EFFECT OF PRUNING ON GROWTH, QUANTITY AND QUALITY OF PRODUCE IN PEPPER (*Piper nigrum*. L)

BY

SAJAN KURIEN

THESIS

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Faculty of Agriculture
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Department of Horticulture (Plantation Crops & Spices)
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1982

To

my

Parents

DECLARATION

I hereby declare that this thesis entitled "Effect of pruning on growth, quantity and quality of produce in pepper (*Piper nigrum* L.) " is a bonafide record of research work done by me during the course of research work and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

SAJAN KURIEN

Vellanikkara,

23rd August 1982

CERTIFICATE

Certified that this thesis entitled "Effect of pruning on growth, quantity and quality of produce in in pepper (*Piper nigrum* L.)" is a record of research work done independently by Sajan Kurien under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associate-ship to him.

Dr. P.C. SIVARAMAN NAIR,
Director of Research,
Kerala Agricultural University.
Vellanikkara,
23rd August, 1982.

CERTIFICATE

We, the undersigned members of the Advisory Committee of Sri. Sajan Kurien, a candidate for the degree of Master of Science in Horticulture agree that the thesis entitled "Effect of pruning on growth, quantity and quality of produce in pepper (*Piper nigrum* L.)" may be submitted by Sri. Sajan Kurien in partial fulfilment of the requirement for the degree.

Dr. P.C. SIVARAMAN NAIR
Adviser and Chairman

Dr. ABI CHEERAN,
Member
(Substituted by Dr. N. Mohanakumaran)

Prof. S. BALAKRISHNAN,
Member

Dr. P.A. WAHID,
Member

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SAJAN KURIEN

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Introduction

INTRODUCTION

The black pepper, Piper nigrum L. is a native of Western Ghats. It has a unique place both in the history and economics of the country. This 'black gold' prompted Vasco De Gama to find a sea route to India. Black pepper of commerce is the dried mature berries of pepper. Although we had the monopoly in pepper trade in the world, we are loosing that covetable position due to stagnant production which was only between 26 to 28 thousand tonnes during the last fifty years, while the countries like Indonesia, Malaysia and Brazil substantially increased their production.

During 1980-81, India exported 25,337 tonnes black pepper valued to the tune of Rs.36.84 crores. India produced 27,410 tonnes from an area of 1.1 lakh hectares during the same period. But the average yield was only 248 kg/ha as against 551 kg to 925 kg in Indonesia, 4067 kg in Malaysia, 3333 kg in Brazil and 636 kg per hectare in Madagascar.

Kerala produces 96.75 per cent of India's production from an area 1.07 lakh hectare with an average yield of 248 kg per hectare. Unless the production and productivity of pepper in Kerala are increased by three to four times by 2000 A.D., it is quite possible that India will decrease its present share of 28 per cent in the world trade substantially.

Source: Directorate of Cocoa, Arecanut & Spices Development, Calicut.

This will also result in substantial reduction in the foreign exchange.

Unproductive vines, non-manuring, under manuring or inbalanced manuring, lack of adoption of known scientific technology in cultural and pest and disease management are the main reasons for low production and productivity.

In horticulture, training and pruning are important tools by which a crop can be managed for quality products. But adoption of such a technology depends upon several factors like fruiting habit, plant growth, physiology of growth and development of the species, climatical and soil conditions. Pepper is found to produce spikes on the leaf axils of the lateral branches of the new season growth when 8 to 10 cm of rains are received in May or June after the severe summer. Although the plant is capable of producing spikes on each axil opposite to the leaf, often several spikes are aborted in the early stages of growth. Therefore, it has to be investigated whether the unwanted growth in the previous season is absolutely necessary or such unwanted portion can be favourably reduced for higher production by proper pruning.

Practically no work has been done on the pruning aspects of pepper. Therefore the work on the pruning of the bearing laterals have been taken up with the objectives of finding out whether the pruning will be able to increase

the production of lateral shoots and yield and whether it is necessary to retain large volume of unproductive lateral shoots.

Review of Literature

REVIEW OF LITERATURE

Training and pruning are important tools available by which a crop can be regulated to the desired level of productivity with higher quality. They are being practised in several horticultural crops. The training and pruning technique varies widely depending upon the nature of plant, cropping and different aspects of growth.

Pepper (Piper nigrum L) generally flowers once in a year under Kerala conditions, although occasional off season crop, in a very low percentage, is noticed in September-October depending upon the rainfall received. The spikes are produced on the axils of the current season growth. Regulation of growth by pruning therefore can optimise the production to a certain extent.

Chandy et al. (1979) observed that in pepper there is a possibility of producing a spike in the axil of every fresh leaf. Chandy and Pillai (1979) stated that the production of fruiting branches can be regulated by proper pruning techniques.

There is practically no work done on the pruning of pepper. An attempt has been made to review the relevant literature on pruning of grapes, Apple, Ber, Guava, Tea to correlate the behaviour with that of pepper.

Pruned material

In grapes, Balakrishnan and Rao (1964) observed no correlations between weight of pruning and yield. Lane (1977) concluded that a significant correlation existed between pruning weight and mean yield.

Available literature on nutrient content of pruned material is scanty. In grapes Winkler (1965) reported that by cutting the tip of the vine every day as much as nineteen litres of liquid was collected per vine and a litre contains 0.04 g of nitrogen, 0.356 g of potassium, 0.148 g of calcium and trace of iron.

Balasubramanyan, et al. (1978) stated that the mineral nutrients especially N, P and K resources were greater in vines with little or no crop than in heavily cropped vines.

Studies conducted by Pillai and Sasikumaran (1976) in pepper has shown that the stem contained 1.883 to 2.065, 0.207 to 0.293, 1.203 to 1.902, 0.232 to 0.253, 0.027 to 0.042 and leaf contained 2.667 to 2.835, 0.047 to 0.065, 2.531 to 2.951, 0.416 to 0.464 and 0.015 to 0.040 per cent of N, P, K, Ca and Mg respectively. A comparative study of nutrient constituents of flowering and nonflowering shoots of pepper showed that N, P, K and Ca of flowering shoots ranged from 1.91 to 2.40, 0.113 to 0.140, 1.39 to 1.62 and 1.29 to 1.61 per cent and in nonflowering shoots from 1.97 to 2.24, 0.105 to 0.152, 1.21 to 1.58 and 1.41 to 1.74 per cent respectively (Geetha, 1981).

Vegetative characters

Gregov (1975) concluded that in Apple, pruning dates had no appreciable effect on trunk girth but in all cases pruned trees had greater trunk girth than unpruned trees, which was also observed in Ber (Gupta and Singh, 1977).

In grapes, Cawthon and Morris (1977) proved that higher degree of lighter pruning did not significantly reduce vine size. Lane (1977) attributed an increase in yield with cane pruning to larger vine size. Spayd and Morris (1978) explained that the weight of pruned material will be increased as the size of vine increased.

Nijjar (1972) opined that pruning greatly influences the growth of a tree and heavy pruning whether young or old generally results in profuse vegetative growth.

In Apple, Negrula and Lupescu (1969) reported that poor growth occurred due to pruning but positive results were obtained by Gregov (1975), Ellving and Forshey (1976), Karpenchuk and Rubanenko (1979) and Lord et al. (1979). In Tea more vigorous growth was noticed by pruning by Basu and Dutta (1974), Escartiya (1976) and Alkazov (1977).

Alexander et al. (1971) concluded that total increment in growth was reduced by shoot and root pruning in sweet orange. In grapes crop load depresses the total growth of the vines (Bakshi and Kanwar, 1970; Lieul, 1969). Shrivastav et al. (1970) reported that the growth of vines

was affected by dates of pruning. Cawthon and Morris (1977), Granada (1977), Makharov (1977) and Kasmatis (1981) reported that pruning enhances vegetative growth. Gupta and Singh (1977) reported significant effect on length of new branches due to pruning in Ber.

Raveendran (1970) obtained no significant difference in the number of matured nodes in grape vine due to pruning.

Rema Menon (1980) stated that maximum growth in pepper (cv. Panniyur-1) was observed for a period of four months from May to August and the maximum growth occurred in July followed by June, May and August.

Variation in nutrient content

Melanta (1967) found that in grapes a variation of 5.32 to 0.84, 0.26 to 0.04, 1.61 to 0.32, 0.64 to 1.28 and 0.15 to 0.43 per cent in N, P, K, Ca and Mg respectively from 24 to 124 days after bud burst. Bava (1971) reported a range of 0.56 to 1.40, 0.56 to 1.12 per cent in respect of N at 120 and 150 days after pruning whereas no change was noticed in P and K but Mg content was more at 150 days after pruning and an increase was noted with increasing severity of pruning both at 120 and 150 days.

In black pepper, the NPK content was higher during flowering and spike development stages from June to November and it was found to decrease from November to December.

Ca content was more in nonflowering shoots from July to December (Geetha, 1981).

Flowering

No significant difference was observed between treatments in percentage of fruitful shoots in grapes both by cane and spur pruning (Subbiah, 1969; Shrivastav et al., 1970; Balasubramanian and Khanduja, 1977a). But fruitful shoots were reported to increase by increasing severity of pruning by Das and Melanta (1972), Chanana and Kumar (1974) and by Balasubramaniam and Khanduja (1977b) when bud numbers on cane increased.

Lieul,(1971), stated that increasing the bud load increased the number of shoots and aborted buds. Chandy et al. (1979) reported that the percentage of abortive spikes ranged from 17.4 to 86.2 per cent in various cultivars of pepper and that in Panniyur-1 it was 32.3 per cent.

Yield

Higher significant difference in yield was reported in grapes due to pruning by many workers namely, Subbiah (1969), Raveendran (1970), Shrivastav et al. (1970), Bhujbal (1972), Chanana and Kumar (1974), Balasubramaniam and Khanduja (1977a), Cawthon and Morris (1977), Spayd and Morris (1978) and Kasimatis (1981). Similar effect was reported in other crops also namely by Daniel (1975) in peach, Lal and Prasad (1980)

in Ber, Rao (1971) and Rao and Shanmughavelu (1976) in mango and by Bajpai et al. (1973) in guava. However, nonsignificant difference were also reported by Nijjar (1972), Chaddha and Kumar (1970) in grapes and by Kumar and Bajwa (1973) and Gupta and Singh (1977) in ber.

Higher significant difference in number of bunches due to pruning was reported in grapes by Subbiah (1969), Raveendran (1970), Bhujbal (1972), Chanana and Kumar (1974) and Tafazoli (1977); and in mango by Rao and Shanmughavelu (1976) and in guava by Bajpai et al. (1973). But, Shrivastav et al. (1970), Kumar and Bajwa (1973), Balasubramaniam and Khanduja (1977) and Chadha and Kumar (1970) found no significant differences in the number of bunches in grapes due to pruning. Higher yields per node were reported in grapes due to pruning by Cawthon and Morris (1977) and Spayd and Morris (1978). Shrivastav et al. (1970) attributed the poor yield in grapes by pruning due to shedding of inflorescence. Dabos (1980) reported a reduction in drop due to cane girdling.

In pepper Pillai et al. (1977) observed spike shedding between 8.80 to 18.16 per cent depending on the cultivars. Rema Menon (1980) observed mean shedding of 23.82 per cent and Geetha (1981) found a mean shedding of 18.04 per cent in Panniyur-1. In pepper cv. Panniyur-1, percentage of spike set was found to vary considerably. It varied from 81.84 to 91.20 per cent (Pillai et al., 1977), 76.18 per cent

(Rema Menon, 1980), 81.96 per cent (Geetha, 1981). Lal and Prasad (1980) reported higher fruitset in ber due to pruning.

Length of bunch was found to be significantly altered by pruning in grapes by Subbiah,(1969) and Bava (1971), but no significance was found by Raveendran (1970), Chanana and Kumar (1974). Rema Menon (1980) recorded that Panniyur-1 spikes reached maximum length of 12.5 cm in just over a month under natural conditions. Geetha (1981) found no significant difference in length of spike by the application of growth regulators.

Subbiah (1969), Kumar and Bajwa (1973) found that there existed no difference in undeveloped berries in grapes due to pruning. Geetha (1981) found no significant difference in percentage of undeveloped berries in pepper due to growth regulator treatment.

Pruning had no appreciable effects on number of berries per cluster in grapes as reported by several workers (Cawthon and Morris, 1977; Lane, 1977; and Spayd and Morris, 1978). Geetha (1981) found no significant difference in the number of berries per spike in pepper. But she reported significant difference in number of berries per unit length of spike when growth regulators were applied.

Significant difference was seen in volume of berries of grapes by pruning by Subbiah (1969). Raveendran (1970),

Cawthon and Morris (1977), Lane (1977), Chadha and Kumar (1970) and Spayd and Morris (1978) found no difference in volume of berries due to pruning.

