exchangeable Ca with increased N rates in plum orchard.

The present studies reveal that urea applications generally increased the availability of DTPA extractable micronutrients, though significant increases in case of Fe were not observed. Low pH, resulting with increased urea supply seems to be the main reason for enhancing the levels of these nutrients on the soil. Vitanova (1974) reported that with decreased pH, resulting from N applications, the level of available and active Mn content may rise considerably in plum orchards, but not to the toxic level. The uptake of Cu and Zn may be affected by pH, organic matter and the metalic ions present in the soil. The presence of organic matter which is promoted by organic as well as inorganic N fertilizers, may promote the availability of Zn presumably by complexing the substances that fix Zn (Kanwar,1976). The present findings are in line with Dev and Mann (1972) and Badyal (1980) who observed that increased doses of N increased the availability of Zn in the soil.

Urea N exhibited a pronounced effect on the microbial activity which continued at an enhanced rate after N application. Bacterial and Fungi populations, stimulated with urea fertilization, continued to rise upto 45 days, while in case of actinomycetes the maximum population appeared just within 15 days, and then declined. The addition of fertilizer would increase the microbial population by improving the nutrient status as well as physical and chemical conditions of the soil. Vijay Kumar (1978) observed the best growth of Fusarium equisetti on sodium and ammonium nitrate out of 10 N sources studied. Venkata Rao et al. (1972) reported that increased N dose generally increased the population of bacteria and fungi, but inhibited that of Azotobacter. Bhutani and Bhatia (1984) reported that increased N doses had no effect on bacteria but stimulated actinomycetes and Fungi population in the plum orchard. Beneficial effects of N fertilization in augmenting the population of micro-organisms have been reported by Khokhar (1984).

5.2. Effect of pre-harvest sprays of mineral nutrients and growth regulators on the storage behaviour and nutrient status of New Castle apricot

5.2.1. Fruit characters

The lowest rate of respiration was measured in the fruits treated with T_{10}($CaCl_2$ + MH) followed by T_2 ($CaCl_2$) and T_{16}($CaCl_2$ + MH + KNO_3). Faust and Shear (1972) reported an inverse relation between respiration and the Ca content of the fruits. Faust (1975) opined that at low Ca, fruit respiration is high and senescence is eminent while sufficient Ca may overcome N-induced respiration, protects the membranes from disorganisation which delays senescence. A sudden decline in the rate of respiration occurred during the first 10 days of storage. Thereafter, with subsequent storage, it rose upto 30 days of storage. This could be due to the supression of enzymic activities in the low temperature to which the fruits were subjected suddenly. Then with subsequent storage, the activity picked up again resulting in increased respiration. Similar observations were recorded by Sachdeva (1985) with apple storage.

The degree of firmness is fairly a good index of storability of the fruits. All the treatments improved and maintained the fruit firmness during storage. $CaCl_2$ + MH (T_{10}) was the most effective treatment followed by T_2($CaCl_2$), T_5(MH) and T_{16}($CaCl_2$+MH+KNO_3). Ca has been shown to preserve the cellular organisation and if deficient will induce disintegration of cytoplasmic membranes. It is associated with pectic substances in the middle lamella and may prevent disorders merely by strengthening structural components of the cell (Shear and Faust, 1975). Increased Ca induced firmness in apple have been reported by Mason (1976), Hartman (1983) and Sachdeva (1985). MH has also been reported to retard fruit softening in apple (Smock et al. 1951) and can inhibit the ripening effects of certain auxins (Smock et al. 1952). Fruit firmness declined continuously during storage.

Different treatments applied had no visible effect on the total soluble solids in apricot fruits. However, a gradual increase in its percentage was noticed during storage. Availability of total soluble solids in fruits may be associated with increased translocation of organic assimilates from other vegetative plant parts (Hansen, 1967) and accumulation upto the harvest time depends upon the strength of the sink created. Thus the effects due to different treatments were not expressed. Increase in soluble solids during storage may result from an increased concentration of organic solutes as a consequence of water loss (Ryall and Pentzer, 1974). Increased TSS during storage have earlier been reported by Kishore (1974), Maini et al. (1982) and Sachdeva (1985).

SADH (T_6) exhibited its superiority in maintaining the highest amount of acid in the fruits and the other treatments found impressive were T_4(GA), T_1(H_3BO_3), T_7(H_3BO_3+GA) and T_9 ($CaCl_2$+GA). An increase in the acid contents of fruits with SADH sprays have been reported by Arora et al. (1973) in plum and Hricovsky and Kosova (1980) in apricot and peach fruits. GA has also been shown to increase the acid contents in Santa Rosa plum by Thakur (1984). Chopra et al. (1982) found H_3BO_3 to raise the acid contents of peach fruits. Acid percentage of fruits was noticed to decline during storage. This may be attributed to increased rate of respiration and other bio-degradable reactions. Fruit cells are able to use organic acids as respiratory substractes, resulting in their lowered amount during ripening and storage (Ulrich, 1974). A gradual decline in acidity during apple storage has also been observed by Kaul (1979), Lal (1982) and Sachdeva (1985).

5.2.2. Fruit nutrient status

The maximum percentage of N occurred in the fruits treated with $CaCl_2$(T_2), which was superior to all other treatments. The lowest fruit N was noticed under control and different treatments varied enough in their influence. This may be due to difference in the sink strength created by treated fruits (Hansen, 1967). $CaCl_2$ treatment must have influenced through its effect on the cell structure and thus enabling the fruits to create the best sink for N and other elements.

P level in apricot fruits did not alter with different treatments or with the storage time. Movement of solutes takes place from lower sink to the higher one (Kramer and Kozlowski, 1979), and apricot fruit is known to be a stronger sink, due to which differential response to growth regulators and mineral nutrients could not be obtained.

K level also increased during storage and T_9($CaCl_2$+GA) was the most effective treatment that could raise fruit K in comparison to control. This could be due to the influence of Ca on the selective permeability of the cell membranes coupled with the regulatory influence of the gibberellin. Failure of the other treatments to exert their individuality could mainly be due to the distinct nature of the apricot fruits that behave as a very strong sink for different solutes. Thakur (1984) did not find any response of different growth regulators on the K level of plum fruits and opined that seeds in the plum fruit might have produced enough hormones that mobilised ions into the fruit and hence added GA proved to be of no use.

Ca, Mg, and Fe also increased during storage, but different treatments applied had no significant influence, Bangerth (1976) observed that endogenous auxins probably, produced by the seeds play a significant role in the translocation of minerals into the fruits. Similar results in Santa Rosa plum have been reported by Thakur (1984) and in case of New Castle apricot by Pandita (1983)

Considerable increase in Cu, Zn and Mn levels occurred in the fruits due to different treatments and the storage period. $CaCl_2$ (T_2) treated fruits resulted in maximum accumulation of Cu and Mn level was maximum with T_9($CaCl_2$+GA) while in case of Zn, it was with T_{11}(KNO_3+MH). Mineral nutrients in general, were more effective, perhaps due to their inter-relation as shown by Smith (1966) while response to growth regulators may be due to the physiological sink (Kramer and Kozlowski, 1979).

Different nutrients increased considerably during storage, which could be attributed to the reduced fruit weight occurring mainly due to water loss and partially due to increased respiration (Ryall and Pentzer, 1974).

5.2.3. Leaf nutrient status

Different treatments of nutrients, growth regulators and their combinations had their distinct influence on the nutrient status of the apricot leaves. Out of the 19 treatments, only T_{11} (KNO_3+MH) could raise the leaf N significantly. MH have been reported to supress the vegetative growth in apricots and peaches (Okasha and Crane, 1963) and in the present case, increased, leaf N might be the combined influence of added nitrate ions and supressed vegetative growth.

P content of the leaves increased with all the treatments applied and T_4(GA) was the most effective followed by T_1(H_3BO_3) and T_6(SADH). GA has been reported to increase the leaf P in sour cherry (Wierszyllowski and Bojar, 1976). Hatch and Powell (1971) were able to direct the transport of labelled P in any direction within apple seedlings, depending upon the area treated with gibberellins. Boron have been observed to enhance the leaf P in apple (Jovanovic, 1972) and SADH in apricot (Pandita, 1983). Composition of leaf nutrient level of plant in response to SADH has been associated with its regulatory role on mineral uptake and translocation aided by its property of rapid mobility (Martin and Williams, 1966).

Different treatments of nutrients and growth regulators enhanced the leaf K in comparison to control. Higher amount of K was obtained with $T_7(H_3BO_3$+GA), $T_{18}(KNO_3$+GA+SADH), $T_2(CaCl_2)$, T_6 (SADH), T_4(GA) and $T_{14}(H_3BO_3$+SADH+GA) which were all at par. Hulme (1970) suggested that growth substances may stimulate some aspects of metabolic activity which establishes or enhances the physiological sink. SADH is considered to be highly versatile and potent by several workers in regulating the influx of nutrients and the foliar K level of treated plants (Arora et al. 1973; Sharma and Singh, 1974 and Gil Albert, 1978). Belyaev and Chekan (1978) reported that spraying B with NPK stimulated the tree growth and accumulation of leaf nutrients in plum. $CaCl_2$ sprays in the present study also maintained a higher level of leaf K, which could be attributed to its influence on the permeability of the cell membranes;

Various mineral nutrients and growth regulators influenced the leaf Ca considerably. Higher Ca level was observed with T_{13} (H_3BO_3+GA+$CaCl_2$), $T_8(H_3BO_3$+SADH), T_4(GA), $T_1(H_3BO_3)$, $T_4(H_3BO_3$+SADH+GA) and T_5(MH) and the lowest level occurred with $T_{11}(KNO_3$+MH). Wieneke et. al. (1971) demonstrated the regulatory role of some hormones on the mobilisation of Ca in the leaf using radio active Ca and concluded that its accumulation is mediated through increased uptake and translocation. Ca is also known to be greatly regulated by its interaction with other elements like Mg, K and N (Smith, 1966). Dixon et al. (1973) demonstrated that Ca in apple leaves could be raised significantly when B was sprayed with Ca in comparison to Ca alone.

Leaf Mg depressed with different treatments and was lowest under T_9($CaCl_2$+GA). Dixon et al. (1973) did not find any influence of Ca or B sprays on the Mg level of apple leaves. Pandita (1983) and Thakur (1984) reported that different growth regulators did not have any influence on the Mg level of apricot and plum leaves. Sharma and Singh (1974) recorded a significant depression of Mg component in pear leaves with SADH application. Luckwill (1973) concluded that concentration and time of application, stage of plant growth and the plant species greatly govern the response to plant regulators. Enhancement of physiological sink in response to plant regulators, may or may not act for all organic and inorganic materials with the same specificity (Hulme, 1970).

Trees sprayed with $CaCl_2$ recovered the maximum leaf Fe, which was superior to all other treatments. Ca has been shown to preserve the cellular organisation (Shear and Faust, 1975), and its role in selective permeability can not be ruled out.

The highest level of leaf Cu was found in the trees sprayed with T_{17}(KNO_3+MH+SADH) followed by T_{14}, T_{12}, T_{11} and T_8 which were superior to control. Sharma and Singh (1979) reported increased Cu in pear leaves with SADH sprays. Differential response of growth regulators to different minerals may be related to their mobilisation effects (Luckwill, 1973). It was interesting to note that $CaCl_2$ individually or in different combinations, reduced the leaf Cu content. Ca acts through its influence on cell membranes and effect the selectivity of different elements.

Zn and Mn accumulation in the leaves was observed to decrease by all the treatments applied. It seems that these failed to build up the necessary sink strength of leaves and accumulate these elements. GA has been reported to be ineffective in causing any alteration in foliage Zn or Mn levels in Santa Rosa plum by Thakur (1984). Sharma and Singh (1974) did not find SADH to be effective in altering the Zn level, but it raised the Mn content in pear leaves. Ashby and Looney (1968) also reported it to be ineffective in altering the Zn and Mn in apple leaves. However, Arora et al. (1973) found both Zn and Mn to increase in plum leaves with SADH ~~leaves~~. Pandita (1983) and Thakur (1984) found Zn level in stone fruits to rise with SADH sprays. Jovanovic (1972) observed B applied as borax in apple to raise the Mn status of the leaves. The discrepency in effectiveness of various growth regulators and mineral nutrients on the foliage micro-nutrients needs further investigations.

CHAPTER VI

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

The present investigations on the nutritional requirements and storage behaviour of New Castle apricot were carried out at Fruit Research Station, Kandaghat. It comprised of 3 experiments. The first one aimed at standardisation of N dose supplemented with foliar urea sprays for full grown trees of New Castle apricot in order to get optimum crop and better nutrient status. Main doses comprised of 200, 400 and 600 g N supplemented with 1-3 foliar urea sprays, at fortnightly intervals, after the leaves were fully expanded. The second experiment was conducted to study the efficacy of urea sprays applied at pre-fall stage with similar objectives as above. Two concentrations of urea (2.5 and 5.0%) were tried on four dates during September and October alongwith a control. In the third experiment, there were 19 treatments comprising of 3 mineral nutrients (H_3Bo_3, 0.2%; $CaCl_2$ and KNo_3, each 0.5%) and 3 growth regulators (GA, 50 ppm; MH and SADH, each 1000 ppm) sprayed individually or in different combinations at pit hardening stage. These fruits, after harvest, were stored at 0^oC and analysed periodically at 10 days interval, upto 30 days of storage for fruit quality and for nutrient status on the date of harvest and after 30 days of storage. The results obtained are summarised below.

6.1. Effect of soil and foliar applications of urea on the tree productivity and nutrient status of New Castle apricot

6.1.1. Trunk girth and shoot growth and the quality of fruits viz. firmness, weight and TSS improved with increased N rate and were maximum with 600 g N supplemented with 2 foliar urea sprays. Fruit yield, acid content and soluble protein on the other hand were optimum with 400 g N coupled with 2 urea sprays.

6.1.2. Leaf N was maximum with 400 g N supplemented with 2 urea sprays, while the same dose with a single spray maintained the higher level of leaf Mg and Cu. Zn content in leaves was better with 600 g N + 2 urea sprays. P, Ca and Mn contents did not alter, but K and Fe decreased in the foliage with enhanced N rate through soil or sprays.

6.1.3. 400 g N with a single urea spray maintained better shoot N status. P content in shoots increased with increased N rate. K, Mg and Cu were optimum with 400 g N, while Zn was maximum with 400 g N + 3 urea sprays. Increased soil and foliar N applications decreased the shoot Fe and Mn, however, Ca remained unaltered.

6.1.4. Increased N application through soil as well as foliage enhanced the fruit N, but did not alter P, K and Cu. Fruit Mg was optimum with 400 g N. Increased N rate decreased the Ca and Zn, but increased the Fe content of fruits. Mn content in fruits was maximum when 600 g N was supplemented with 2 foliar urea sprays.

6.1.5. Chlorophyll and amino N in the leaves increased with raised N supply.

6.1.6. Soil pH decreased with increased N fertilization, though its level was higher in the deeper soil segments. Increased N rate increased the level of available N, K, Mg and Zn while organic C, P, Cu, and Mn were better with 400 g N. Exchangeable Ca and available Fe did not alter with enhanced N supply. Available nutrient status decreased with increased soil depth, though Cu content was maximum in the middle profile of 15-30 cm.

6.1.7. N application exhibited a pronounced influence on the soil microbial activity. Bacterial and Fungal population was stimulated with increased N dose upto 45 days of N application and then declined gradually. In case of actinomycetes, the stimulatory influence was better with 400 g N and increased population rate was noticed within 15 days of N fertilization.

6.2. Effect of pre-fall urea sprays on the tree productivity and nutrient status of New Castle apricot

6.2.1. Fruit set, retention and yield increased, with pre-fall urea sprays and the best results were obtained with 2.5 per cent spray of 15 October. However, fruit quality was not influenced with urea sprays applied on senescing leaves.

6.2.2. Leaf N, Ca and Zn increased with pre-fall urea sprays and the higher concentration was more effective in enhancing N and Ca contents. Mg and Cu also increased but the lower concentration had better impact. Accumulation of K and Fe declined, but P and Mn did not alter in leaves with pre-fall urea sprays. Spraying time had distinct influence on the leaf nutrient status. K and Cu declined with delayed spraying, while sprays of October 15 or 30 enhanced the leaf N considerably. Ca, Mg, Zn and Mn raised with pre-fall sprays of September 30.

6.2.3. Pre-fall urea sprays applied on October 15, raised the N and K contents of the shoots. P, Ca, Mg, Cu, Zn and Mn did not alter, however, Fe content declined in shoots with such sprays. Higher concentration of urea maintained better Ca and Fe, while the lower one was more effective in accumulating Mn in the shoots.

6.2.4. N, P, Ca, Mg, Cu and Mn remained unaltered while K and Fe declined in the fruits with pre-fall sprays of urea. The lower urea concentration maintained a better fruit K level, and the higher one that of Fe. Fruit Zn increased with such sprays, applied on September 30 and the higher concentration was more effective. Delayed spraying reduced considerably the fruit Mg, while Fe and Mn enhanced. Fruit P raised with urea sprays of September 30.

6.3. Effect of pre-harvest sprays of mineral nutrients and growth regulators on the storage behaviour and nutrient status of New Castle apricot

6.3.1. T_{10}($CaCl_2$ + MH) was most effective in controlling the rate of fruit respiration and maintaining its firmness during storage. TSS and pulp pH enhanced while the acid content declined during storage. T_6(SADH) maintained a higher level of acidity, while T_{17}(KNo_3+MH+SADH) resulted in maximum pulp pH. TSS was, however, not affected with different treatments applied.

6.3.2. Fruit nutrient content raised during 30 days of storage. Fruit N, Mg, Fe and Cu were maximum with T_2($CaCl_2$). T_9 ($CaCl_2$+GA) was most effective in maintaining the higher level of K and Mn during storage. Zn level in fruits was maximum with T_{11} (KNo_3+MH). The level of P and Ca, however, did not alter in fruits with different treatments.

6.3.3. Different treatments had their distinct influence on the leaf nutrient status. Leaf N was maximum with T_{11}(KNo_3+ MH), P with T_4 (GA), K with T_7(H_3Bo_3+GA), and Ca with T_{13}(H_3Bo_3+$CaCl_2$+GA). The highest level of leaf Fe occurred with T_2($CaCl_2$) and that of Cu with T_{17}(KNo_3+ MH+SADH). However, Mg, Zn and Mn declined in the foliage with different treatments applied.

The findings lead us to the conclusion that 400 g N, supplemented with 2 foliar sprays of urea was needed for better yield of optimal fruit quality and maintenance of assured tree N status. Urea sprays applied at pre-fall stage were also found to be quite effective in enhancing the fruit set, retention, yield and maintaining the tree nutrient status. Better results could be obtained with 2.5 per cent urea applied on October 15. T_{10} ($CaCl_2$, 0.5% + MH, 1000 ppm) applied at the pit-hardening stage, was the best treatment which could control the rate of respiration and maintain better firmness of the fruits during the 30 days of cold storage.

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* Original not seen.

APPENDICES

Appendix 1. Effect of soil and foliar applications of urea on the fruit yield of apricot cv. New Castle

Treatment	Yield (kg)			
	1981	1982	1983	1984
<u>N dose</u> (g $tree^{-1}$)				
200 (N_1)	31.3	37.6	76.6	43.8
400 (N_2)	39.4	43.7	93.6	51.8
600 (N_3)	39.3	42.2	95.2	57.3
L.S.D.($p = 0.05$)	4.9	4.8	7.8	3.2
<u>Mode of application</u>				
Soil (M_1)	32.6	35.2	79.2	45.0
Soil + 1 spray (M_2)	36.6	38.3	84.9	50.5
Soil + 2 sprays (M_3)	40.0	45.2	92.7	54.2
Soil + 3 sprays (M_4)	37.3	46.0	97.0	54.0
L.S.D.($p=0.05$)	5.7	5.5	9.0	3.7
<u>N dose x mode</u>				
N_1 M_1	27.5	33.4	69.5	41.0
N_1 M_2	30.0	35.6	73.8	43.5
N_1 M_3	33.8	40.2	79.8	47.5
N_1 M_4	33.8	41.3	83.3	43.0
N_2 M_1	36.6	35.7	81.0	44.5
N_2 M_2	38.9	40.9	88.0	51.0
N_2 M_3	44.8	46.3	99.5	54.5
N_2 M_4	37.3	51.9	105.8	57.0
N_3 M_1	33.8	36.5	87.0	49.5
N_3 M_2	40.9	38.4	93.0	57.0
N_3 M_3	41.4	49.1	98.8	60.5
N_3 M_4	41.0	44.8	102.0	62.0
L.S.D.($p = 0.05$)	N.S.	N.S.	N.S.	N.S.