Berry weight in grapes was found to differ in pruning treatment in experiments conducted by Subbiah (1969), Shrivastav et al. (1970), Bava (1971), Kumar and Bajwa (1973), Cawthon and Morris (1977), Lane (1977). But Raveendran (1970) found significant difference due to treatments. Similar results were obtained by in Ber by Gupta and Singh (1977) and Lal and Prasad (1980). Significant difference in berry weight was reported in pepper by Geetha (1981).

No significant difference on percentage weight of berries to spike and oleoresin content was reported by Geetha (1981) in pepper.

Time of pruning

The principal pruning in grapes is done when the vine is dormant. Winkler (1965), Bakshi and Kanwar (1970), Nijjar (1972) and Patil (1975) found that pruning in first October resulted in higher yields. Gaprindashvili (1976) observed that summer pruning improved quality. Sachs (1976) reported that autumn pruning did not cause loss of yield. Vitosevic (1978) reported that late pruning in April gave an average of 33 per cent higher yield.

Daniel (1975) concluded that June pruning increased yields when compared to pruning done in November, December and January in the case of peach.

Materials and Methods

MATERIALS AND METHODS

The studies on the effect of pruning on growth, quantity and quality of produce in bearing pepper (*Piper nigrum*) cv. Panniyur-1 were carried out at the Pepper Research Scheme, Vellanikkara for a period of 14 months from December 1980 to February 1982. The vines were trained on dead wood standards, were six year old and received uniform cultural and manurial treatments as per package of practices of Kerala Agricultural University.

The experiment was laid out in a Randomised Block Design with the following treatments.

T_1 - Control - no pruning

T_2 - Tipping of all the laterals

T_3 - Pruning hanging shoots

T_4 - Pruning 25% of length of last season's laterals

T_5 - Pruning 25% of length of two year old laterals

T_6 - Pruning 50% of length of last season's laterals

T_7 - Pruning 50% of length of two year old laterals

Under each treatment, there were two standards and replicated six times. 20 bearing and 20 nonbearing laterals were located from each plant in December 1980 and tagged separately. Treatments were carried out by April 25th, following the receipt of first pre-monsoon showers. The following observations were recorded.

1. Pruned material

1.1. Fresh and dry weight of pruned material

The pruned materials both leaf and twig were collected and the fresh and dry weights recorded.

1.2. Nutrient content of pruned material

Nitrogen was estimated on dry weight basis by the calorimetric method (Snell and Snell, 1967). The total phosphorus on the triple acid extract was determined by Vanadomolybdophosphoric yellow colour method. Potassium was determined using flame photometer. Calcium and Magnesium were determined using Atomic absorption Spectrophotometer. Utilizing the above data, the nutrient removal was also calculated.

2. Vegetative characters

Extension of shoot growth at fortnight intervals was recorded after pruning till December 25th, 1981. Spread of the vines was recorded at a fixed height prior to pruning, after pruning and in November. Number of nodes per shoot was calculated after recording the number of nodes under each shoot and taking into account the total number of shoots. Nutrient content of new growth was analysed for N, P, K, Ca and Mg in July, September and November 1981, as per the methods of analysis stated earlier.

3. Flowering characters

The number of spikes produced in each vine both bearing and nonbearing laterals selected in December 1980 was recorded. This was again grouped into bearing and nonbearing based on the flowering pattern of 1981 season. From the data the percentage of spikes produced under each category was calculated. The number of spikes aborted was also counted and calculated as per the above procedure.

4. Yield

4.1. Characters

The number of spikes produced under bearing and nonbearing laterals was counted and yield under each category was weighed separately and recorded. Number of spikes produced per node was calculated based on the number of node per shoot and spikes produced. Spike shedding was recorded by counting the spikes every month from bearing and nonbearing shoots and the spikes shedded was determined in case of individual shoots. To find out the total drop from the plant, the individual plant was taken as weight and the spikes shed by each plant were counted and recorded once in three days and the percentage of drop was worked out.

4.2. Spike characters

The following observations were recorded from the harvested spikes of both bearing and nonbearing laterals of 1980 season separately during 1981.

i) Length of spike

ii) Percentage of undeveloped berries per spike

iii) Number of berries per spike

iv) Number of berries per unit length of spike

4.3. Berry characters

The berry characters recorded were

i) Volume of thousand green berries by water displacement method

ii) Weight of thousand green berries

iii) Weight of spikes and berries. The percentage of berry weight to spike weight was then calculated.

5. Quality

Oleoresin content from bearing and nonbearing laterals of previous season was found out separately by Cold Percolation method.

6. Moisture stress studies

Two samples were collected from each replication during the period 10-5-81 to 25-12-1981 at 0-12.5 cm and 12.5-25 cm depth at fortnightly intervals and moisture content of samples determined by Gravimetric method (Michael, 1978).

7. Weather data

The meteorological observations were taken from the University Observatory which is about one kilometer away from the experimental field from January 1981 to January 1982.

8. Effect of time of pruning

A separate observational trial was conducted to find the best time of pruning by pruning four standards at each time interval. Twelve laterals were selected for pruning treatment from each and two standards were available under each treatment and interval. The treatments were as follows.

1. Pruning 25% of length of last season growth
2. Pruning 50% of length of last season growth

The time of pruning were

1. April 15th
2. May 1st
3. May 15th
4. June 1st

All observations except weight of pruned material, nutrient content of pruned and new growth spike shedding, percentage of set and moisture studies were recorded as in the former.

Statistical analysis

The experiment on effect of pruning on growth, quantity and quality of produce in pepper was in Randomised Block Design and analysis of variance technique was applied. Simple correlations were obtained between each nutrient removal by way of pruning and mean extension of growth and another between

the nutrient content at bimonthly interval and the mean yield from the bearing laterals of previous season.

The observational trial to know the effect of time of pruning (2 x 4 factorial) was analysed as complete randomised design (Snedecor and Cochran, 1967).

Results

RESULTS

In order to find out the effect of pruning of the bearing laterals of pepper cv. Panniyur-1, a study was conducted at the Pepper Research Scheme, Vellanikkara for a period of 14 months. The details of the above study are presented under the following major headings.

1.1. Extent of nutrient removal by pruning

1.2. Shoot growth

1.3. Production of spikes

1.4. Characters of spike

1.5. Spike shedding

1.6. Variation in nutrients

1.7. Yield and quality

An observational trial was also laid out to find out the probable optimum period at which pruning can be more efficient and useful and the data on the following are presented under the following headings.

2.1. Shoot growth

2.2. Production of spikes

2.3. Yield and quality

1.1. Extent of nutrient removal by pruning

There was significant difference in the quantity of pruned material removed from plant both in case of green and

Table 1. The extent of removal of pruned material and nutrient from pepper (cv. Panniyur-1) due to pruning

Treatments	Quantity of pruning (g)				Nutrient content of leaves %				
	Green weight		Dry weight		N	P	K	Ca	Mg
	L	T	L	T					
T_2	130.438	8.416	45.256	2.760	1.650	0.167	2.766	0.233	0.723
T_3	14.416	40.886	6.510	18.166	2.690	0.191	2.586	0.237	0.770
T_4	117.830	18.683	36.633	4.393	2.242	0.152	2.505	0.254	0.789
T_5	125.180	51.178	38.783	14.325	2.275	0.171	2.733	0.262	0.821
T_6	154.150	43.758	46.630	7.990	1.827	0.169	2.973	0.221	0.790
T_7	239.900	110.143	77.975	32.766	2.108	0.145	2.260	0.208	0.948
0.05%	S	S	S	S	NS	NS	S	NS	NS
CD	79.725	23.767	28.720	6.967			0.3708		
0.01%	S	S	S	S					

$T_7 T_6 T_2 T_5 T_4 T_3$ $T_7 T_5 T_6 T_3 T_4 T_2$ $T_7 T_6 T_2 T_5 T_4 T_3$ $T_7 T_3 T_5 T_6 T_4 T_2$ $T_6 T_2 T_5 T_3 T_4 T_7$

(contd.)

Table 1. continued

Treatments	Nutrient content in twigs %					Total mean nutrient removal				
	N	P	K	CA	Mg	N	P	K	Ca	Mg
T_2	1.855	0.178	1.460	0.237	0.868	0.775	0.101	1.313	0.076	0.364
T_3	2.105	0.205	1.553	0.237	0.667	0.511	0.093	0.535	0.056	0.170
T_4	2.324	0.181	1.713	0.250	1.083	0.949	0.073	1.031	0.088	0.356
T_5	1.911	0.153	1.393	0.242	0.925	1.140	0.113	1.347	0.132	0.410
T_6	1.750	0.165	1.600	0.214	0.818	0.941	0.103	1.512	0.249	0.401
T_7	1.846	0.251	1.597	0.242	0.892	1.989	0.211	2.302	0.247	0.974
0.05%	NS	S	NS	NS		S	S	S	S	NS	S
CD		0.05357				0.1447	0.6596	0.0726	0.8229		0.3435
0.01%						S	S	S	S		S
		$\underline{T_7T_3T_4T_2T_6T_5}$				$\underline{T_4T_5T_7T_2T_6T_3}$	$\underline{T_7T_5T_4T_6T_2T_3}$	$\underline{T_7T_5T_6T_2T_3T_4}$	$\underline{T_7T_6T_5T_2T_4T_3}$		$\underline{T_7T_5T_6T_2T_4T_3}$

dry weight. There was no significant difference in case of nutrients of leaves and twigs due to treatments except in case of potassium in leaves and phosphorus in twigs. Data are presented in table 1.

There was significant difference in nutrients removed (N, P, K, Mg) by way of pruning materials, except in case of calcium, where there was no significant difference. In case of all the treatments, maximum nutrient removal was in T_7 because of higher quantities of materials removed. In general, the quantity of pruned material and nutrients removed was more in T_7, T_5 and T_6. In case of T_3, the twigs were more but the leaf weight was very low and as such the nutrients removed were found to be comparatively low.

1.2. Shoot growth

1.2.1. Extension growth

No significant difference in mean extension of shoot growth from first fortnight after pruning to 25th June was observed. But from tenth July onwards the growth from the previous season bearing laterals showed significant difference between treatments and the same trend was observed till the cessation of growth. T_3 was the best and was on par with T_7, but was significantly different from the rest of the treatments. Among all the treatments, T_4 recorded the least extension in growth. From the nonbearing laterals of previous season, T_3 recorded the highest extension growth and was on par with T_7,

Table 2. Mean extension growth of shoots in pepper (cm) due to pruning (cv. Pannlyur-1)

Treat-ments	10/5		25/5		10/6		25/6		10/7		25/7		10/8		25/8	
	B	NB	B	NB	B	NB	B	NB	B	NB	B	NB	B	NB	B	NB
T_1	0.168	0.158	0.689	0.666	1.116	1.477	2.716	2.779	3.704	3.418	4.493	4.271	4.696	4.458	4.802	4.511
T_2	0.248	0.316	0.940	0.944	1.388	1.711	2.860	3.850	3.660	4.807	4.198	5.352	4.332	5.432	4.361	5.563
T_3	0.402	0.310	1.245	1.016	1.781	2.029	3.866	4.088	5.064	5.614	6.404	6.771	6,723	7.079	6.781	7.148
T_4	0.218	0.168	0.667	0.587	1.280	1.072	2.589	2.302	3.192	3.003	3.751	3.496	3.889	3.687	3.915	3.687
T_5	0.236	0.248	0.725	0.875	1.106	1.555	2.525	2.506	3.306	3.706	3.882	4.282	3.987	4.401	4.019	4.432
T_6	0.260	0.344	0.901	1.061	1.554	1.691	3.073	2.337	3.958	4.284	4.727	4.998	4.825	5.142	4.854	5.173
T_7	0.257	0.264	1.024	1.155	1.637	1.924	3.228	3.779	4.437	4.706	5.471	5.920	5.471	6.212	5.471	6.302
0.05% CD	NS	NS	NS	NS	NS	NS	NS	NS	S 1.0437	S 1.5705	S 1.334	S 1.8813	S 4.3499	S 1.9004	S 1.3748	S 1.9268
0.01%											S		S		S	