	(mg g^{-1} fresh wt.)		(mg g^{-1} fresh wt.)		(mg g^{-1} fresh wt.)		(% dry weight)	
	1982	1983	1982	1983	1982	1983	1982	1983
N doses (g tree^{-1})								
200 (N_1)	33.3	35.1	20.2	15.5	13.0	19.6	1.5	1.6
400 (N_2)	33.8	38.3	20.3	17.8	13.6	20.5	1.7	1.9
600 (N_3)	36.5	41.3	20.3	20.5	16.1	21.0	1.8	2.1
L.S.D ($p = 0.05$)	N.S.	1.9	N.S.	2.3	0.9	N.S.	0.1	0.1
Mode of application								
Soil (M_1)	33.0	35.9	20.4	17.3	12.6	18.6	1.5	1.6
Soil + 1 spray(M_2)	34.1	37.3	20.2	17.4	13.9	19.9	1.7	1.9
Soil +2 sprays(M_3)	34.4	39.1	20.0	18.1	14.4	21.0	1.8	2.1
Soil +3 sprays(M_4)	36.6	40.8	20.5	18.9	16.1	22.0	1.8	2.0
L.S.D.($p=0.05$)	N.S.	2 .1	N.S.	N.S.	1.0	1.5	0.2	0.1
N dose x mode								
N_1 M_1	31.5	32.8	19.1	15.4	12.4	17.4	1.4	1.6
N_1 M_2	33.1	34.3	20.4	14.5	12.7	19.3	1.5	1.7
N_1 M_3	33.4	35.6	19.9	14.8	13.5	20.8	1.7	1.8
N_1 M_4	35.0	37.7	21.6	17.0	13.4	20.8	1.4	1.4
N_2 M_1	32.4	36.6	20.4	18.3	12.0	18.3	1.5	1.6
N_2 M_2	33.3	37.3	20.1	17.4	13.2	19.9	1.7	1.9
N_2 M_3	35.5	39.0	20.2	18.3	13.3	20.7	1.8	2.1
N_2 M_4	35.9	40.3	20.3	17.2	15.6	23.1	1.9	2.2
N_3 M_1	35.2	38.2	21.8	18.3	13.3	19.9	1.5	1.7
N_3 M_2	35.8	40.2	20.0	19.9	15.8	20.3	1.8	2.1
N_3 M_3	36.2	42.7	20.0	21.3	16.2	21.4	1.9	2.4
N_3 M_4	38.7	44.2	19.4	22.5	19.3	22.2	2.0	2.4
L.S.D. ($p=0.05$)	N.S.	N.S.	1.8	N.S.	1.8	N.S.	N.S.	1.1

Appendix 3. Effect of soil and foliar applications of urea on the fruit quality of New Castle apricot

Treatment	Firmness(kg)				Weight(g)				Total soluble solids(%)				Acidity(%)				Pulp pH		Protein(mg g^{-1})	
	81	82	83	84	81	82	83	84	81	82	83	84	81	82	83	84	82	83	82	83
N dose (g $tree^{-1}$)																				
200 (N_1)	5.7	5.6	5.9	6.0	20.7	19.1	14.5	17.7	14.1	14.2	11.9	13.9	0.70	0.50	0.60	0.71	3.9	3.9	4.6	4.5
400 (N_2)	5.9	5.7	6.0	6.1	21.0	19.9	15.0	17.7	14.3	14.5	12.1	14.8	0.87	0.59	0.64	0.78	3.9	3.8	6.2	5.9
600 (N_3)	6.0	5.7	6.0	6.3	22.0	21.6	15.9	18.6	15.3	15.1	13.1	15.8	0.81	0.60	0.69	0.85	3.9	3.8	4.8	4.9
L.S.D.(p=0.05)	N.S	0.1	N.S	N.S	N.S	1.0	0.6	0.2	0.5	0.3	0.4	0.3	N.S.	0.02	0.02	0.06	N.S	N.S	0.8	0.2
Mode of application																				
Soil (M_1)	5.6	5.4	5.8	5.9	19.8	18.9	14.4	17.6	13.8	14.0	11.3	13.7	0.70	0.53	0.58	0.64	3.9	3.9	4.5	4.4
Soil + 1 spray(M_2)	5.7	5.7	6.0	6.1	20.8	19.9	14.9	18.0	14.5	14.5	12.4	14.6	0.73	0.57	0.64	0.73	3.9	3.8	4.8	4.8
Soil +2 sprays(M_3)	6.0	5.8	6.1	6.3	21.5	20.8	15.4	18.2	14.9	14.8	12.7	15.3	0.84	0.57	0.67	0.81	3.9	3.8	5.4	5.4
Soil +3 sprays(M_4)	6.1	5.8	6.0	6.3	22.9	21.2	16.0	18.3	15.0	15.0	13.1	15.7	0.92	0.60	0.68	0.93	3.8	3.8	6.0	5.8
L.S.D. (p=0.05)	0.3	0.2	N.S	0.3	0.7	1.2	0.7	0.2	0.5	0.4	0.4	0.4	N.S.	0.03	0.03	0.07	N.S	N.S	0.9	0.2
N dose x mode																				
N_1 M_1	5.5	5.3	5.7	5.7	19.5	17.5	14.1	17.1	13.6	13.9	11.1	13.3	0.64	0.50	0.52	0.62	3.9	3.9	4.1	4.0
N_1 M_2	5.6	5.5	5.9	5.9	20.7	18.9	14.0	17.8	13.9	14.0	12.1	13.6	0.69	0.50	0.61	0.67	3.9	3.9	4.1	4.1
N_1 M_3	5.8	5.7	6.0	6.1	20.9	19.5	14.7	17.8	14.4	14.1	12.5	13.6	0.74	0.50	0.62	0.71	3.9	3.8	4.7	4.7
N_1 M_4	6.0	5.7	6.1	6.2	21.9	20.4	15.3	17.9	14.6	14.7	11.9	14.5	0.74	0.51	0.63	0.83	3.8	3.8	5.4	5.3
N_2 M_1	5.6	5.4	5.8	5.9	19.9	18.9	14.5	17.4	13.7	13.9	11.2	13.4	0.71	0.57	0.59	0.64	3.9	3.9	5.0	4.9
N_2 M_2	5.8	5.8	6.0	6.1	20.7	19.7	14.9	17.8	14.4	14.4	12.3	14.6	0.72	0.58	0.62	0.72	3.9	3.8	5.6	5.5
N_2 M_3	6.0	5.8	6.1	6.3	21.0	20.7	14.8	17.7	14.9	14.6	12.7	15.6	0.86	0.57	0.67	0.80	3.9	3.8	6.4	6.3
N_2 M_4	6.0	5.9	6.0	6.2	22.3	20.2	16.0	18.0	14.4	15.1	12.3	15.6	1.21	0.65	0.68	0.95	3.8	3.8	7.6	6.9
N_3 M_1	5.6	5.5	5.9	6.0	20.2	20.2	14.7	18.0	14.2	14.3	11.7	14.5	0.74	0.52	0.63	0.67	3.9	3.8	4.4	4.4
N_3 M_2	5.8	5.8	6.0	6.3	21.0	21.0	15.6	18.4	15.3	15.2	12.7	15.7	0.78	0.63	0.69	0.79	3.9	3.8	4.7	4.8
N_3 M_3	6.2	5.8	6.1	6.4	22.6	22.2	16.6	18.7	15.6	15.7	13.1	16.1	0.92	0.62	0.71	0.93	3.9	3.8	5.0	5.1
N_3 M_4	6.3	5.8	6.0	6.5	24.4	23.1	16.6	19.0	16.1	15.1	15.0	16.9	0.82	0.63	0.72	1.02	3.8	3.7	5.0	5.1
L.S.D. (p = 0.05)	N.S	N.S	N.S	N.S	N.S	N.S	N.S	0.4	N.S	N.S	0.8	N.S	N.S	0.05	0.05	N.S.	N.S	N.S	N.S	0.4

Appendix 4. Effect of nitrogen on the pH level and organic carbon content of the soil

Treatment	pH		Organic carbon (%)	
	1982	1983	1982	1983
N dose (g $tree^{-1}$)				
200 (N_1)	7.69	7.24	2.23	2.28
400 (N_2)	7.61	7.18	2.38	2.41
600 (N_3)	7.56	7.15	2.40	2.44
L.S.D. ($p = 0.05$)	0.09	N.S.	0.13	0.05
Soil depth (cm)				
0 - 15 (D_1)	7.40	7.09	2.88	2.91
15 - 30 (D_2)	7.59	7.06	2.24	2.30
30 - 60 (D_3)	7.86	7.41	1.89	1.92
L.S.D. ($p = 0.05$)	0.09	0.08	0.13	0.05
N dose x depth				
N_1 D_1	7.48	7.12	2.74	2.80
N_1 D_2	7.64	7.15	2.10	2.15
N_1 D_3	7.95	7.46	1.85	1.88
N_2 D_1	7.38	7.10	2.94	2.96
N_2 D_2	7.59	7.05	2.30	2.35
N_2 D_3	7.85	7.37	1.90	1.93
N_3 D_1	7.35	7.06	2.97	2.98
N_3 D_2	7.54	6.98	2.32	2.39
N_3 D_3	7.78	7.39	1.92	1.94
L.S.D. ($p = 0.05$)	N.S.	N.S.	N.S.	N.S.

endix 5. Effect of urea on the available nutrient status of the soil (Fe, Cu, Zn and Mn; ppm) at different depths

atment	Iron		Copper		Zinc		Manganese	
	1982	1983	1982	1983	1982	1983	1982	1983
ose (g)								
(N_1)	63.7	60.3	6.4	8.1	2.3	1.5	41.3	42.8
(N_2)	63.5	60.6	7.6	8.7	3.2	2.9	54.2	55.1
(N_3)	64.2	64.2	7.3	8.4	4.0	3.5	49.0	48.4
.D.(p=0.05)	N.S.	N.S.	0.3	0.4	0.1	0.1	3.4	3.2
l depth (cm)								
- 15 (D_1)	96.6	96.3	6.9	7.9	4.1	3.5	65.2	71.3
- 30 (D_2)	52.5	47.0	7.3	8.9	3.3	2.7	47.8	48.1
- 60 (D_3)	42.2	41.7	7.1	8.4	2.1	1.7	31.8	26.8
D.(p=0.05)	2.8	3.5	0.3	0.4	0.1	0.1	3.4	3.2
ose x depth								
D_1	98.5	94.2	6.2	7.3	3.1	2.1	57.5	62.4
D_2	52.2	48.0	6.2	8.7	1.9	1.3	42.4	44.6
D_3	40.3	38.6	6.7	8.2	1.8	1.2	24.1	21.3
D_1	96.5	96.4	7.3	8.3	4.3	3.9	78.6	86.3
D_2	51.6	46.0	8.1	9.3	3.7	3.2	48.7	50.2
D_3	42.4	39.4	7.4	8.6	1.8	1.6	35.3	28.7
D_1	94.8	98.2	7.2	8.3	4.9	4.4	59.5	65.1
D_2	53.8	47.1	7.5	8.6	4.4	3.8	51.4	49.6
D_3	44.0	47.2	7.3	8.3	2.6	2.4	36.0	30.4
D.(p=0.05)	4.9	N.S.	0.5	N.S.	0.3	0.2	5.8	5.5