B = Bearing laterals of 1980
NB = Nonbearing laterals of 1980

$T_3T_7T_6T_1T_2T_5T_4$

$T_3T_2T_7T_6T_5T_1T_4$

$T_3T_7T_6T_1T_2T_5T_4$

$T_3T_7T_2T_6T_1T_5T_4$

$T_3T_7T_6T_1T_2T_5T_4$

$T_3T_7T_2T_6T_1T_5T_4$

$T_3T_7T_6T_1T_2T_5T_4$

$T_3T_7T_2T_6T_1T_5T_4$

Table 2. continued

Treatments	10/9		25/9		10/10		25/10		10/11		25/11	
	B	NB	B	NB	B	NB	B	NB	B	NB	B	NB
T_1	4.810	4.511	4.812	4.511	4.812	4.545	4.894	4.600	4.691	4.627	4.911	4.630
T_2	4.381	5.569	4.392	5.578	4.251	5.597	4.465	5.647	4.550	5.697	4.502	5.697
T_3	6.782	7.152	6.784	7.157	6.816	7.222	6.888	7.271	6.930	7.400	6.930	7.400
T_4	3.915	3.682	3.921	3.702	3.962	3.735	3.982	3.784	4.003	3.804	4.029	3.804
T_5	4.023	4.432	4.025	4.436	4.034	4.449	4.139	4.487	4.173	4.548	4.175	4.559
T_6	4.864	5.175	4.869	5.183	4.905	5.218	4.956	5.254	4.948	5.269	4.962	5.269
T_7	5.471	6.302	5.478	6.355	5.540	6.355	5.582	6.462	5.601	6.426	5.568	6.426
0.05% CD	S 1.3747	S 1.9397	S 1.3725	S 1.9301	S 1.367	S 1.9339	S 1.3711	S 1.9395	S 1.3764	S 1.9497	S 1.3917	S 1.9486
0.01%	S		S		S		S		S		S	

$\underline{T_3T_7T_6T_1T_2T_5T_4}$ $\underline{T_3T_7T_2T_6T_1T_5T_4}$ $\underline{T_3T_7T_6T_1T_2T_5T_4}$ $\underline{T_3T_7T_2T_6T_1T_5T_4}$ $\underline{T_3T_7T_6T_1T_2T_5T_4}$ $\underline{T_3T_7T_2T_6T_1T_5T_4}$ $\underline{T_3T_7T_6T_1T_2T_5T_4}$ $\underline{T_3T_7T_2T_6T_1T_5T_4}$ $\underline{T_3T_7T_6T_1T_2T_5T_4}$ $\underline{T_3T_7T_2T_6T_1T_5T_4}$ $\underline{T_3T_7T_6T_1T_2T_5T_4}$ $\underline{T_3T_7T_2T_6T_1T_5T_4}$

B = Bearing laterals of 1980

NB = Nonbearing laterals of 1980

Table 2. continued

Treatments	10/9		25/9		10/10	
	B	NB	B	NB	B	NB
T_1	4.810	4.511	4.812	4.511	4.812	4.545
T_2	4.381	5.569	4.392	5.578	4.251	5.597
T_3	6.782	7.152	6.784	7.157	6.816	7.222
T_4	3.915	3.682	3.921	3.702	3.962	3.735
T_5	4.023	4.432	4.025	4.436	4.034	4.449
T_6	4.864	5.175	4.869	5.183	4.905	5.218
T_7	5.471	6.302	5.478	6.355	5.540	6.355
0.05% CD	S 1.3747	S 1.9397	S 1.3725	S 1.9301	S 1.367	S 1.9339
0.01%	S		S		S	

$\underline{T_4T_7T_6T_1T_2T_5T_4}$ $\underline{T_3T_7T_2T_6T_1T_5T_4}$ $\underline{T_4T_7T_6T_1T_2T_5T_4}$ $\underline{T_3T_7T_2T_6T_1T_5T_4}$ $\underline{T_3T_7T_6T_1T_2T_5T_4}$ $\underline{T_3T_7T_2T_6T_1T_5T_4}$

B = Bearing laterals of 1980

NB = Nonbearing laterals of 1980

25/10			10/11		
B	NB	B	MB	B	MB
4.894	4.600	4.691	4.627	4.911	4.630
4.465	5.647	4.550	5.697	4.502	5.697
6.888	7.271	6.930	7.400	6.930	7.400
3.982	3.784	4.003	3.804	4.029	3.804
4.139	4.487	4.173	4.548	4.175	4.559
4.956	5.254	4.948	5.269	4.962	5.269
5.582	6.462	5.601	6.426	5.563	6.426
S	S	S	S	S	S
1.3711	1.9395	1.3764	1.9497	1.3917	1.9486
S	S	S	S	S	S
$T_3T_7T_6T_1T_2T_5T_4$	$T_3T_7T_2T_6T_1T_5T_4$	$T_3T_7T_6T_1T_2T_5T_4$	$T_3T_7T_2T_6T_1T_5T_4$	$T_3T_7T_6T_1T_2T_5T_4$	$T_3T_7T_2T_6T_1T_5T_4$

T_2 and T_6 upto 10th August, but thereafter, there existed significant difference between T_3 and T_6. T_7 and T_2 were on par with T_3. Growth from both bearing and nonbearing of the previous season occurred only till last fortnight of November (Table 2).

There were two growth flushes - in May and October-November. The first May flush started by 10th of May and extended upto 25th August. The October-November flushes were relatively small in quantity. However, it was seen that such flushes were often overlapped when the entire vine was taken into account and depended mainly on weather conditions.

There existed no correlation between the amount of N, K and Mg removed and mean extension in growth in various treatments, whereas in the case of P (r=0.88) and Ca (r=0.871) removed, there existed a positive correlation.

1.2.2. Spread of vines

The spread of T_3 plants after pruning was superior to rest of treatments but in the North-south direction T_3 was on par with T_1 (control). T_6 recorded the least spread after pruning. After full growth in November, T_3 again recorded the best spread and was significantly superior to all other treatments. T_7 recorded the least spread in both direction. The mean decrease in spread after pruning and in November after full growth showed no significant difference between treatments.

Table 3. Spread of plants after pruning and

Treatments	After pruning (cm)		Difference of mean spread of after or before pruning
	NS	EW	
T_1	52.916	52.330	-17.708
T_2	41.080	47.000	-22.375
T_3	62.660	67.000	-19.625
T_4	42.000	47.083	-27.125
T_5	40.000	44.330	-22.000
T_6	39.420	42.790	-20.646
T_7	38.950	46.330	-26.750
0.05%	S	S	NS
CD	11.1284	11.602	
0.01%	S	S	

$\underline{T_3 T_1 T_4 T_2 T_5 T_7 T_6}$

$\underline{T_3 T_1 T_4 T_2 T_7 T_5 T_6}$

after full growth (cv. Pannlyur-1)

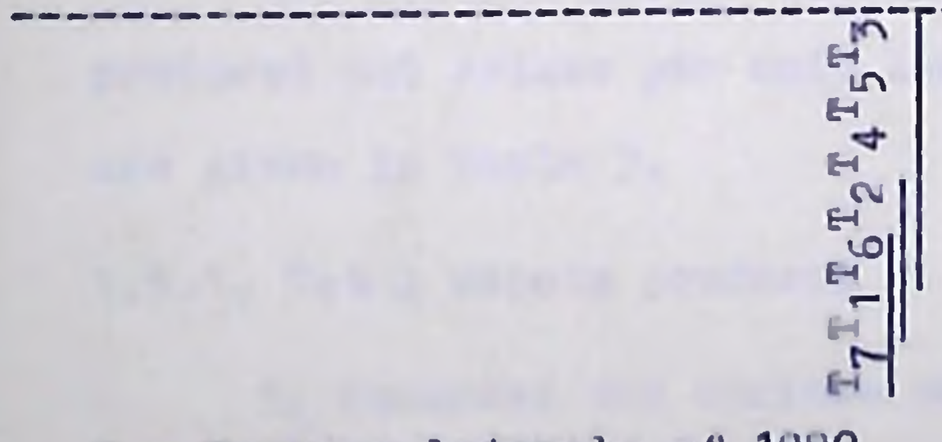
After full growth (cm)		Difference of mean of EW+NS after full growth to before pruning
NS	EW	
52.208	52.208	-14.500
59.208	59.583	-6.8236
76.000	76.000	-9.110
47.208	47.208	-23.400
53.920	53.920	-12.000
52.458	52.458	-10.354
46.458	46.458	-23.502
S	S	NS
12.7647	13.493	
S	S	

$T_3T_2T_5T_1T_6T_4T_7$

$T_3T_2T_5T_6T_1T_4T_7$

Table 4. Nodes per shoot and average length of node due to pruning (cv. Pannlyur-1)

Treatments	Number of nodes per shoot		Average length of node	
	B	NB	B	NB
T_1	1.513	1.513	3.238	3.179
T_2	1.068	1.265	3.216	3.456
T_3	1.161	1.090	3.494	3.417
T_4	1.185	1.118	3.108	2.984
T_5	1.166	1.114	2.996	3.773
T_6	1.218	1.282	3.031	3.286
T_7	1.268	1.646	3.209	3.557
0.05%	NS	S	NS	NS
CD		0.3711		



B = Bearing laterals of 1980

NB = Nonbearing laterals of 1980

The spread of plants with higher degree of pruning was low after pruning and after full growth (Table 3).

1.2.3. Number of nodes per shoot

In the number of nodes per shoot, there existed no significant difference in bearing laterals whereas in non-bearing shoots there existed significant difference. T_7 was the best and was on par with T_1 and T_6 and T_3 recorded the lowest.

1.2.4. Average length of node

No significant difference between the treatments was noted in respect of average length of nodes.

1.3. Production of laterals and spikes

The data on nature of shoots, spiking, number of spikes produced and spikes per unit length due to different treatments are given in Table 5.

1.3.1. Total shoots produced

T_3 recorded the maximum number of shoot production both from bearing and non-bearing laterals and was not significantly different from T_7. T_4 was the lowest in the former and T_5 in the latter.

1.3.2. Bearing shoots

T_3 recorded the maximum number of bearing shoots and was significantly superior to the rest of the treatments in bearing

Table 5. Shoot production and spiking in pepper (cv. Pannlyur-1) due to pruning

Treatments	Total shoots from 20 shoots		Bearing shoots in 1981		Nonbearing shoots in 1981		Percentage of bearing 1981		Percentage of nonbearing 1981	
	B	NB	B	NB	B	NB	B	NB	B	NB
T_1	24.666	25.083	12.166	11.917	12.500	13.166	49.323	47.509	50.677	52.491
T_2	23.000	23.833	7.916	9.917	15.083	13.917	34.825	41.608	65.175	58.392
T_3	31.083	33.666	17.333	18.333	13.750	15.333	56.700	54.455	43.230	45.445
T_4	20.416	22.417	10.250	9.417	10.166	13.000	50.215	42.296	49.785	57.704
T_5	21.166	21.083	4.417	5.833	16.750	15.250	20.864	27.667	79.136	72.333
T_6	24.166	24.416	9.333	8.166	14.833	16.250	38.621	33.480	61.379	66.550
T_7	26.833	29.833	10.166	12.417	16.667	17.416	37.513	41.620	62.487	58.378
0.05% CD	S 4.6348	S 5.3387	S 4.255	S 3.4388	NS	NS	S 14.2265	NS	S 14.294	NS
0.01%	S	S	S				S		S	

$\underline{T_3T_7T_1T_6T_2T_5T_4}$ $\underline{T_3T_7T_1T_6T_2T_4T_5}$ $\underline{T_3T_1T_4T_7T_6T_2T_5}$ $\underline{T_3T_7T_1T_2T_4T_6T_5}$ $\underline{T_3T_4T_1T_6T_7T_2T_5}$ $\underline{T_5T_2T_7T_6T_1T_4T_3}$

B = Bearing laterals of 1980

NB = Nonbearing laterals of 1980

(contd.)

Table 5. continued

Treatments	Number of spikes produced		Number of aborted spikes		Spikes per unit length	
	B	NB	B	NB	B	NB
T_1	13.416	13.000	15.666	15.833	0.140	0.154
T_2	8.833	11.833	17.333	19.250	0.096	0.092
T_3	20.000	21.083	17.583	18.833	0.235	0.140
T_4	12.000	10.666	11.080	14.750	0.163	0.152
T_5	5.583	6.583	18.666	17.416	0.062	0.070
T_6	10.583	9.833	20.080	21.166	0.114	0.144
T_7	10.500	15.000	19.000	20.833	0.590	0.106
0.05%	S	S	NS	NS	NS	NS
CD	5.8789	7.6570				
0.01%	S					

$\underline{T_3 T_1 T_4 T_6 T_7 T_2 T_5}$

$\underline{T_3 T_7 T_1 T_2 T_4 T_6 T_5}$

and non-bearing. In the former, T_1 was the next best and in the latter, T_7 which was on par with T_1. In both cases T_5 was the worst. No significant difference was noted in the number of non-bearing shoots following pruning.

1.3.3. Percentage of bearing shoots

Significant difference was noted in the percentage of bearing from previous season bearing shoots. T_3 was the best but was on par with T_4 and T_1. T_5 had the lowest value. Results from nonbearing shoots were nonsignificant (Table 5). The previous season bearing shoots showed significant difference. T_5 had the maximum percentage of nonbearing shoots and was on par with T_2. T_3 recorded the least. In general in control, 50% of the shoots of the bearing and nonbearing groups of 1980 flowered and produced spikes in 1981. But the treatment had its effect on flowering as stated above.

1.3.4. Number of spikes produced

T_3 recorded the maximum number of spikes and was significantly superior in the case of bearing laterals whereas in nonbearing laterals it was on par with T_7. In both the cases T_5 produced least number of spikes. There was no significant difference in the number of aborted spikes and number of spikes per unit length due to different treatment.

1.4. Characters of spike

The spike and berry characters are presented in Table 6. The length of spike, number of berries per spike, percentage

Table 6. Spike and berry characters of pepper cv. Panniyur-1

Treatments	Length of spike		Number of berries/ spike		Percentage of undeveloped berries		Number of berries/ unit length	
	B	NB	B	NB	B	NB	B	NB
T_1	11.717	11.408	92.953	91.430	6.340	6.354	7.823	7.283
T_2	11.079	10.290	83.349	74.780	8.224	7.654	7.618	7.721
T_3	11.027	12.080	94.493	98.490	6.553	5.920	7.680	8.053
T_4	12.323	11.676	95.516	89.960	7.803	7.239	7.585	7.093
T_5	12.232	11.090	98.949	95.833	5.918	5.866	8.218	8.044
T_6	12.006	10.866	95.949	96.060	5.116	6.469	7.326	7.473
T_7	10.872	10.973	95.422	96.482	5.481	5.549	7.993	7.653
0.05%	NS	NS	NS	NS	NS	NS	NS	NS

B = Bearing laterals of 1980
NB = Nonbearing laterals of 1980

(contd.)

Table 6. continued

Treatments	Percentage weight of berries to weight of spike		Weight of 1000 berries (g)		Volume of 1000 berries (cc)	
	B	NB	B	NB	B	NB
T_1	90.520	91.606	142.100	142.650	141.830	142.000
T_2	89.403	90.963	145.180	146.330	144.000	145.000
T_3	91.749	91.146	149.166	149.160	145.660	145.000
T_4	90.370	89.932	152.700	151.916	149.500	153.500
T_5	89.874	82.343	147.650	149.250	148.500	149.830
T_6	89.930	88.789	148.200	147.900	145.330	148.160
T_7	89.980	89.334	148.116	147.933	149.500	147.830
0.05%	NS	NS	NS	NS	NS	NS

of undeveloped berries, number of berries per unit length, percentage weight of berries to spike weight, weight and volume of thousand berriee were not significantly different due to treatments.

Percentage weight of berries to the spike varied between 82.34 and 91.74, weight of thousand berries varied between 142.1 g and 152.7 g, the volumes varied between 141.83 and 153.5 oc although they were not significant.

1.5. Spike shedding

1.5.1. Number of spikes shed

T_3 had the highest drop followed by T_1 and both were on par. T_5 recorded the lowest drop in the case of previous season bearing laterals. But from the previous season non-bearing laterals treatments were not significant. The maximum number of spikes set was recorded in T_3 and was significantly superior over the rest of treatments in case of previous season bearing laterals whereas it was on par with T_7 in the case of nonbearing laterals of previous season. In both the cases, T_5 recorded the least set (Table 7). Analysis of data showed no significant effect between treatments in case of percentage of set and percentage of drop.

There existed no significant difference in the percentage of spike shed under different treatments in May, July, August, October, November, January and total shedding. Whereas in June and September, T_6 showed maximum shedding and was significantly

Table 7. Mean number of spikes produced, shed, set and percentage of set and drop from 20 B + 20 NB of pepper cv. Panniyur-1

Treatments	Number of spikes produced		Number of spikes dropped		Number of set		Percentage of set		Percentage of drop	
	B	NB	B	NB	B	NB	B	NB	B	NB
T_1	13.416	13.000	2.000	2.167	11.416	10.833	85.092	83.331	14.908	16.669
T_2	8.833	11.833	0.833	1.667	8.000	10.166	90.569	85.912	9.431	14.088
T_3	20.000	21.083	2.583	2.583	17.417	18.500	87.085	87.748	12.915	12.252
T_4	12.000	10.666	1.500	1.417	10.500	9.250	87.500	86.720	12.500	13.280
T_5	5.583	6.833	0.750	0.833	4.833	6.000	86.560	87.809	13.434	12.191
T_6	10.583	9.833	1.250	1.250	9.333	8.583	88.189	87.288	11.811	12.712
T_7	10.500	15.000	1.500	2.000	9.000	13.000	85.715	86.667	14.285	13.333
0.05%	S	S	S	NS	S	S	NS	NS	NS	NS
CD	5.8739	7.657	0.6608		5.0467	6.7767				
0.01%	S				S					

$T_3 T_1 T_4 T_6 T_7 T_2 T_5$ $T_3 T_7 T_1 T_2 T_4 T_6 T_5$ $T_3 T_1 T_4 T_7 T_6 T_2 T_5$ $T_3 T_1 T_4 T_6 T_7 T_2 T_5$ $T_3 T_7 T_1 T_2 T_4 T_6 T_5$

B = Bearing laterals of 1980
NB = Nonbearing laterals of 1980

Table 10. Spike shedding as percentage of tot

Treat-ments	May 1981	June 1981	July 1981	August 1981	September 1981
T_1	0.098 (1.042)	0.275 (1.135)	0.275 (1.151)	0.256 (1.149)	0.295 (1.125)
T_2	0.206 (1.050)	0.165 (1.032)	0.701 (1.253)	0.412 (1.147)	0.907 (1.426)
T_3	0.000 (1.000)	0.043 (1.031)	0.343 (1.257)	0.150 (1.288)	0.483 (1.342)
T_4	- (1.031)	- (1.000)	0.163 (1.077)	0.261 (1.069)	0.261 (1.069)
T_5	0.056 (1.028)	0.056 (1.028)	0.502 (1.236)	0.559 (1.195)	0.014 (1.291)
T_6	0.038 (1.029)	0.837 (1.039)	0.419 (1.324)	1.674 (1.248)	1.408 (1.841)
T_7	- (1.000)	0.136 (1.354)	0.204 (1.083)	0.936 (1.717)	0.407 (1.231)
0.05%	NS	S	NS	NS	S
CD		0.18318			0.6085
0.01%		S			S

$$\frac{T_6 T_1 T_7 T_2 T_3 T_5 T_4}{}$$

$$\frac{T_6 T_2 T_3 T_5 T_7 T_4 T_1}{}$$

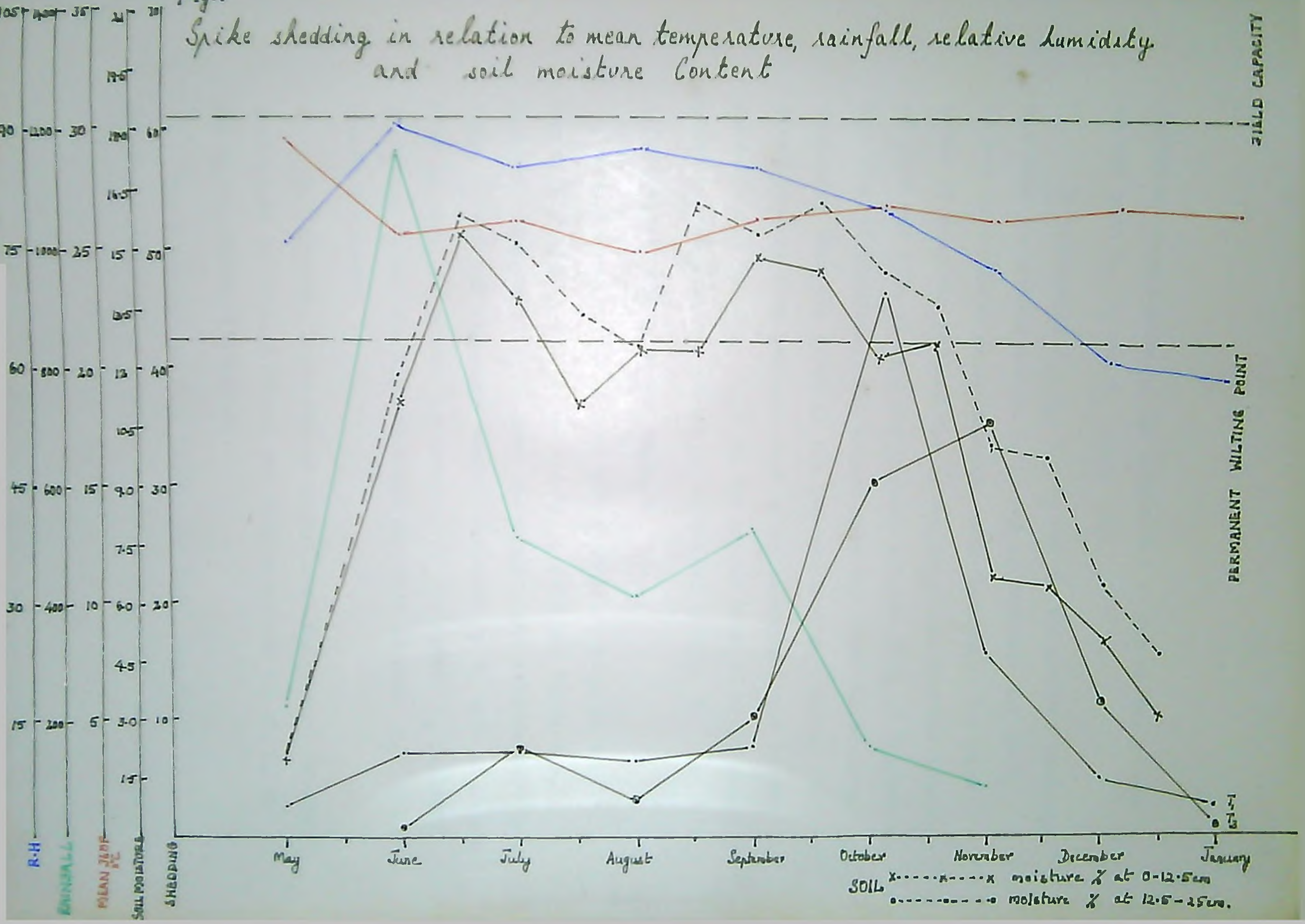
al produced on vine

October 1981	November 1981	December 1981	January 1982	Total
1.771 (1.492)	0.610 (1.261)	0.177 (1.078)	0.078 (1.042)	3.835
0.866 (1.376)	0.247 (1.188)	0.082 (1.065)	- (1.000)	3.588
1.437 (1.732)	1.705 (1.778)	0.547 (1.334)	0.032 (1.012)	4.739
0.390 (1.225)	0.228 (1.144)	1.176 (1.066	- (1.000)	2.515
0.893 (1.429)	0.390 (1.216)	0.168 (1.066)	- (1.000)	3.237
0.571 (1.421)	0.228 (1.137)	0.380 (1.208)	0.038 (1.029)	5.599
0.740 (1.494)	0.407 (1.278)	0.102 (1.068)	- (1.000)	2.240
NS	NS	NS	NS	NS

Values in brackets shows transformed values $\sqrt{x+1}$

Fig. 1

Spike shedding in relation to mean temperature, rainfall, relative humidity and soil moisture Content



different from others in the former but in the latter it was on par with T_2, T_3 and T_5 (Table 10).

In treatments T_1, T_2, T_5, T_6 and T_7 the maximum shedding was seen in October and in T_3 it was in November and in T_4 it was in December which recorded peak shedding. Two main waves of drop was noticed during the year; one between 15th of June and 15th of July and another between 15th of September and 15th of November. The second wave was found to be more intensive than the first in all the treatments. During the first peak of drop perhaps, lack of pollination might be responsible for the drop while in the second peak of drop, moisture might be the limiting factor as evidenced in Fig. 1.

1.6. Variation in nutrient content

There existed no significant difference between treatments in respect of N, P, Ca and Mg in July and September. However, in respect of K there was significant difference. In July, T_2 had the highest K content followed by T_7 both of which were on par. T_5 showed the lowest. In September, T_4 followed by T_2 and T_1 had the highest value and were on par. T_6 had the lowest K content.

In November, there was no significant difference between treatments in respect of all the five nutrients (N, P, K, Ca and Mg) estimated (Table 8).