Appendix 6. Effect of pre-fall urea sprays on the fruit characters of New Castle apricot

Treatment	Fruit set (%)		Fruit retention (%)		Yield (Kg)		Weight (g)		Firmness (kg)		T.S.S. (%)		Acidity (%)		Pulp pH	
	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
Urea concentration(%)																
2.5 (C_1)	42.1	41.8	28.2	21.5	79.9	65.0	15.0	16.5	5.5	6.8	12.8	13.6	0.62	0.96	3.7	3.7
5.0 (C_2)	36.4	37.6	26.0	18.9	60.2	52.5	13.6	15.6	5.3	6.2	12.5	12.6	0.60	0.85	3.8	3.8
Mean	39.3	39.7	27.1	20.2	70.1	58.6	14.3	16.1	5.4	6.5	12.6	13.1	0.61	0.90	3.7	3.8
Control	29.4	31.2	20.3	18.2	63.0	42.3	13.0	15.0	5.4	6.5	12.5	11.9	0.62	0.87	4.1	3.8
L.S.D. (p=0.05) Control vs spray	2.3	2.5	1.6	N.S.	4.6	6.6	N.S.	0.7	N.S.	N.S.	N.S.	0.3	N.S.	N.S.	0.2	N.S.
Urea concentration	2.4	2.6	1.7	1.3	4.9	7.0	N.S.	0.5	N.S.	0.1	N.S.	0.4	N.S.	0.05	N.S.	N.S.
Date of spray																
15 Sept. (D_1)	31.7	33.5	26.1	20.2	60.0	57.1	14.2	15.6	5.2	5.9	12.5	12.5	0.59	0.88	3.8	3.7
30 Sept. (D_2)	36.9	37.7	24.6	19.0	63.4	60.9	14.4	16.6	5.5	6.5	12.8	13.7	0.63	0.94	3.8	3.8
15 Oct. (D_3)	41.8	44.5	28.2	21.5	80.0	62.8	14.4	16.2	5.5	6.5	13.1	13.3	0.61	0.95	3.7	3.8
30 Oct. (D_4)	46.7	43.3	29.5	20.1	77.0	54.3	14.2	15.9	5.5	7.1	12.2	12.9	0.61	0.87	3.7	3.7
L.S.D. (p=0.05)	3.4	3.7	2.5	N.S.	6.9	N.S.	N.S.	N.S.	N.S.	0.1	N.S.	0.5	N.S.	0.07	N.S.	0.1
Concentration x date																
C_1 D_1	34.0	36.4	25.9	22.0	72.0	64.0	15.1	16.2	5.4	6.0	12.2	12.8	0.63	0.85	3.8	3.7
C_1 D_2	38.7	39.6	24.9	20.3	72.8	63.7	15.1	17.0	5.4	6.8	13.0	14.3	0.65	0.99	3.8	3.8
C_1 D_3	45.6	46.5	30.8	22.7	95.0	76.5	15.0	16.9	5.5	6.9	13.7	13.6	0,62	1.03	3.6	3.7
C_1 D_4	50.3	44.7	31.4	20.9	82.0	55.9	14.7	16.0	5.6	7.5	12.5	13.8	0.60	0.96	3.7	3.7
C_2 D_1	29.7	30.6	26.4	18.4	50.0	50.2	13.3	15.0	5.0	5.7	12.8	12.3	0.55	0.86	3.9	3.8
C_2 D_2	35.0	35.7	24.3	17.7	54.0	58.0	13.7	16.2	5.6	6.2	12.7	13.2	0.61	0.88	3.7	3.8
C_2 D_3	38.0	42.4	25.6	20.3	65.0	48.1	13.7	15.6	5.4	6.1	12.4	13.1	0.60	0.87	3.7	3.9
C_2 D_4	43.1	41.8	27.5	19.3	72.0	52.7	13.8	15.8	5.3	6.7	11.9	13.1	0.63	0.78	3.8	3.7
L.S.D. (p=0.05)	N.S.	N.S.	N.S.	N.S.	9.7	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.7	N.S.	0.09	N.S.	0.1

Appendix 7. Effect of pre-fall urea sprays on the chlorophyll and amino-nitrogen contents of apricot leaves

Treatment	Total chlorophyll (mg g-1 fresh weight)		Chlorophyll 'a' (mg g-1 fresh wt.)		Chlorophyll 'b' (mg g-1 fresh wt.)		Amino nitrogen (% dry weight)	
	1982	1983	1982	1983	1982	1983	1982	1983
Urea concentration (%)								
2.5 (C_1)	35.2	35.8	18.7	19.0	16.4	16.7	1.7	1.9
5.0 (C_2)	36.0	36.0	19.2	19.1	16.9	16.9	1.8	1.9
Mean	35.6	35.9	18.9	19.0	16.7	16.8	1.7	1.9
Control	31.4	32.6	17.0	17.3	14.4	15.3	1.5	1.6
L.S.D.(p=0.05) Control vs spray	1.5	0.5	0.5	0.3	0.5	0.3	0.1	0.1
Urea concentration	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Date of spray								
15 Sept. (D_1)	35.8	36.1	19.0	19.0	16.5	16.6	1.5	1.6
30 Sept. (D_2)	36.0	36.4	19.1	19.2	16.9	17.0	1.8	2.0
15 Oct. (D_3)	35.4	36.2	18.8	19.1	16.7	16.9	1.9	2.0
30 Oct. (D_4)	35.3	35.9	18.7	18.9	16.6	16.7	1.8	1.9
L.S.D.(p = 0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.1	0.1
Concentration x date								
C_1 D_1	35.2	35.7	18.6	18.9	16.6	16.4	1.5	1.5
C_1 D_2	35.8	36.2	19.0	19.2	16.8	17.0	1.9	2.1
C_1 D_3	34.9	35.4	18.5	18.8	16.4	16.6	1.8	1.9
C_1 D_4	35.0	35.8	18.6	19.0	16.5	16.8	1.8	2.0
C_2 D_1	36.4	35.9	19.5	19.0	17.0	16.9	1.5	1.7
C_2 D_2	36.1	36.1	19.3	19.1	16.9	17.0	1.8	2.0
C_2 D_3	35.8	36.5	19.1	19.4	17.0	17.2	1.9	2.0
C_2 D_4	35.6	35.5	18.9	18.9	16.7	16.7	1.8	1.9
L.S.D.(p = 0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Appendix 8. Effect of pre-fall urea sprays on the nutrient content of leaf, shoot and fruit of New Castle apricot (N,P,K)

Treatment	Nitrogen						Phosphorus						Potassium					
	Leaf		Shoot		Fruit		Leaf		Shoot		Fruit		Leaf		Shoot		Fruit	
	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
Urea concentration (%)																		
2.5 (C_1)	1.93	2.27	1.88	2.67	178.2	190.1	0.23	0.19	0.15	0.14	23.0	26.4	2.18	2.19	1.83	1.84	106.7	98.2
5.0 (C_2)	1.92	2.42	1.98	2.76	183.6	201.3	0.23	0.19	0.15	0.14	21.1	25.6	1.79	2.18	1.81	1.82	105.5	96.7
Mean	1.92	2.35	1.92	2.71	180.9	195.7	0.23	0.19	0.15	0.14	22.0	26.0	1.98	2.23	1.82	1.83	106.1	97.4
Control	1.69	1.65	1.85	2.35	173.8	194.7	0.24	0.19	0.15	0.13	22.0	28.0	2.50	2.50	1.74	1.69	136.0	111.7
L.S.D.(p=0.05) Control vs spray	N.S.	0.09	N.S.	0.09	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.04	0.05	0.02	0.08	5.19	4.3
Concentration	N.S.	0.10	N.S.	N.S.	N.S.	11.0	N.S.	N.S.	N.S.	N.S.	1.0	N.S.	0.05	0.06	N.S.	N.S.	N.S.	N.S.
Date of spray																		
15 Sept. (D_1)	1.74	2.24	1.86	2.68	179.7	189.4	0.25	0.18	0.13	0.12	20.0	25.0	2.22	2.45	1.93	1.98	100.5	93.0
30 Sept. (D_2)	1.86	2.26	1.86	2.77	176.7	195.5	0.22	0.19	0.15	0.14	24.0	26.0	2.05	2.33	1.82	1.81	105.0	97.4
15 Oct. (D_3)	1.99	2.50	1.94	2.72	183.5	199.2	0.23	0.19	0.16	0.15	22.0	27.7	1.92	2.05	1.78	1.80	105.5	90.5
30 Oct. (D_4)	2.10	2.38	2.06	2.67	183.6	198.6	0.23	0.19	0.16	0.15	22.1	25.1	1.74	2.12	1.73	1.74	113.5	108.9
L.S.D. (p = 0.05)	0.27	0.14	N.S.	N.S.	N.S.	N.S.	0.02	N.S.	0.01	0.01	1.2	N.S.	0.07	0.08	0.04	0.13	7.8	6.4
Concentration x date of spray																		
C_1 D_1	1.74	2.21	1.84	2.64	179.7	187.0	0.25	0.17	0.12	0.12	21.0	26.0	2.41	2.48	1.95	1.99	105.0	82.0
C_1 D_2	1.93	2.23	1.82	2.74	176.7	187.2	0.22	0.20	0.15	0.14	27.0	31.0	2.27	2.38	1.83	1.79	99.0	103.7
C_1 D_3	1.88	2.30	1.90	2.70	179.7	191.5	0.23	0.19	0.15	0.15	22.0	28.2	1.98	2.12	1.78	1.82	104.0	101.0
C_1 D_4	2.18	2.36	1.98	2.60	176.7	194.7	0.23	0.18	0.16	0.15	22.0	24.2	2.05	2.18	1.74	1.76	119.0	106.0
C_2 D_1	1.74	2.28	1.88	2.72	179.7	191.7	0.25	0.19	0.13	0.13	19.0	24.0	2.03	2.41	1.91	1.97	96.0	104.0
C_2 D_2	1.80	2.30	1.90	2.80	176.7	203.7	0.23	0.18	0.14	0.14	21.0	25.0	1.84	2.27	1.81	1.82	111.0	91.0
C_2 D_3	2.10	2.70	1.98	2.75	187.2	207.0	0.23	0.20	0.16	0.15	22.0	27.2	1.86	1.98	1.78	1.77	107.0	80.0
C_2 D_4	2.03	2.40	2.15	2.75	190.5	202.5	0.23	0.19	0.16	0.15	22.2	26.0	1.43	2.05	1.72	1.72	108.0	80.0
L.S.D. (p= 0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	2.0	N.S.	0.10	N.S.	N.S.	N.S.	11.0	9.1