The N content in July (2.789 per cent) was found to decrease gradually as berries mature in November. A similar

Table 8. Percentage of nutrient content of bearing shoots at 3 intervals in pepper cv. Panniyur-1

Treatments	July					September				
	N	P	K	Ca	Mg	N	P	K	Ca	Mg
T_1	2.789	0.137	2.327	0.075	0.776	2.695	0.121	2.707	0.196	0.926
T_2	2.856	0.126	2.720	0.075	0.724	2.632	0.210	3.093	0.196	0.374
T_3	2.635	0.126	2.140	0.175	0.803	2.559	0.137	2.480	0.217	0.837
T_4	2.313	0.100	2.040	0.083	0.634	2.724	0.123	3.200	0.183	0.830
T_5	2.560	0.108	1.773	0.046	0.818	2.645	0.155	2.293	0.196	0.757
T_6	2.782	0.105	2.120	0.088	0.689	2.848	0.132	2.086	0.192	0.842
T_7	2.689	0.160	2.386	0.108	0.729	2.654	0.158	2.353	0.204	0.872
0.05%	NS	NS	S	NS	NS	NS	NS	S	NS	NS
CD			0.3619					0.5278		
0.01%			S					S		

$\underline{T_2 T_7 T_1 T_3 T_6 T_4 T_5}$

$\underline{T_4 T_2 T_1 T_3 T_7 T_5 T_6}$

(contd.)

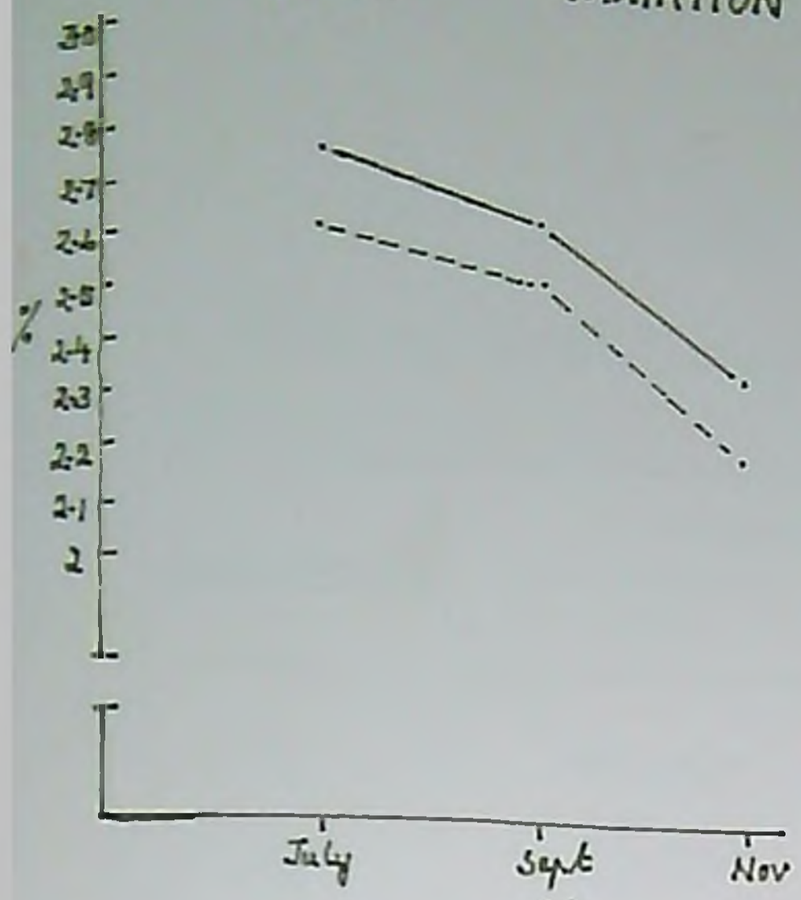
Table 8. continued

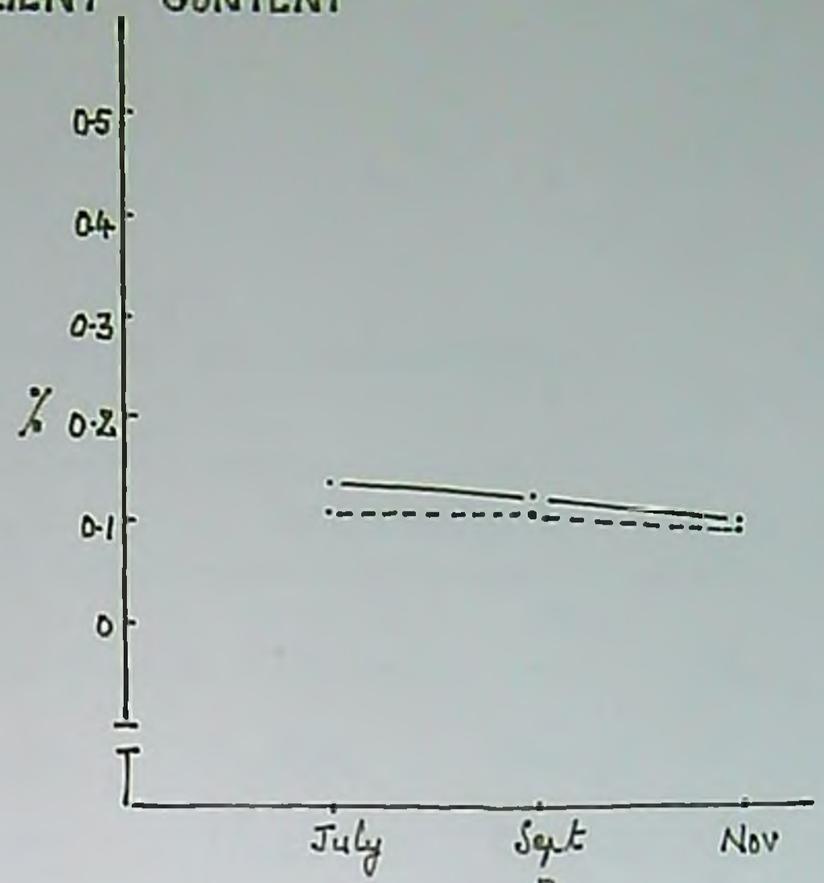
Treatments	November				
	N	P	K	Ca	Mg
T_1	2.371	0.104	2.013	0.233	0.924
T_2	2.479	0.133	2.113	0.246	0.911
T_3	2.239	0.121	2.153	0.234	0.826
T_4	2.319	0.134	2.333	0.242	0.889
T_5	1.968	0.130	2.426	0.208	0.839
T_6	2.427	0.103	2.160	0.217	0.725
T_7	2.422	0.141	2.260	0.217	0.797
0.05%	NS	NS	NS	NS	NS

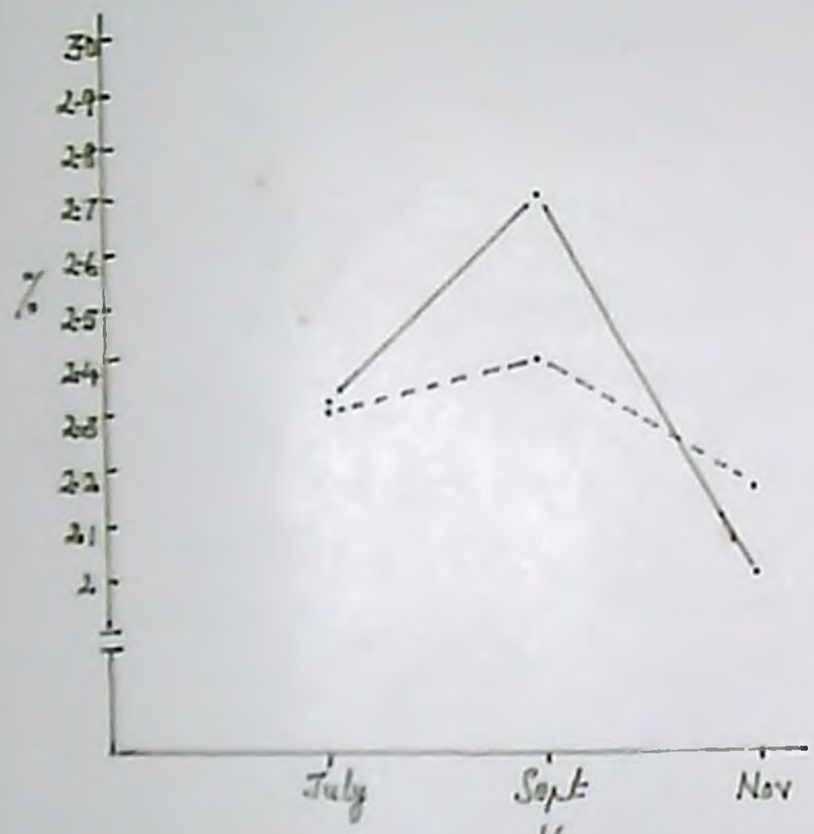
Table 8. continued

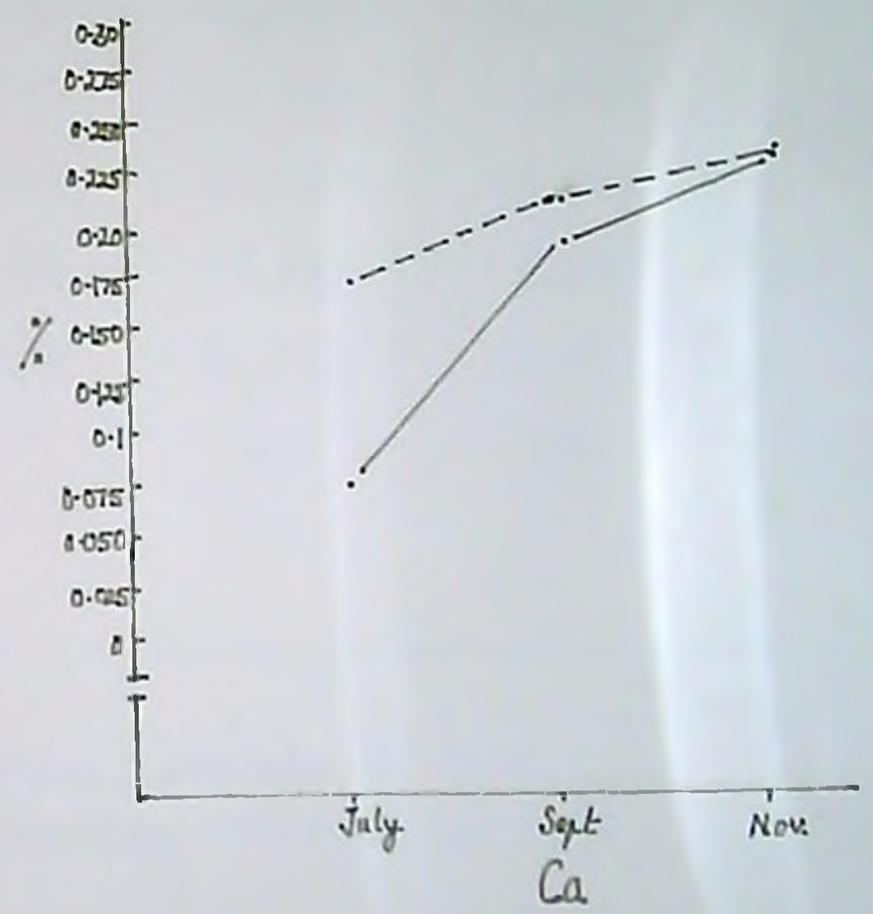
Treatments	November				
	N	P	K	Ca	Mg
T_1	2.371	0.104	2.013	0.233	0.924
T_2	2.479	0.133	2.113	0.246	0.911
T_3	2.239	0.121	2.153	0.234	0.826
T_4	2.319	0.134	2.333	0.242	0.889
T_5	1.968	0.130	2.426	0.208	0.839
T_6	2.427	0.103	2.160	0.217	0.725
T_7	2.422	0.141	2.260	0.217	0.797
0.05%	NS	NS	NS	NS	NS