Leaf and shoot: % dry weight, Fruit: mg 100^{-1} g fresh weight

	Calcium						Magnesium						Iron					
	Leaf		Shoot		Fruit		Leaf		Shoot		Fruit		Leaf		Shoot		Fruit	
	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
<u>Urea concentration</u> (%)																		
2.5 (C_1)	2.52	3.34	0.68	0.69	73.7	57.2	0.82	0.92	0.39	0.45	48.8	49.0	142.0	162.0	81.2	89.2	0.62	0.61
5.0 (C_2)	2.57	3.54	0.71	0.71	77.0	58.1	0.81	0.85	0.42	0.46	48.0	45.5	148.5	168.0	92.0	100.2	0.97	0.89
Mean	2.25	3.44	0.70	0.70	75.3	57.7	0.82	0.88	0.41	0.46	48.4	47.2	145.0	165.0	86.5	94.8	0.79	0.75
Control	2.25	3.30	0.65	0.70	75.0	57.5	0.74	0.77	0.38	0.45	52.0	50.0	198.0	205.0	108.0	115.0	1.50	1.30
L.S.D. (p=0.05)																		
Control vs spray	0.12	N.S.	0.01	N.S.	N.S.	N.S.	0.02	0.03	N.S.	N.S.	N.S.	N.S.	9.9	10.3	3.2	2.0	0.07	0.04
Concentration	N.S.	0.12	0.01	N.S.	N.S.	N.S.	N.S.	0.03	0.02	N.S.	N.S.	2.1	N.S.	N.S.	3.4	2.1	0.08	0.05
<u>Date of spray</u>																		
15 Sept. (D_1)	2.52	3.33	0.68	0.71	76.0	57.7	0.80	0.85	0.42	0.48	49.4	50.0	148.5	179.0	90.0	101.0	0.64	0.55
30 Sept. (D_2)	2.79	3.51	0.71	0.72	76.7	57.7	0.84	0.88	0.45	0.51	50.2	48.0	152.0	164.0	87.5	96.0	0.71	0.68
15 Oct. (D_3)	2.59	3.67	0.73	0.73	75.2	57.5	0.82	0.95	0.40	0.45	49.0	48.0	146.0	162.0	86.0	92.5	0.85	0.81
30 Oct. (D_4)	2.28	3.27	0.66	0.64	73.4	57.7	0.80	0.84	0.37	0.38	45.0	43.0	134.5	155.0	83.0	89.5	0.98	0.96
L.S.D. (p=0.05)	0.18	0.17	0.02	0.03	N.S.	N.S.	N.S.	0.04	0.03	0.05	3.4	3.0	N.S.	14.6	4.8	2.9	0.11	0.07
<u>Concentration x date of spray</u>																		
C_1 D_1	2.50	3.25	0.62	0.65	73.0	58.0	0.81	0.88	0.41	0.46	48.7	54.0	150.0	168.0	88.0	96.0	0.52	0.44
C_1 D_2	2.63	3.37	0.69	0.71	75.2	57.5	0.85	0.91	0.43	0.50	52.5	50.0	144.0	170.0	81.0	90.0	0.57	0.53
C_1 D_3	2.81	3.55	0.74	0.78	74.2	56.7	0.82	0.93	0.38	0.47	50.0	50.0	142.0	172.0	80.0	87.0	0.61	0.65
C_1 D_4	2.12	3.20	0.67	0.64	72.2	56.7	0.78	0.96	0.36	0.38	44.0	42.0	132.0	162.0	76.0	84.0	0.77	0.83
C_2 D_1	2.54	3.40	0.74	0.77	79.0	57.5	0.78	0.83	0.43	0.50	50.0	46.0	147.0	190.0	92.0	106.0	0.76	0.67
C_2 D_2	2.94	3.64	0.74	0.73	78.2	58.0	0.83	0.86	0.46	0.52	48.0	46.0	160.0	158.0	94.0	102.0	0.85	0.83
C_2 D_3	2.36	3.78	0.72	0.69	76.2	58.2	0.81	0.98	0.41	0.43	48.0	46.0	150.0	152.0	92.0	98.0	1.08	0.98
C_2 D_4	2.44	3.33	0.66	0.64	74.5	58.7	0.82	0.72	0.37	0.39	46.0	44.0	137.0	148.0	90.0	95.0	1.19	1.09
L.S.D. (p=0.05)	0.26	N.S.	N.S.	0.04	N.S.	N.S.	N.S.	0.06	N.S.	N.S.	N.S.	4.2	N.S.	20.6	N.S.	N.S.	N.S.	N.S.

Leaf and shoot: % dry weight, Fruit: mg/100 g fresh weight

Appendix 10. Effect of pre-fall urea sprays on the nutrient content of leaf, shoot and fruit of New Castle apricot (Cu, Zn and Mn)

	Copper						Zinc						Manganese					
	Leaf		Shoot		Fruit		Leaf		Shoot		Fruit		Leaf		Shoot		Fruit	
	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
Urea concentration(%)																		
2.5 (C_1)	5.5	4.6	4.1	3.9	0.09	0.08	17.5	17.8	25.5	37.2	0.33	0.32	22.0	15.3	54.3	60.1	0.34	0.22
5.0 (C_2)	4.5	4.7	4.0	3.9	0.11	0.09	18.0	18.1	26.4	37.0	0.34	0.36	23.0	16.7	49.5	56.4	0.34	0.21
Mean	5.0	4.6	4.0	3.9	0.10	0.09	17.8	17.9	25.9	37.1	0.33	0.34	23.0	16.0	51.9	58.3	0.34	0.22
Control	3.6	3.9	3.3	3.8	0.09	0.08	11.6	12.1	24.6	35.6	0.24	0.22	23.0	20.0	53.4	58.5	0.33	0.22
L.S.D.(p=0.05)																		
Control vs spray	0.2	0.2	0.1	N.S.	N.S.	N.S.	0.7	0.2	N.S.	1.0	0.01	0.01	N.S.	1.2	N.S.	N.S.	N.S.	N.S.
Concentration	0.2	N.S.	0.1	N.S.	N.S.	N.S.	N.S.	0.2	N.S.	N.S.	N.S.	0.01	N.S.	1.3	1.9	2.9	N.S.	N.S.
Date of spray																		
15 Sept. (D_1)	5.8	4.9	4.1	3.9	0.10	0.08	16.7	17.3	23.9	37.0	0.26	0.31	21.0	14.6	49.7	58.3	0.34	0.19
30 Sept. (D_2)	5.3	4.6	4.1	3.9	0.09	0.08	19.5	18.8	24.9	37.2	0.35	0.34	24.5	16.7	54.3	65.8	0.33	0.22
15 Oct. (D_3)	4.5	4.5	4.0	3.9	0.10	0.08	18.9	18.9	29.7	40.2	0.38	0.34	25.5	18.4	56.1	58.8	0.34	0.22
30 Oct. (D_4)	4.2	4.6	3.8	3.9	0.09	0.09	16.0	16.8	25.2	34.1	0.35	0.36	19.0	14.5	47.6	50.3	0.34	0.23
L.S.D. (p=0.05)	0.3	0.2	N.S.	N.S.	N.S.	N.S.	1.1	0.3	1.3	1.5	0.02	0.02	2.6	1.8	2.7	4.2	N.S.	N.S.
Concentration x date of spray																		
C_1 D_1	6.2	5.0	3.9	3.6	0.12	0.08	15.1	16.2	23.4	36.4	0.24	0.29	20.0	12.5	51.0	62.5	0.34	0.18
C_1 D_2	5.5	4.5	4.1	3.7	0.10	0.07	19.9	18.7	24.1	36.4	0.36	0.34	24.0	14.6	56.2	71.5	0.33	0.22
C_1 D_3	5.1	4.3	4.2	4.1	0.11	0.07	18.9	19.0	30.5	41.7	0.38	0.30	26.0	20.0	57.6	53.0	0.33	0.22
C_1 D_4	5.0	4.4	4.1	4.1	0.10	0.08	16.2	17.4	23.9	34.4	0.33	0.34	18.0	14.2	52.4	53.5	0.35	0.24
C_2 D_1	5.3	4.8	4.3	4.1	0.08	0.08	18.2	18.4	24.5	37.6	0.27	0.33	22.0	16.6	48.4	54.0	0.34	0.20
C_2 D_2	5.1	4.6	4.2	4.1	0.09	0.09	19.2	18.9	25.7	38.0	0.35	0.34	25.0	18.8	52.3	60.0	0.33	0.21
C_2 D_3	4.0	4.6	3.9	3.8	0.09	0.09	18.5	18.8	28.8	38.8	0.38	0.37	25.0	16.8	54.6	64.5	0.34	0.22
C_2 D_4	3.5	4.7	3.6	3.8	0.09	0.10	15.7	16.2	26.4	33.8	0.36	0.38	20.0	14.7	42.8	47.0	0.33	0.22
L.S.D. (p=0.05)	0.4	N.S.	0.3	0.3	0.01	N.S.	1.6	0.4	1.8	2.1	N.S.	0.01	N.S.	2.6	N.S.	5.9	N.S.	N.S.

Leaf and shoot: ppm dry weight. Fruit: mg 100^{-1} fresh weight

Appendix 11. Effect of nutrients and growth regulators on the rate of respiration and firmness of New Castle apricot fruits stored at 0°C

Treatment No.	Treatment	Respiration (mg $CO_2 kg^{-1} h^{-1}$)										Fruit firmness (kg)									
		1982					1983					1982					1983				
		Days after storage										Days after storage									
		0	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	Mean
T_1	H_3BO_3(0.2%)	5.9	3.4	5.9	6.5	5.4	5.8	3.2	5.1	5.4	4.9	6.5	5.3	4.3	3.4	5.4	8.3	6.1	5.1	3.7	5.8
T_2	$CaCl_2$(0.5%)	4.4	2.9	4.2	4.9	4.1	4.1	2.7	3.7	4.1	3.7	10.0	7.8	6.5	5.0	7.3	10.1	8.3	7.3	6.1	8.0
T_3	KNO_3 (0.5%)	5.7	3.3	5.8	6.5	5.3	5.7	3.2	5.1	5.3	4.8	8.5	6.9	5.6	3.3	6.1	9.0	7.4	6.5	3.6	6.6
T_4	GA (50 ppm)	5.4	3.2	5.4	6.3	5.1	5.1	3.1	5.1	5.2	4.6	8.9	7.1	5.5	3.6	6.3	9.0	6.7	5.8	4.5	6.5
T_5	MH (1000 ppm)	4.6	3.0	4.6	5.4	4.4	4.2	2.9	3.9	4.8	3.9	9.8	8.4	6.5	4.4	7.3	10.0	8.5	6.9	5.3	7.7
T_6	SADH(1000 ppm)	5.8	3.8	4.8	6.2	5.1	5.0	3.7	5.0	5.1	4.7	8.8	7.1	5.5	4.2	6.4	9.3	7.7	6.8	4.5	7.1
T_7	H_3BO_3+GA	5.7	3.3	5.8	6.5	5.3	5.5	3.2	5.2	5.4	4.8	8.6	6.9	6.2	4.1	6.5	9.2	7.7	6.7	4.5	7.0
T_8	H_3BO_3+SADH	5.6	3.2	5.7	6.5	5.2	5.4	3.2	5.2	5.4	4.8	8.4	6.7	5.8	4.1	6.3	9.2	7.8	6.2	4.4	6.9
T_9	$CaCl_2$+GA	5.5	3.2	4.5	6.3	4.9	5.3	3.1	4.1	5.3	4.4	8.7	7.5	6.3	4.6	6.8	9.3	8.0	6.5	5.1	7.2
T_{10}	$CaCl_2$+MH	4.3	2.5	4.1	4.8	3.9	3.9	2.3	3.7	4.7	3.6	9.4	8.0	7.2	4.9	7.4	11.3	9.4	8.7	7.3	9.2
T_{11}	KNO_3+MH	4.7	3.3	5.5	6.3	4.9	4.4	3.1	5.1	5.2	4.4	9.1	7.6	6.5	3.8	6.8	9.6	9.4	6.7	4.8	7.6
T_{12}	KNO_3+SADH	5.5	3.2	5.6	6.4	5.2	5.3	3.2	5.2	5.3	4.7	8.4	6.7	5.1	3.8	6.0	9.2	7.9	5.4	3.3	6.5
T_{13}	H_3BO_3+$CaCl_2$+GA	5.8	3.3	5.6	6.4	5.3	5.7	3.2	5.1	5.3	4.8	8.4	7.4	6.3	3.9	6.5	9.4	8.3	6.9	3.9	7.1
T_{14}	H_3BO_3+SADH+GA	5.7	3.4	5.8	6.7	5.4	5.4	3.2	5.2	5.3	4.8	8.3	7.4	5.5	4.0	6.3	9.1	8.1	6.0	4.6	7.0
T_{15}	$CaCl_2$+GA+MH	5.0	3.1	5.4	6.2	4.9	4.8	3.1	4.8	5.1	4.4	9.0	7.4	6.3	4.5	6.8	9.8	7.8	6.7	4.7	7.3
T_{16}	$CaCl_2$+KNO_3+MH	4.4	2.7	4.5	5.1	4.2	3.9	2.3	3.9	4.9	3.7	9.5	7.9	6.4	4.1	7.0	9.9	8.4	7.6	4.9	7.7
T_{17}	KNO_3+MH+SADH	5.2	3.3	5.6	6.5	5.2	4.9	3.1	5.0	5.1	4.5	9.2	7.2	5.3	3.5	6.3	9.8	7.7	6.7	3.5	6.9
T_{18}	KNO_3+GA+SADH	5.7	3.5	5.8	6.7	5.4	5.4	3.3	5.3	5.5	4.9	8.7	6.8	5.6	4.0	6.3	9.7	7.6	6.0	5.2	7.1
T_{19}	Control	5.6	3.3	5.7	6.2	5.2	5.4	3.2	5.1	5.3	4.7	6.9	6.3	4.8	3.2	5.3	8.3	6.7	4.6	3.3	5.7
	Mean	5.3	3.2	5.3	6.1	5.0	5.0	3.1	4.8	5.1	4.5	8.6	7.2	5.8	4.0	6.5	9.5	7.8	6.5	4.6	7.1

L.S.D. (p=0.05)	Respiration 1982	Respiration 1983	Fruit firmness 1982	Fruit firmness 1983
Treatment	0.38	0.37	0.28	0.30
Storage date	0.17	0.17	0.13	0.14
Treatment x date	-	-	0.56	0.59

Appendix 12. Effect of nutrients and growth regulators on the total soluble solids of New Castle apricot fruits stored at 0°C

Treatment No.	Treatment	Total soluble solids (%)									
		1982					1983				
		Days after storage									
		0	10	20	30	Mean	0	10	20	30	Mean
T_1	H_3Bo_3 (0.2%)	11.8	12.6	13.7	13.3	12.6	10.1	10.4	10.7	13.1	11.3
T_2	$CaCl_2$ (0.5%)	10.5	11.2	11.5	11.6	11.2	9.9	10.3	10.9	11.1	10.5
T_3	KNO_3 (0.5%)	12.4	12.7	12.9	12.3	12.6	11.2	11.7	11.9	11.6	11.6
T_4	GA (50 ppm)	10.8	11.7	12.5	12.7	11.9	10.3	10.7	12.0	12.0	11.7
T_5	MH (1000 ppm)	11.9	12.3	14.0	13.4	12.9	10.6	11.5	12.0	12.9	11.7
T_6	SADH(1000 ppm)	12.0	12.8	13.6	13.9	13.1	11.3	11.9	12.4	12.8	12.1
T_7	H_3BO_3+GA	10.6	10.8	11.9	11.4	11.2	9.9	10.3	11.1	11.2	10.6
T_8	H_3BO_3+SADH	11.0	12.4	12.7	12.8	12.2	11.0	11.3	11.7	11.4	11.3
T_9	$CaCl_2$+GA	10.2	11.6	12.4	12.9	11.8	10.5	11.8	12.7	13.0	10.7
T_{10}	$CaCl_2$+MH	10.2	11.7	11.9	12.1	11.5	10.0	10.3	10.7	10.8	10.4
T_{11}	KNO_3+MH	11.7	12.1	13.2	13.6	12.6	10.8	11.2	12,3	12.5	11.7
T_{12}	KNO_3+SADH	11.8	12.6	13.7	13.8	13.0	11.1	11.9	12.7	13.2	12.2
T_{13}	H_3BO_3+$CaCl_2$+GA	11.5	12.1	13.0	11.9	12.1	10.4	10.8	11.4	12.7	11.3
T_{14}	H_3BO_3+GA+SADH	10.1	10.6	11.0	11.5	10.8	9.5	10.3	11.2	11.3	10.6
T_{15}	$CaCl_2$+GA+MH	11.4	12.7	11.6	11.2	11.7	10.5	11.2	11.7	11.9	11.3
T_{16}	$CaCl_2$+KNO_3+MH	10.6	11.1	12.6	11.9	11.5	9.8	10.2	10.7	11.0	10.4
T_{17}	KNO_3+MH+SADH	11.1	11.6	12.0	12.9	11.9	10.4	10.9	11.4	11.9	11.2
T_{18}	KNO_3+GA+SADH	10.3	11.1	12.5	11.6	11.4	9.9	10.3	11.0	11.3	10.6
T_{19}	Control	9.8	12.0	12.7	13.1	11.9	9.4	11.2	12.4	12.4	11.4
	Mean	11.9	11.9	12.6	12.5	12.0	10.3	10.9	11.7	12.0	11.2

L.S.D.(p=0.05)

	1982	1983
Treatment	N.S.	N.S.
Storage date	N.S.	0.9
Treatment x date	N.S.	N.S.

Appendix 13. Effect of nutrients and growth regulators on the acid content and pulp pH of New Castle apricot fruits stored at 0°C

ment Treatment	Acidity(%)										Pulp pH									
	1982					1983					1982					1983				
	Days after storage																			
	0	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	Mean
H_3BO_3(0.2%)	0.91	0.72	0.68	0.60	0.73	0.68	0.64	0.57	0.55	0.61	3.4	3.6	3.6	3.7	3.6	3.6	3.8	3.9	3.9	3.8
$CaCl_2$(0.5%)	0.91	0.66	0.66	0.55	0.70	0.73	0.63	0.54	0.44	0.59	3.4	3.6	3.6	3.7	3.6	3.7	3.9	4.0	4.2	3.9
KNO_3 (0.5%)	0.89	0.61	0.61	0.59	0.67	0.71	0.58	0.56	0.51	0.59	3.5	3.6	3.6	3.7	3.6	3.8	3.8	3.9	4.2	3.9
GA (50 ppm)	0.98	0.67	0.66	0.64	0.74	0.82	0.59	0.57	0.50	0.62	3.5	3.5	3.6	3.7	3.6	3.8	3.8	3.9	4.2	3.9
MH (1000 ppm)	0.72	0.69	0.67	0.66	0.68	0.56	0.54	0.52	0.52	0.54	3.4	3.5	3.6	3.6	3.5	3.6	3.7	3.8	3.9	3.8
SADH(1000 ppm)	0.99	0.73	0.72	0.51	0.74	0.76	0.71	0.57	0.52	0.64	3.5	3.6	3.6	3.7	3.6	3.7	3.8	3.9	4.1	3.9
H_3BO_3+GA	0.81	0.79	0.78	0.52	0.72	0.72	0.63	0.55	0.54	0.61	3.4	3.6	3.6	3.7	3.6	3.7	3.8	3.9	4.0	3.8
H_3BO_3+SADH	0.88	0.65	0.63	0.60	0.69	0.73	0.57	0.55	0.51	0.59	3.5	3.5	3.6	3.6	3.6	3.7	3.8	3.9	3.9	3.8
$CaCl_2$+GA	0.85	0.76	0.65	0.63	0.72	0.72	0.63	0.55	0.53	0.61	3.5	3.6	3.6	3.7	3.6	3.8	3.9	3.9	4.1	3.9
$CaCl_2$+MH	0.80	0.67	0.67	0.56	0.67	0.68	0.54	0.49	0.47	0.55	3.4	3.5	3.6	3.7	3.6	3.7	3.7	3.9	3.9	3.8
KNO_3+MH	0.77	0.65	0.64	0.50	0.64	0.71	0.57	0.49	0.41	0.55	3.4	3.5	3.6	3.7	3.6	3.7	3.8	3.9	4.0	3.9
KNO_3+SADH	0.84	0.79	0.62	0.47	0.68	0.66	0.63	0.57	0.50	0.59	3.4	3.5	3.5	3.5	3.5	3.6	3.7	3.7	3.8	3.7
H_3BO_3+$CaCl_2$+GA	0.80	0.74	0.64	0.58	0.69	0.64	0.63	0.55	0.55	0.59	3.3	3.5	3.7	3.7	3.5	3.5	3.6	3.8	3.9	3.7
H_3BO_3+SADH+GA	0.81	0.68	0.66	0.64	0.70	0.64	0.59	0.58	0.56	0.59	3.5	3.5	3.6	3.7	3.6	3.6	3.8	3.8	4.1	3.8
$CaCl_2$+GA+MH	0.70	0.66	0.65	0.63	0.66	0.65	0.63	0.57	0.44	0.57	3.4	3.5	3.7	3.7	3.6	3.8	3.9	4.1	4.1	4.0
$CaCl_2$+KNO_3+MH	0.92	0.67	0.60	0.59	0.69	0.82	0.63	0.62	0.41	0.62	3.4	3.5	3.6	3.7	3.5	3.7	3.8	3.8	3.9	3.8
KNO_3+MH+SADH	0.83	0.71	0.71	0.56	0.70	0.74	0.65	0.57	0.45	0.60	3.4	3.4	3.8	3.8	3.6	3.8	3.8	4.1	4.2	4.0
KNO_3+GA+SADH	0.84	0.67	0.66	0.64	0.70	0.81	0.58	0.53	0.47	0.60	3.4	3.5	3.6	3.7	3.5	3.6	3.6	3.7	3.8	3.7
Control	0.97	0.56	0.55	0.57	0.66	0.67	0.59	0.49	0.43	0.54	3.2	3.5	3.6	3.8	3.5	3.5	3.7	3.8	3.9	3.7
Mean	0.85	0.69	0.66	0.58	0.70	0.71	0.61	0.54	0.49	0.59	3.4	3.5	3.6	3.7	3.6	3.7	3.8	3.9	4.0	3.8

L.S.D. ($p=0.05$)	Acidity 1982	Acidity 1983	Pulp pH 1982	Pulp pH 1983
Treatment	0.03	0.02	0.05	0.06
Storage date	0.01	0.01	0.02	0.03
Treatment x date	0.06	0.03	0.10	N.S.