FIG 2. VARIATION IN NUTRIENT CONTENT









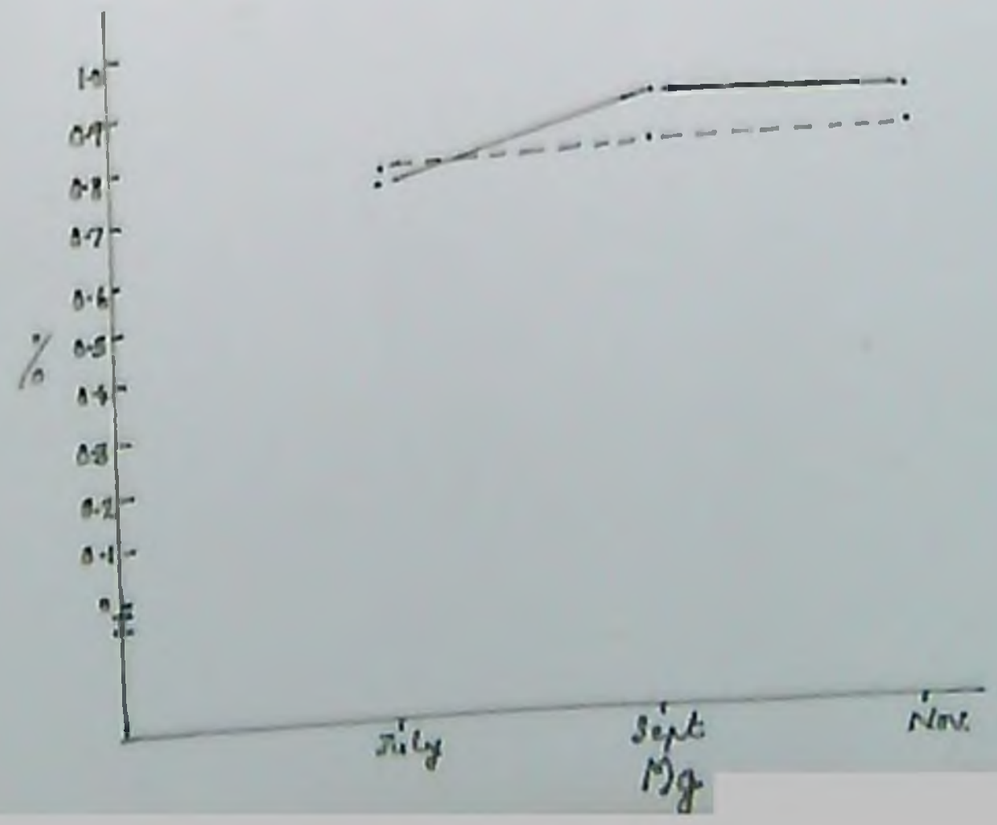


Table 9. Yield and quality of pepper cv. Panniyur-1

Treatments	Weight of produce		Oleoresin %	
	B	NB	B	NB
T_1	100.905	103.292	12.290	12.737
T_2	75.262	79.882	12.451	11.990
T_3	187.023	169.690	12.680	12.010
T_4	89.678	86.970	12.323	13.380
T_5	48.354	63.603	12.127	12.503
T_6	81.410	86.293	12.104	12.672
T_7	92.623	122.246	11.376	13.113
0.05% CD	S 54.323	NS	NS	NS
0.01%	S			

$T_2 T_1 T_7 T_4 T_6 T_3 T_5$

B = Bearing laterals of 1980

NB = Nonbearing laterals of 1980

trend was also noticed in case of P but in case of K there was slight increase in September followed by a decrease in November. In case of Ca and Mg, reverse trend was noticed where there was a gradual increase from July to November i.e., as berries mature. This is presented in Fig. 2. Ca content in July showed a positive significant correlation with yield whereas no correlations existed in N, P, K and Mg. In September and November no correlations were obtained in case of all the five elements.

1.7. Yield and quality

In terms of yield, the highest was recorded in case of T_3 from both bearing shoots (187.023 g) and nonbearing shoots (169.69 g), but the yield was statistically significant in case of bearing shoots only. Data are presented in Table 9.

Oleoresin content varied between 11.990 and 12.737 per cent but there was no statistical difference in oleoresin content due to treatments (Fig.3).

2. Effect of time of pruning

2.1. Shoot growth

In the observational trial to fix up the optimum time of pruning, the maximum mean extension growth was recorded in case of May 15th pruning (5.68 cm). This was closely followed by June 1st (5.48 cm). The different time of pruning could not bring any significant difference in the number of nodes per shoot and average length of node (Table 11).

Table 11. Effect of time of pruning

Time of pruning	Mean extent of laterals	Number of nodes per shoot	Average length of node	Number of laterals produced	Number of spikes per 12 shoots	Number of aborted spikes per 12 shoots	Length of spike (cm)
April 15th (T_1)	4.69	1.19	3.18	14.75	13.50	6.50	12.24
May 1st (T_2)	5.48	1.24	2.99	17.25	12.75	9.50	12.41
May 15th (T_3)	5.68	1.28	3.25	16.50	10.00	10.75	12.83
June 1st (T_4)	4.10	1.15	2.66	15.50	10.25	7.50	12.55
0.05%	NS	NS	NS	NS	NS	NS	NS

(contd.)

Table 11. continued

Time of pruning	Number of berries per spike	Percentage of undeveloped berries	Number of berries/ unit length
April 15th (T_1)	93.05	7.19	7.62
May 1st (T_2)	96.43	7.21	7.78
May 15th (T_3)	97.34	6.54	7.64
June 1st (T_4)	95.82	6.55	7.95
0.05% CD	NS	NS	NS
0.01%			

Percentage of berries to spike	Weight of 1000 berries (g)	Volume of 1000 berries (cc)	Yield	Oleo-resin
93.81	135.58	130.00	93.69	12.29
93.24	124.68	128.75	116.58	12.33
93.19	127.58	135.00	89.45	11.65
94.07	129.40	125.00	86.05	12.86
NS	S	NS	NS	NS
	1.6305			
	S			

$T_1 T_4 T_3 T_2$

2.2. Production of spike and spike characters

Though the number of laterals produced was highest in May 1st (17.25) and May 15th (16.5), it was not significantly different from the rest. The number of spikes also showed no significant difference. April 15th (13.5) followed by May 1st (12.75) recorded the highest number of spikes. The number of aborted spikes was maximum in May 15th (9.5) and was not significantly different from the rest of the treatments.

The length of spike was highest in May 15th (12.83 cm). The highest number of berries was produced in May 15th pruning (97.34) followed by May 1st (96.43). Percentage of undeveloped berries was maximum in May 1st pruning (7.21) and the variation was from 6.54 to 7.21. The highest number of berries per unit length ranged between 7.62 and 7.95 and was highest in June 1st pruning. The percentage of berries to spike showed a minor variation ranging between 93.19 and 94.07. None of the characters on lateral production, spiking and spike characters were significant. The weight of thousand berries showed significant difference. April 15th pruning was the best (134.50) followed by June 1st pruning (129.4). But the volume of thousand berries was not significant (Table 11).

of pruning on yield of Pepper

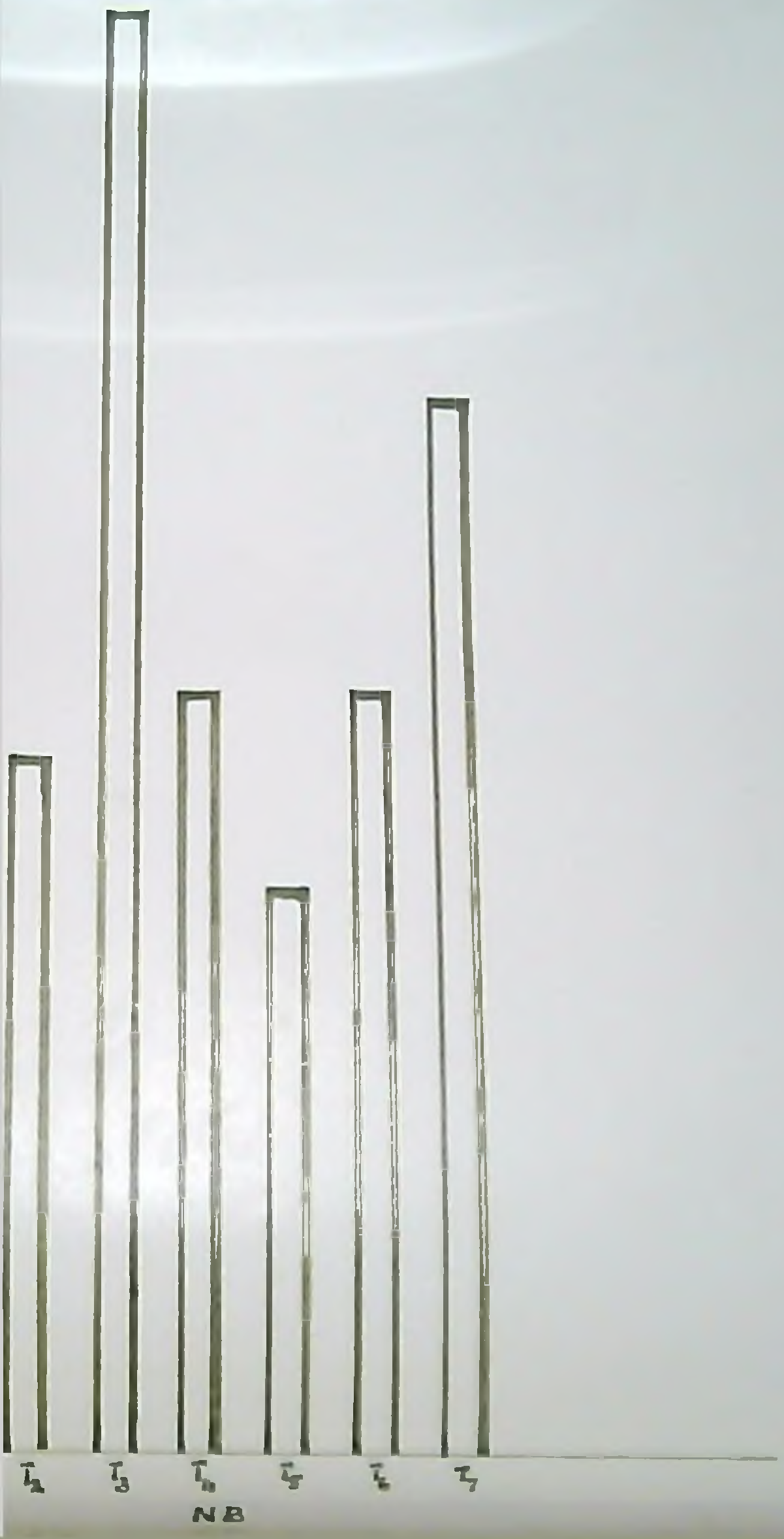
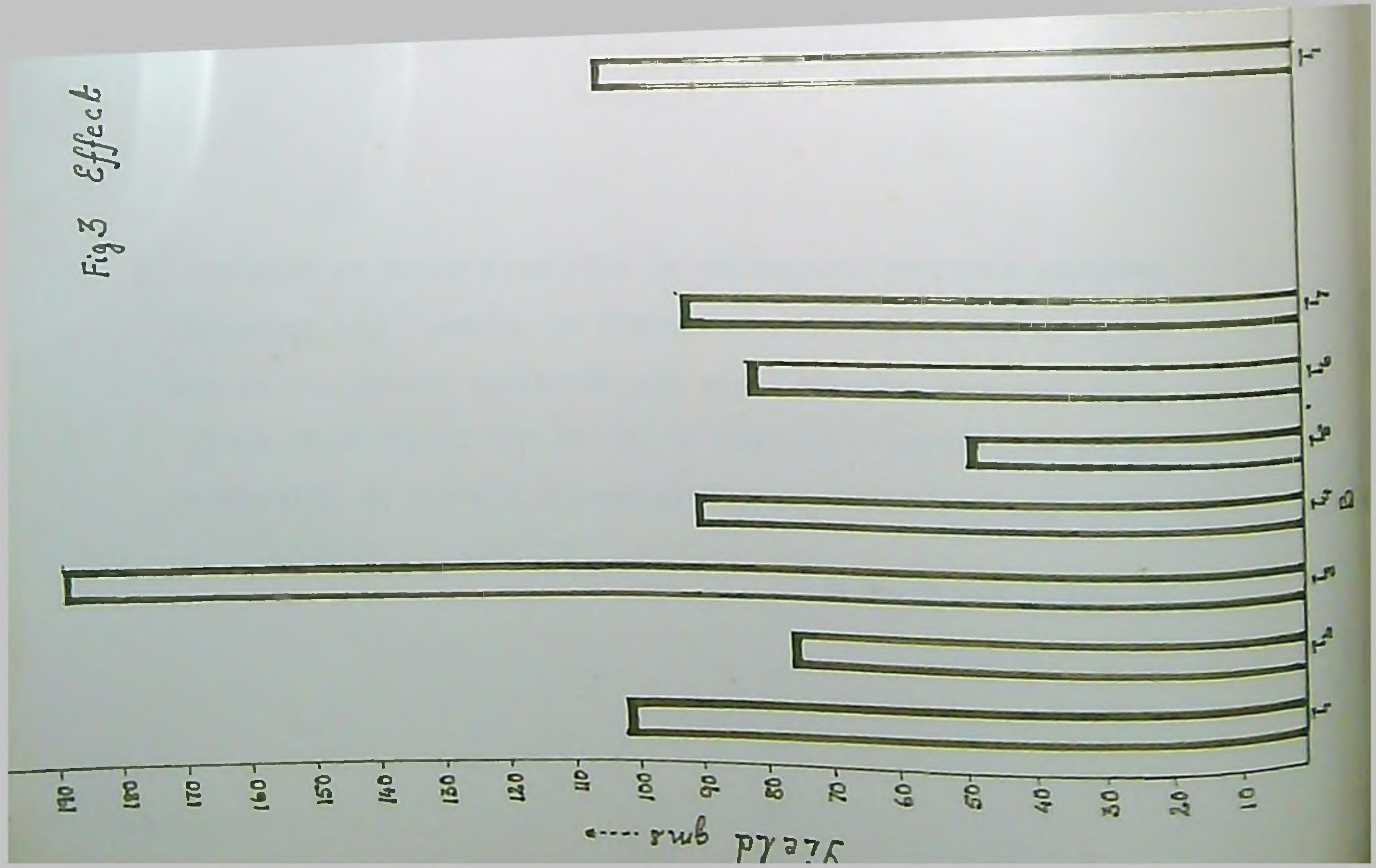


Fig 3 Effect


Yield gms ....
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
T1
T7
T8
T6
T4
T5
T2
T3
B

3. Yield and quality

The yield was not significantly altered by different dates of pruning. Pruning on 1st of May followed by April 15th produced highest yield and therefore around 1st of May will be the best time for pruning of pepper. The oleoresin content remained unaffected by different dates of pruning.