Appendix 14. Effect of nutrients and growth regulators on the nutrient status (N,P,K) of NewCastle apricot fruits stored at $0^{o}C$ (mg 100^{-1} g fresh weight)

Treatment No.	Treatment	Nitrogen						Phosphorus						Potassium					
		1982			1983			1982			1983			1982			1983		
		Days after storage																	
		0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean
T_1	H_3BO_3(0.2%)	138.0	134.7	136.3	128.7	137.7	133.2	27.0	29.0	28.0	31.0	32.0	31.5	120.0	111.0	115.5	118.3	116.9	117.2
T_2	$CaCl_2$(0.5%)	217.0	202.3	209.7	224.7	217.0	220.8	27.7	30.0	28.8	31.0	31.6	31.3	105.0	125.0	115.0	120.7	142.0	131.3
T_3	KNO_3 (0.5%)	120.0	188.0	154.0	140.7	167.3	154.0	30.0	31.0	30.5	30.0	30.6	30.3	116.0	122.3	119.2	135.3	122.0	128.7
T_4	GA (50 ppm)	99.7	173.0	136.3	186.0	193.0	189.5	30.0	35.0	32.5	30.0	34.3	32.2	105.3	100.3	102.8	122.0	124.0	123.0
T_5	MH (1000 ppm)	102.7	180.0	141.0	144.0	212.3	178.2	31.0	28.7	29.8	25.7	26.6	26.2	91.0	116.7	103.8	104.0	114.0	109.0
T_6	SADH(1000 ppm)	132.0	188.0	160.2	185.3	159.7	172.5	24.0	26.0	25.0	23.0	26.0	24.5	112.0	131.3	121.7	130.7	136.0	133.3
T_7	H_3BO_3+GA	146.7	172.3	159.5	137.7	170.0	153.8	28.0	34.3	31.2	30.0	34.0	32.0	138.3	121.3	129.8	82.0	105.0	93.5
T_8	H_3BO_3+SADH	112.3	179.0	145.7	127.3	186.3	156.8	23.7	30.0	26.8	23.0	28.0	25.5	106.0	132.0	119.0	108.0	116.0	112.0
T_9	$CaCl_2$+GA	110.7	157.3	134.0	176.7	162.7	169.7	28.7	29.7	29.2	29.0	30.3	29.7	158.0	141.7	149.8	118.7	122.0	120.3
T_{10}	$CaCl_2$+MH	142.0	207.0	174.5	142.3	210.3	176.3	28.0	30.0	29.0	27.3	26.7	27.0	88.7	114.0	101.3	107.3	116.0	111.7
T_{11}	KNO_3+MH	106.3	157.0	131.7	125.7	168.3	147.0	32.0	30.0	31.0	28.0	29.0	28.5	102.7	104.7	103.7	94.3	112.0	103.2
T_{12}	KNO_3+SADH	111.7	195.0	153.3	179.7	186.0	182.8	31.0	34.0	32.5	30.0	32.0	31.0	108.3	120.3	114.3	92.3	116.0	104.2
T_{13}	H_3BO_3+$CaCl_2$+GA	115.7	189.0	152.3	174.3	194.7	184.5	27.7	34.0	30.8	32.0	32.7	32.3	110.0	121.0	115.5	106.0	119.0	112.5
T_{14}	H_3BO_3+SADH+GA	156.3	198.0	177.2	185.7	223.0	204.3	27.0	34.0	30.5	34.0	32.7	33.3	130.0	132.3	131.2	87.0	112.0	99.5
T_{15}	$CaCl_2$+GA+MH	113.7	175.0	144.3	133.3	165.0	149.2	31.0	27.0	29.0	35.0	31.0	33.0	90.0	99.0	94.5	118.3	122.0	120.2
T_{16}	$CaCl_2$+KNO_3+MH	112.3	192.0	152.2	173.7	174.0	173.8	28.0	26.0	27.0	27.0	25.3	26.2	103.0	146.7	124.8	85.0	114.0	99.5
T_{17}	KNO_3+MH+SADH	116.0	142.3	129.2	147.3	165.0	156.2	32.0	30.0	31.0	25.0	26.3	25.7	93.0	114.0	103.5	110.0	119.0	114.5
T_{18}	KNO_3+GA+SADH	106.0	149.3	127.7	132.0	136.7	134.3	30.0	32.3	31.2	30.0	31.0	30.5	94.0	121.0	107.5	104.0	121.0	112.5
T_{19}	Control	101.0	146.3	123.7	127.0	156.3	141.7	25.0	26.0	25.5	25.3	25.0	25.2	114.0	136.7	125.3	82.0	122.3	102.2
	Mean	124.2	175.0	149.6	156.4	174.4	167.3	28.5	30.4	29.4	28.8	29.8	29.3	109.8	121.6	115.7	106.6	119.5	113.1

L.S.D. (p=0.05)	Nitrogen 1982	Nitrogen 1983	Phosphorus 1982	Phosphorus 1983	Potassium 1982	Potassium 1983
Treatment	22.7	15.8	N.S.	N.S.	11.0	8.3
Storage date	7.4	5.1	N.S.	N.S.	3.6	2.7
Treatment x date	32.0	22.3	N.S.	N.S.	15.6	11.8

Appendix 15. Effect of nutrients and growth regulators on the nutrient status (Ca, Mg, Fe) of New Castle apricot fruits stored at $0^{o}C$

Treatment No.	Treatment	Calcium 1982			Calcium 1983			Magnesium 1982			Magnesium 1983			Iron 1982			Iron 1983		
		Days after storage																	
		0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean
T_1	H_3BO_3(0.2%)	44.0	60.0	52.0	42.0	56.0	50.0	55.7	75.3	65.5	51.0	60.7	55.8	0.44	0.96	0.70	0.50	1.14	0.82
T_2	$CaCl_2$(0.5%)	54.0	56.0	52.0	50.0	52.0	52.0	61.7	88.7	75.2	52.7	63.7	58.2	0.60	0.83	0.72	0.75	1.11	0.93
T_3	KNO_3 (0.5%)	46.0	50.0	48.0	46.0	48.0	48.0	52.0	87.7	69.8	44.0	68.0	56.0	0.39	0.83	0.61	0.50	1.31	0.90
T_4	GA (50 ppm)	46.0	44.0	46.0	48.0	50.0	50.0	65.3	73.0	69.2	49.7	55.0	52.3	0.36	0.58	0.47	0.42	0.88	0.65
T_5	MH (1000 ppm)	50.0	48.0	50.0	52.0	52.0	52.0	70.7	69.0	69.8	51.7	55.0	53.3	0.33	0.60	0.46	0.40	0.86	0.63
T_6	SADH(1000 ppm)	52.0	46.0	50.0	44.0	42.0	44.0	54.0	65.0	59.5	47.0	54.7	50.8	0.31	0.64	0.47	0.37	0.92	0.64
T_7	H_3BO_3+GA	48.0	56.0	52.0	50.0	54.0	52.0	57.3	74.0	65.7	46.7	61.0	53.8	0.32	0.65	0.48	0.48	0.94	0.71
T_8	H_3BO_3+SADH	44.0	48.0	46.0	42.0	[illegible]	44.0	59.0	79.3	69.2	45.7	55.7	50.7	[illegible]	[illegible]	0.47	[illegible]	[illegible]	0.77
T_9	$CaCl_2$+GA	52.0	58.0	56.0	[illegible]	[illegible]	[illegible]	60.0	71.7	[illegible]	[illegible]	[illegible]	51.3	0.41	0.60	0.51	0.60	0.92	0.76
T_{10}	$CaCl_2$+MH	46.0	48.0	[illegible]	[illegible]	46.0	44.0	57.3	73.0	65.2	44.0	56.0	50.0	0.32	0.74	0.53	0.44	1.09	0.76
T_{11}	KNO_3+MH	48.0	[illegible]	[illegible]	42.0	50.0	50.0	58.3	64.7	61.5	54.0	61.0	57.5	0.33	0.70	0.51	0.61	1.12	0.86
T_{12}	KNO_3+SADH	46.0	42.0	44.0	50.0	44.0	48.0	57.7	66.7	62.2	47.3	53.7	50.5	0.32	0.74	0.53	0.47	1.32	0.89
T_{13}	H_3BO_3+$CaCl_2$+GA	[illegible]	48.0	48.0	50.0	48.0	50.0	62.7	75.3	69.0	52.7	58.7	55.7	0.32	0.66	0.49	0.48	0.94	0.71
T_{14}	H_3BO_3+SADH+GA	48.0	54.0	52.0	44.0	48.0	46.0	61.3	66.0	63.7	46.3	54.0	50.2	0.27	0.58	0.43	0.40	0.89	0.64
T_{15}	$CaCl_2$+GA+MH	48.0	52.0	50.0	48.0	54.0	52.0	52.7	72.7	62.7	45.0	55.3	50.2	0.33	0.68	0.50	0.40	1.22	0.81
T_{16}	$CaCl_2$+KNO_3+MH	48.0	48.0	48.0	46.0	48.0	48.0	64.0	79.3	71.7	48.7	59.0	53.8	0.26	0.64	0.45	0.38	1.00	0.69
T_{17}	KNO_3+MH+SADH	48.0	54.0	52.0	48.0	52.0	50.0	54.0	67.3	60.7	44.7	55.0	49.8	0.32	0.66	0.49	0.41	1.09	0.75
T_{18}	KNO_3+GA+SADH	44.0	56.0	50.0	42.0	52.0	48.0	60.3	67.0	63.7	46.7	55.3	51.0	0.26	0.58	0.42	0.39	0.80	0.59
T_{19}	Control	48.0	52.0	50.0	46.0	50.0	48.0	55.7	59.0	57.3	46.3	53.3	49.8	0.33	0.62	0.47	0.41	0.92	0.66
	Mean	47.4	50.8	49.1	46.8	49.7	48.3	58.9	72.3	65.6	48.0	57.3	52.7	0.34	0.68	0.51	0.46	1.03	0.75
	L.S.D. (p=0.05)																		
	Treatment	4.2			5.3			3.2			4.2			0.06			0.08		
	Storage date	1.4			1.7			1.0			1.4			0.02			0.03		
	Treatment × date	6.0			N.S.			4.5			6.0			0.08			0.11		