Discussion

DISCUSSION

The results of the studies on effect of pruning on growth, quantity and quality of produce in pepper are discussed below.

Extent of nutrient removal by pruning

The extent of nutrient removal is found to be significantly superior in severe pruning treatments as the weight of pruned material increased. This is natural because of high quantity of plant material removed in case of severe pruning. In case of pruning of hanging shoots, the dry weight of material removed was low and as such the nutrient removal was also low.

Shoot growth

The mean shoot growth in case of pruning of hanging shoots was more. But it was on par with fifty per cent pruning of the two year old laterals. There was no correlation between the amount of N, K and Mg removed and mean extension in growth. But positive correlation was recorded in case of P and Ca content. More number of laterals and extension growth in case of pruning hanging shoots is possible in case of pepper because it is a well established fact that when terminal shoots are pruned, more laterals are induced. Similarly it is also known that higher the severity of pruning, the more the number of shoots produced. This may be the reason for higher shoot

growth in case of fifty per cent pruning of two season growth. The increased growth supports the statement of Nijjar (1972) that heavy pruning results in profuse vegetative growth.

Although there is no correlation between the extension growth N, K and Mg removed by pruning, it may not be very correct to conclude the above fact from this limited study. More detailed study is required to work out the correlation of the nutrient removal with that of shoot growth and plant performance.

Generally two growth flushes were noticed; the major one being after the receipt of south west monsoon with its peak growth in June and July. The mean temperature, total rainfall and R.H. were 25.66°C, 116.6 mm and 90.04 per cent respectively while the corresponding figures in July were 26.04°C, 512° mm and 85.07 per cent. The trend of soil moisture at each fortnight in June and July is presented in Fig.1. The optimum temperature and rain may be responsible for higher growth. Rema Menon (1980) found only single flush in June-July.

In perennial plants, several growth flushes are noticed i.e., one extension growth is followed by a period of quiescence. The same phenomenon is also found in pepper. The number of flushes may vary from year to year depending upon weather parameters.

Nodes per shoot and length of node

The previous season bearing laterals could not bring any significant effect but in the nonbearing laterals, the severe pruning treatment (fifty per cent of two year old) produced significantly more number of nodes per shoot and the least was in case of pruning hanging shoots. It was also noticed that most of the laterals produced were single noded in the latter case. The more number of nodes per shoot is quite significant in case of pepper because the spikes are produced in each node. However, more detailed study for few years is required to confirm whether such pruning treatment will be beneficial to produce more spikes and more yield.

There is no significant difference in the average length of nodes. This is because of the fact that the plants are being grown under identical conditions and are of the same genetical stock.

Production of spikes

The total shoots and percentage of shoots were more in the case of hanging shoots pruning. This also resulted in more spike development as the pepper bears only in the current season laterals. The pruning of terminal shoot encourages development of lateral shoots, hence higher production of spikes. Although there is no reported work on this aspect in pepper, the production of large number of bearing laterals

after terminal pruning was reported in grapes by several workers (Das and Melanta, 1972; Chanana and Kumar, 1972; Balasubramaniam and Khanduja, 1977). The trend was noticed both on flowering and nonflowering shoots of previous season.

Number and characters of spikes

Owing to the more number of laterals produced in case of hanging shoot pruning, the spike production was also maximum. Most severe pruning which was although on par with it in case of shoot production was inferior in case of spikes production as the number of aborted spikes were more, though not significant. Higher significant number of bunches due to pruning was reported in grapes by Subbiah (1969), Raveendran (1970), Bhujbal (1972), Chanana and Kumar (1974) and in Mango by Rao and Shanmugavelu (1976) and in Guava by Bajpai et al. (1973). The reason for more number of aborted spikes in case of severe pruning (T_7) may be due to higher quality of nutrient removal by way of pruning. This indicates that severe pruning, unless supported by better nutrient supply, may not be useful from the production point of view. However, for confirmation of such indications more detailed studies of pruning in relation to nutrient uptake are required.

There was no significant difference in the spikes per unit length, length of spike, number of berries per spike, percentage of undeveloped berries, number of berries per unit

length due to different treatments. Under normal nutritive conditions, each node produces one spike in pepper. Hence, when the extension of growth is more the chances of production of more spikes are more. Similarly, the results indicate that the above characters are not very much influenced by pruning techniques. The development of berries often depend on timely pollination. Lack of pollination alone will be responsible for the formation of undeveloped berries and it may not be due to the direct or indirect effect of pruning. In crops like grapes, the production of heavier bunch was possible by adopting pruning mainly because of the restriction of the growth and due to diversion of such food materials for fruit bud differentiation and subsequent development of inflorescence. Perhaps such situations are not met with in pepper.

Berry characters

There was no significant difference due to different pruning treatments in percentage weight of berries to spike, weight and volume of thousand berries. This result is contrary to findings in grapes where berry size is found to increase due to pruning (Subbiah, 1969; Chaddha and Kumar, 1970; Raveendran, 1970; Cawthon and Morris, 1977; Lane, 1977; Spayd and Morris, 1978). In grapes this may be due to the effect of better availability of nutrients which are generally translocated to stem portion before leaf fall. Pepper being evergreen,

such storage of materials are not being affected in stems and twigs. Hence they will not be made available for better development due to pruning.

Spike shedding

There was significant difference in number of spikes shed both in case of experimental shoots and whole plants in case of bearing shoots. More shed was noticed in case of pruned hanging shoots but when the percentage is taken into account, there was no statistical difference in both the bearing and nonbearing shoots. There was no significant difference in percentage of set also. Naturally, the pruned hanging shoots had produced more laterals and more spikes which resulted in higher number of set and consequently the higher number of drop. Since there was no significant difference in percentage of set, it can be concluded that the pruning treatments had no effect on either the percentage of set or percentage of drop.

Two main waves of drop was noticed during the year; one between 15th of June and 15th of July and another between 15th of September and 15th of November.

The second wave was found to be bigger than the first in all the treatments. During the first peak of drop perhaps, lack of pollination may be responsible for the drop while the second peak of drop, the moisture level in the soil may be the limitation. Earlier studies by Rema Menon (1980) and

Geetha (1981) also observed two waves of drop in pepper. Rema Menon (1980) observed maximum shedding in June whereas Geetha (1981) observed peak shedding in December.

Variation in nutrient content

The N content in July (2.789 per cent) was found to decrease gradually as berries mature in November. A similar trend was also noticed in case of P but in case of K, there was slight increase in September followed by a decrease in November. In case of Ca and Mg, the reverse trend was noticed where there was a gradual increase from July to November i.e., as berries matured. Ca content in July showed a positive significant correlation with yield whereas no correlations existed in N, P, K and Mg. In September and November, no correlations was obtained in case of all five elements.

The decrease in N and P in leaves from berry set to maturity is natural due to the more utilization of these nutrients by the developing berries. A slight increase in K in September may be due to the better absorption due to application of fertilizers in July. Although this may be true with regard to N and P the utilization may be perhaps quicker. Ca and Mg contents of leaves had shown only an increase from July to November as berries mature. There was no application of Mg and Ca during this period. Perhaps, the gradual accumulation in the leaves may be due to a better absorbing area and favourable conditions in the soil and also comparatively low

utilization by the growing berries. However, the studies on variation in nutrient content is only very preliminary and no conclusive results can be drawn from this data alone.

Yield and quality

In terms of yield, the highest yield was recorded in case of T_3 from bearing and nonbearing but was significant only in bearing shoots. Oleoresin content varied between 11.99 and 12.37 per cent but was not statistically significant.

The highest yield in T_3 was due to the fact that the treatment produced more number of lateral shoots and spikes. The study had indicated that the pruning of hanging shoots had effect on increasing the number of laterals. Similarly in the case of severe pruning (i.e., pruning 50% of two year growth) had also encouraged higher production of new lateral shoots. This indicates the necessity of more detailed pruning studies and also the physiological studies in respect of photosynthetic efficiency of leaves, the maximum age at which the photosynthetic efficiency is reduced, the optimum number of leaves required for individual spike set and development and stomatic index.

The pruning of growing leader shoots is also likely to encourage more lateral shoots even in the lower area of the standard which generally do not produce laterals. By training vines by proper pruning in the initial stage, it will be possible to encourage lateral shoots at a very low height

which will lead to higher yield and better efficiency in harvesting. The present study therefore indicates the possibility of studies on the above lines.

Effect of time of pruning

In the observational trial, maximum mean extension growth was recorded in case of May 15th pruning and this was closely followed by June 1st. The number of laterals produced was also highest in the pruning done in May although it was not statistically significant.

Although there was difference in length of spike, the number of berries, number of lateral production and yield due to different periods of pruning, no significant difference was noticed. However, pruning on 1st of May followed by April 15th produced the highest yield although not significant statistically. During the year of study (1981) the spiking started by 10th June. In the control and in the pruning treatments the spiking was at the same period.and 50% of flowering was recorded around June 25th. Therefore it can be assumed that the spiking is not influenced by the time of pruning. Correct period of pruning coincoiding with spiking time may not be practicable in pepper as the spiking habit of the vine is more related to rainfall pattern of a particular year.

Summary

SUMMARY

The present investigations were carried out at the Pepper Research Scheme attached to the College of Horticulture, Vellanikkara for a period of fourteen months from December 1980 with a view to study whether there is any necessity to retain a large volume of unproductive lateral shoots or the laterals can be pruned to certain extent to encourage more lateral growth and thereby increase the quality and quantity of produce without detrimental effect to the plant.

Based on the above study the following inferences were drawn.

1. The quantity of pruned materials and nutrient removal was significant and more in treatments with higher intensity of pruning.

2. At the start of growth, there was no significant differences in growth but from tenth July onwards the pruning of hanging shoots recorded the highest extension growth. The spread of plants was also affected by pruning. Hanging shoot removal recorded the best spread in November. There existed no difference between treatments in respect of number of nodes per shoot and average length of node. There were two growth flushes in May and October-November. The first May flush started by tenth of May and extended upto twentyfifth August. The October-November flush were relatively small in

quantity. However, it was seen that such flushes were often overlapped.

3. There was significant difference in the production of shoots in 1981. Pruning of hanging shoots ranked first. The number of nonbearing shoots was not significant. There was significant difference in the production of bearing shoots in 1981 by different pruning treatments in which also pruning of hanging shoots was the best. The maximum number of spikes was produced in this case and it was significant in respect of bearing shoots of 1980. No significant difference was noted in the production of spikes per unit length.

4. There was no significant increase in the number of spikes, number of berries per spike, percentage of undeveloped berries, number of berries per unit length, percentage weight of berries to spike, weight and volume of thousand berries due to pruning.

5. In the case of spike shedding T_3 (Hanging shoot pruning) was highest and was on par with T_5 in bearing laterals of 1980 but in nonbearing laterals of 1980 it was not significant. The number of spike set was also high in T_3 and was significantly superior. No significant difference was noted in the total shedding from whole plants.

Two main waves of drop was noticed during the year; one between fifteenth June and fifteenth July and the second between fifteenth of September and fifteenth of November, the

quantity. However, it was seen that such flushes were often overlapped.