Appendix 16. Effect of nutrients and growth regulators on the nutrient status (Cu, Zn, Mn) of New Castle apricot stored at 0°C (mg 100^{-1}g fresh weight)

Treatment No.	Treatment	Copper						Zinc						Manganese					
		1982			1983			1982			1983			1982			1983		
		Days after storage																	
		0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean	0	30	Mean
T_1	H_3BO_3(0.2%)	0.07	0.12	0.10	0.08	0.13	0.11	0.39	0.56	0.47	0.40	0.51	0.46	0.22	0.33	0.27	0.31	0.43	0.37
T_2	$CaCl_2$(0.5%)	0.07	0.13	0.10	0.09	0.14	0.11	0.31	0.50	0.41	0.31	0.49	0.40	0.21	0.34	0.27	0.32	0.45	0.39
T_3	KNO_3 (0.5%)	0.07	0.11	0.09	0.08	0.11	0.10	0.35	0.46	0.40	0.33	0.41	0.37	0.22	0.33	0.27	0.30	0.41	0.36
T_4	GA (50 ppm)	0.08	0.11	0.09	0.08	0.11	0.10	0.44	0.58	0.51	0.41	0.50	0.46	0.20	0.33	0.26	0.32	0.42	0.37
T_5	MH (1000 ppm)	0.08	0.11	0.09	0.08	0.11	0.10	0.36	0.57	0.46	0.37	0.50	0.44	0.19	0.35	0.27	0.29	0.44	0.37
T_6	SADH(1000 ppm)	0.07	0.11	0.09	0.08	0.11	0.10	0.42	0.56	0.49	0.39	0.49	0.44	0.20	0.34	0.27	0.28	0.38	0.33
T_7	H_3BO_3+GA	0.08	0.11	0.10	0.10	0.11	0.10	0.31	0.52	0.41	0.30	0.45	0.37	0.20	0.32	0.26	0.30	0.40	0.35
T_8	H_3BO_3+SADH	0.07	0.14	0.11	0.08	0.13	0.10	0.38	0.54	0.46	0.41	0.52	0.46	0.19	0.34	0.27	0.28	0.40	0.34
T_9	$CaCl_2$+GA	0.07	0.11	0.09	0.08	0.11	0.09	0.36	0.46	0.41	0.33	0.38	0.35	0.23	0.35	0.29	0.32	0.48	0.40
T_{10}	$CaCl_2$+MH	0.07	0.12	0.10	0.08	0.12	0.10	0.44	0.58	0.51	0.42	0.50	0.46	0.18	0.32	0.25	0.28	0.39	0.33
T_{11}	KNO_3+MH	0.07	0.11	0.09	0.08	0.11	0.10	0.46	0.59	0.52	0.42	0.49	0.45	0.18	0.32	0.25	0.30	0.37	0.33
T_{12}	KNO_3 +SADH	0.07	0.10	0.08	0.07	0.10	0.09	0.38	0.55	0.47	0.39	0.52	0.46	0.20	0.32	0.26	0.30	0.41	0.35
T_{13}	H_3BO_3+$CaCl_2$+GA	0.06	0.10	0.08	0.07	0.11	0.09	0.38	0.52	0.45	0.38	0.47	0.42	0.20	0.33	0.26	0.29	0.41	0.35
T_{14}	H_3BO_3+SADH+GA	0.07	0.11	0.09	0.09	0.11	0.10	0.39	0.48	0.43	0.36	0.43	0.39	0.20	0.33	0.26	0.27	0.38	0.33
T_{15}	$CaCl_2$+GA+MH	0.07	0.11	0.09	0.08	0.07	0.08	0.37	0.47	0.42	0.35	0.43	0.39	0.19	0.35	0.27	0.31	0.45	0.38
T_{16}	$CaCl_2$+~~GA~~ (KNO_3)+MH	0.07	0.10	0.09	0.08	0.11	0.09	0.35	0.41	0.38	0.33	0.40	0.37	0.19	0.35	0.27	0.29	0.46	0.37
T_{17}	KNO_3+MH+SADH	0.09	0.10	0.09	0.08	0.10	0.09	0.39	0.45	0.42	0.38	0.42	0.40	0.18	0.34	0.26	0.29	0.42	0.35
T_{18}	KNO_3+GA+SADH	0.07	0.11	0.09	0.09	0.11	0.10	0.37	0.43	0.40	0.36	0.42	0.39	0.18	0.35	0.26	0.31	0.40	0.35
T_{19}	Control	0.07	0.10	0.09	0.07	0.11	0.09	0.22	0.39	0.31	0.27	0.37	0.32	0.17	0.32	0.24	0.27	0.36	0.31
	Mean	0.07	0.11	0.09	0.08	0.11	0.10	0.37	0.51	0.44	0.36	0.46	0.41	0.20	0.33	0.26	0.30	0.41	0.36

L.S.D.(p=0.05)

	Copper 1982	Copper 1983	Zinc 1982	Zinc 1983	Manganese 1982	Manganese 1983
Treatment	0.005	0.006	0.02	0.02	0.013	0.020
Storage date	0.002	0.002	0.01	0.01	0.004	0.008
Treatment x date	0.007	0.008	0.03	0.02	N.S.	N.S.

Appendix 17. Effect of nutrients and growth regulators on the leaf nutrient status of New Castle apricot

Treatment No.	Treatment	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Calcium (%)		Magnesium (%)		Iron (ppm)		Copper (ppm)		Zinc (ppm)		Manganese (ppm)	
		1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983
T_1	H_3BO_3(0.2%)	1.87	1.90	0.29	0.28	2.95	3.11	3.11	3.53	0.64	0.74	216.0	218.0	5.6	5.4	12.8	12.4	16.0	14.4
T_2	$CaCl_2$(0.5%)	1.63	1.68	0.26	0.25	3.40	3.60	2.92	3.16	0.70	0.82	295.0	291.0	5.9	6.2	14.2	14.6	23.6	21.1
T_3	KNO_3 (0.5%)	1.71	1.76	0.25	0.25	3.08	3.15	3.19	3.44	0.71	0.70	240.0	229.0	5.9	6.1	14.5	14.8	24.1	21.0
T_4	GA (50 ppm)	1.62	1.68	0.32	0.36	3.34	3.50	3.00	3.65	0.68	0.69	238.0	201.0	5.6	5.5	15.8	16.0	21.2	19.5
T_5	MH (1000 ppm)	1.79	1.82	0.25	0.24	2.74	2.62	2.98	3.55	0.72	0.76	167.0	195.0	6.7	6.7	11.5	12.0	13.3	14.0
T_6	SADH (1000 ppm)	1.56	1.59	0.30	0.28	3.37	3.51	2.88	3.26	0.69	0.71	192.0	189.0	6.5	6.7	13.4	13.0	18.1	17.5
T_7	H_3BO_3+GA	1.70	1.73	0.29	0.27	3.60	3.65	2.60	2.65	0.75	0.66	260.0	240.0	6.9	6.8	15.1	15.4	22.5	18.0
T_8	H_3BO_3+SADH	1.68	1.73	0.26	0.25	2.95	3.15	3.10	3.78	0.75	0.74	233.0	220.0	7.0	7.2	13.8	14.0	22.1	18.0
T_9	$CaCl_2$+GA	1.65	1.72	0.27	0.27	3.00	3.15	2.60	2.92	0.66	0.64	294.0	242.0	5.2	5.5	14.5	15.0	22.0	20.5
T_{10}	$CaCl_2$+MH	1.52	1.60	0.29	0.26	2.62	2.79	2.88	3.38	0.80	0.74	270.0	269.0	6.8	7.1	15.0	14.2	25.0	22.5
T_{11}	KNO_3+MH	2.12	2.19	0.28	0.26	2.66	2.69	2.50	2.43	0.78	0.71	152.0	170.0	7.1	7.2	14.0	13.6	22.5	20.0
T_{12}	KNO_3+SADH	1.55	1.61	0.28	0.27	2.78	2.88	2.61	3.03	0.75	0.68	258.0	208.0	7.4	7.3	11.0	11.8	16.1	14.0
T_{13}	H_3BO_3+$CaCl_2$+GA	1.86	1.92	0.26	0.27	3.43	3.30	3.08	3.88	0.64	0.78	274.0	262.0	6.3	6.7	13.5	14.0	18.1	13.0
T_{14}	H_3BO_3+SADH+GA	1.58	1.66	0.25	0.26	3.26	3.56	2.94	3.62	0.65	0.84	196.0	185.0	7.7	7.8	12.4	12.6	13.8	13.5
T_{15}	$CaCl_2$+GA+MH	1.58	1.63	0.25	0.25	3.06	3.01	2.44	2.89	0.63	0.69	236.0	205.0	5.4	5.8	12.6	13.0	16.5	13.8
T_{16}	$CaCl_2$+KNO_3+MH	1.57	1.65	0.26	0.25	2.63	2.81	2.88	3.12	0.77	0.79	231.0	188.0	5.8	6.1	13.2	13.0	19.4	17.5
T_{17}	KNO_3+MH+SADH	1.38	1.44	0.26	0.24	3.22	3.30	2.33	2.80	0.61	0.81	291.0	219.0	8.6	8.8	12.0	12.4	15.3	14.0
T_{18}	KNO_3+GA+SADH	1.78	1.85	0.29	0.27	3.50	3.55	2.74	3.11	0.83	0.88	192.0	213.0	5.2	5.6	16.6	16.0	25.2	23.5
T_{19}	Control	1.88	1.96	0.19	0.18	2.67	2.56	2.82	3.14	0.84	0.74	253.0	223.0	6.4	6.6	16.0	17.5	34.0	32.0
	L.S.D.(p=0.05)	0.16	0.13	0.03	0.02	0.20	0.35	0.29	0.17	0.05	0.08	29 .8	25.6	0.3	0.3	1.0	0.7	2.2	5.9