3. There was significant difference in the production of shoots in 1981. Pruning of hanging shoots ranked first. The number of nonbearing shoots was not significant. There was significant difference in the production of bearing shoots in 1981 by different pruning treatments in which also pruning of hanging shoots was the best. The maximum number of spikes was produced in this case and it was significant in respect of bearing shoots of 1980. No significant difference was noted in the production of spikes per unit length.

4. There was no significant increase in the number of spikes, number of berries per spike, percentage of undeveloped berries, number of berries per unit length, percentage weight of berries to spike, weight and volume of thousand berries due to pruning.

5. In the case of spike shedding T_3 (Hanging shoot pruning) was highest and was on par with T_5 in bearing laterals of 1980 but in nonbearing laterals of 1980 it was not significant. The number of spike set was also high in T_3 and was significantly superior. No significant difference was noted in the total shedding from whole plants.

Two main waves of drop was noticed during the year; one between fifteenth June and fifteenth July and the second between fifteenth of September and fifteenth of November, the

first drop may be due to lack of pollination while in the second peak soil moisture was the limitation.

6. No significant difference was noted in respect of N, P, Ca and Mg in July and September. K was significantly different in July and September with T_2 and T_4 showing the highest values. In November there was no statistical difference. The N and P content was found to decrease from July as berries mature in November whereas in K content there was a slight increase in September followed by a decrease in November.

7. Higher yield was noted in case of T_3 but was significant only in case of bearing shoots of 1980. Oleoresin content was unaffected.

8. In the observational trial to fix the optimum date of pruning, May 15th pruning was better in mean length of laterals though it was not significant. Neither the nodes per shoot nor the average length of node was affected by different dates of pruning. The number of laterals was highest in May 1st and May 15th pruning, the number of spikes was highest in April 15th pruning followed by May 1st but in both the above cases, the results were not significant. The length of spikes, number of aborted spikes, percentage of undeveloped berries, number of berries per unit length, percentage of berries to spike and volume of thousand berries were not affected by different dates of pruning.

Yield was not significantly altered by different dates of pruning. May 1st pruning followed by April 15th gave higher yields. Oleoresin content also remained unaffected.

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* Originals not seen

Appendices

APPENDIX I

Weather and soil moisture data from April 1981 to Jaunary 1982

Month	Mean temp. °C	Total rainfall (mm)	Relative humidity (%)	Time	Soil moisture % 0-12.5cm	Soil moisture % 12.5-25 cm
1981						
April	30.74	16.10	64.38	9/5	2.002	2.004
May	29.88	225.80	75.84	10/6	11.209	11.946
				25/6	15.351	16.105
June	25.66	1160.60	90.04	10/7	13.705	15.268
July	26.04	512.90	85.07	25/7	11.113	13.465
August	25.32	407.90	87.53	10/8	12.539	12.599
				25/8	12.535	16.273
September	26.15	523.80	85.36	10/9	14.965	15.505
October	26.83	156.40	79.24	25/9	14.567	16.371
November	26.70	80.20	72.10	10/10	12.361	12.976
				25/10	12.623	13.604
December	26.88	-	60.51	10/11	6.857	10.041
1982				25/11	6.511	9.748
				10/12	5.259	6.563
January	26.77	-	58.80	25/12	3.033	4.781

APPENDIX II

Analysis of variance for extent of removal of pruned material and nutrients from pepper

	df	Mean squares								
		Quantity of pruning				Nutrient content in leaves				
		Green weight		Dry weight						
		L	T	L	T	N	P	K	Ca	Mg
Treatment	5	31429.9**	7599.36**	3149.62**	746.709**	0.7966	0.0018	0.3556*	0.0024	0.0348
Error	25	4493.447	399.35	583.223	34.317	0.3811	0.0013	0.0972	0.0019	0.0254

	df	Mean squares									
		Nutrient content in twigs					Total nutrient removal				
		N	P	K	Ca	Mg	N	P	K	Ca	Mg
Treatment	5	0.2683	0.0074*	0.0767	0.0009	0.1112**	1.5328**	0.0150**	2.038**	0.0447	0.4483**
Error	25	0.2328	0.0020	0.0457	0.0024	0.01486	0.3076	0.0037	0.4787	0.0218	0.08342

* Significant at 5% level
** Significant at 1% level

APPENDIX III

Analysis of variance table for mean extension of growth

	df	Mean squares													
		10/5		25/5		10/6		25/6		10/7		25/7		10/8	
		B	NB	B	NB	B	NB	B	NB	B	NB	B	NB	B	NB
Treatment	6	41789.39	0.0633	0.5269	0.5197	0.7143	1.2364	2.5990	5.2448	5.1961*	9.83114*	10.7287**	14.8319*	11.5806**	16.179*
Interaction	30	41853.23	0.0380	0.4334	0.2948	0.5360	0.5852	2.0059	2.2195	2.3324	2.588	3.4397	3.628	3.6414	3.8028
Sampling error	42	1757486.10	0.0497	0.466	0.3461	0.3350	0.9293	1.3284	3.060	1.6035	3.630	2.6226	5.2095	2.6623	5.3156

	df	Mean squares													
		25/8		10/9		25/9		10/10		25/10		10/11		25/11	
		B	NB	B	NB	B	NB	B	NB	B	NB	B	NB	B	NB
Treatment	6	11.7255**	16.955*	11.7529**	17.050*	11.7531**	17.1366*	11.7913**	17.2886*	11.9803**	17.306*	11.947**	18.008*	11.845**	18.056*
Interaction	30	3.6269	4.1434	3.6386	4.1435	3.6511	4.179	3.7047	4.1879	3.7104	4.2563	3.7723	4.1549	3.754	4.1575
Sampling error	42	2.782	5.465	2.7815	5.487	2.773	5.483	2.754	5.504	2.7702	5.5369	2.7887	5.5885	2.8509	5.5915

* Significant at 5% level

** Significant at 1% level

APPENDIX -IV

Analysis of variance for spread of vines

	df	Mean squares					
		After pruning (cm)		Mean difference in reduction after pruning	In November (cm)		Mean difference in November before pruning
		E.W.	N.S.		E.W.	N.S.	
Treatment	6	408.072**	491.205**	74.422	603.16**	609.957**	61.006
Error	30	96.84	89.100	84.787	117.229	130.99	110.508

APPENDIX - V

Analysis of variance for length of node and number of nodes per shoot

	df	Mean squares			
		Number of nodes per shoot		Average length of node	
		B	NB	B	NB
Treatment	6	0.2365	0.5557*	0.3302	125.426
Error	30	0.1996	0.2940	0.7018	49.017

* Significant at 5% level
** Significant at 1% level

B = Bearing laterals of 1980
NB = Nonbearing laterals of 1980

APPENDIX -VII

Analysis of variance for spike and berry characters of spike

	df	Mean squares							
		Length of spike		Number of berries/ spike		Percentage of undeveloped berries		Number of berries/ unit length	
		B	NB	B	NB	B	NB	B	NB
Treatment	6	4.458	4.1104	295.076	788.757	15.979	7.027	1.025	1.592
Error	30	6.188	7.625	485.746	377.33	18.692	8.678	1.183	2.914

	df	Mean squares					
		Percentage of berries to spike		Weight of 1000 berries		Volume of 1000bberries	
		B	NB	B	NB	B	NB
Treatment	6	6.737	120.809	65.183	49.575	51.880	84.55
Error	30	5.024	96.718	50.397	42.284	60.593	44.394

B = Bearing laterals of 1980

NB = Nonbearing laterals of 1980

APPENDIX -VIII

Analysis of variance for spike shed, set and percentage of set and drop

	df	Mean squares							
		Number of spikes dropped		Number of set		Percentage of set		Percentage of drop	
		B	NB	B	NB	B	NB	B	NB
Treatment	6	4.777*	3.802*	178.194**	189.623*	38.355	8650.26	34.69	65.31
Error	30	1.449	2.163	35.737	76.28	45.002	8134.47	49.005	75.482

B = Bearing laterals of 1980

NB = Nonbearing laterals of 1980

APPENDIX -VIII

Analysis of variance for spike shed, set and percentage of set and drop

	df	Mean squares							
		Number of spikes dropped		Number of set		Percentage of set		Percentage of drop	
		B	NB	B	NB	B	NB	B	NB
Treatment	6	4.777*	3.802*	178.194**	189.623*	38.355	8650.26	34.69	63.31
Error	30	1.449	2.163	35.737	76.28	45.002	8134.47	49.005	75.482

B = Bearing laterals of 1980

NB = Nonbearing laterals of 1980

APPENDIX -IX

Analysis of variance for percentage of nutrient content of bearing shoots at 3 intervals

	df	Mean squares									
		July					September				
		N	P	K	Ca	Mg	N	P	K	Ca	Mg
Treat-ment	6	0.2018	0.0011	0.5373**	0.0074	0.0255	0.0488	0.0057	1.0475**	0.0007	0.0162
Error	30	0.1135	0.0003	0.0942	0.0064	0.0418	0.1583	0.0050	0.2004	0.0003	0.0346

	df	Mean squares				
		November				
		N	P	K	Ca	Mg
Treatment	6	0.1802	0.0014	0.1187	0.0012	0.0296
Error	30	0.1732	0.001	0.2157	0.0006	0.0554

** Significant at 1% level

APPENDIX -X

Analysis of variance for yield and quality

	df	Mean squares			
		Yield		Oleoresin	
		B	NB	B	NB
Treatment	6	22544.32**	14858.196	1.6183	1.0095
Error	30	3885.09	8910.27	1.6488	0.8183

APPENDIX -XI

Analysis of variance for spike shedding in different months

	df	Mean squares									
		May	June	July	August	September	October	November	December	January	Total
Treatment	6	0.0029	0.0894**	0.0541	0.2756	0.3485**	0.1405	0.2995	0.0662	0.0018	1.2012
Error	30	0.0042	0.0241	0.0527	0.1396	0.0444	0.1545	0.3237	0.0593	0.1157	0.7342

** Significant at 1% level

B = Bearing laterals of 1980
NB = Nonbearing laterals of 1980

APPENDIX -XII

Analysis of variance for effect of time of pruning

	df	Mean squares							
		Mean extent of laterals	Number of nodes/ shoot	Average length of node	Number of laterals produced	Number of spikes	Number of aborted spikes	Length of spike	Number of berries per spike
Time	3	2.116	0.013	0.277	4.833	12.417	14.729	0.251	13.693
Error	8	4.3612	0.015	0.536	18.125	35.375	7.313	0.776	64.306

	df	Mean squares						
		Percentage of undeveloped berries	Number of berries/ unit length	Percentage of weight of berries to spike	Weight of 1000 berries	Volume of 1000 berries	Yield	Oleoresin
Time	3	0.579	0.097	0.752	69.29**	68.229	759.72	0.989
Error	8	0.391	0.189	0.693	1.00	32.813	2565.57	0.431

** Significant at 1% level

EFFECT OF PRUNING ON GROWTH, QUANTITY AND QUALITY OF PRODUCE IN PEPPER (*Piper nigrum*. L)

BY

SAJAN KURIEN

ABSTRACT OF A THESIS

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ABSTRACT

The present investigations were carried out at the Pepper Research Scheme, Vellanikkara during the period December 1980 to February 1982. The objectives were to find out

1. Whether pruning encourages more lateral growth and thereby an increase in yield.

2. Whether it is necessary to retain large volume of unproductive shoots.

Studies were conducted on six year old bearing vines and the following inferences were drawn.

The nutrient removal was significantly superior in higher intensity pruning. Pruning of hanging shoots recorded significant difference in mean extension of growth and spread of plants after full growth. There were two growth flushes in May and October-November. The latter was relatively smaller.

Significant difference was noted in the production of shoots, number of bearing shoots, and number of spikes. In all the above three characters, hanging shoot removal was best. Spike and berry characters were unaffected by pruning.

The number of spike set and number of spike drop was higher and significantly superior in hanging shoot removal but no difference was noted in percentage of set, percentage

of drop and total shedding from whole plant. Two main waves of drop was noted; one from middle of June to middle of July and next second peak between middle of September to middle of November which was superior. The first drop is attributed to lack of pollination and in the second peak, moisture limitation was observed.

N and P content was found to decrease as berries mature in November whereas in K content there was a slight increase in September followed by a decrease in November.

Higher yield was noted in case of pruning hanging shoots but was significant only in case of bearing shoots of 1930. Oleoresin content was unaffected.

May 15th pruning gave better mean content of laterals and May 1st in number of laterals, but in both the cases it was not significant. Among the characters of spike and berries, only the weight of thousand berries was significantly affected. Yield was not significantly altered by dates of pruning. May 1st followed by April 15th gave higher yields. Oleoresin content was unaffected by different dates of pruning.