NITROGEN PHOSPHORUS AND POTASSIUM REQUIREMENTS OF CHILLI (*Capsicum annuum* L.) VARIETY PANT. C - I

BY

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THESIS

Submitted in partial fulfilment of the requirement for the Degree of

Master of Science in Agriculture

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DECLARATION

I hereby declare that this thesis entitled "Nitrogen, Phosphorus and Pottassium requirements of chilli, (Capsicum annuum L.) variety Pant.C.1" is a bonafide record of research work done by me during the course of research and that 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.

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Introduction

INTRODUCTION

Chilli (*Capsicum annuum* L.) otherwise known in other parts of the world as red pepper or Cayenne pepper is an important cash crop in India and is grown for its pungent fruits, which are used both green and ripe (dried form) to impart pungency to the food. As a condiment it has become indispensable in every Indian home. The pungency is due to the active principle capsicin.

Chilli is a native of South America. Being a warm season fruit vegetable and spice crop, it is cultivated throughout the world in tropical and subtropical climate. In India it is cultivated in almost all the states over an area of approximately 8.25 lakh hectares. Dry chilli is one of the important commercial crops all over the country. The annual production of dry chilli is 4.85 lakh tonnes. India exports about 30,211 tonnes of dry chilli fetching an amount of Rs.29.23 crores.

In Kerala it is cultivated commercially in an area of 800 hectares, besides the smaller areas occupied in every homestead. The agroclimatic conditions of many parts of this state are quite conducive for the expansion of this crop. The cultivation of this crop is giving substantial economic returns to the cultivator and there is every scope to increase the total production both by bringing more area under chilli crop and by producing more from unit area, provided improved varieties and better production technology are available.

The introduction of high yielding varieties has opened up new horizons in stepping up chilli production in our country. But the object of getting higheryield cannot be achieved by the introduction of high yielding varieties alone. Development of suitable agronomic practices such as time of planting, manurial requirements etc. assumes greater importance in giving full expression of the yield potentialities of these varieties. Therefore it is of great significance that the response of this crop to different levels of major nutrients and different seasons may be studied in detail under various agroclimatic conditions to find out the optimum levels of nutrients for each variety and the best season to get maximum return.

Pant C.1 is a selection from a cross made by Peter.K.V. at Pantnagar in 1974 between NP-46A and Local Kandhari. This variety was released by the State and the Central Variety Release Committee in the year 1980. This variety has performed very well in all tropical countries.

Being a new variety of recent introduction, experimental evidence on its agronomic requirements is meagre. Some of the agronomic trials on optimum manurial requirements for the variety, South Malabar, conducted at the Agricultural College, Vellayani, have revealed that the crop responds well to the application of graded doses of nitrogen, phosphorus and potassium. Highest yield was obtained for an optimum combination of 75 kg nitrogen, 60 kg phosphate and 60 kg potash. Under Kerala conditions so far no research work has been conducted on the nitrogen, phosphorus and potash requirements of Pant-C.1 and the best season for its cultivation.

It is in the light of the above facts that the present investigation was undertaken with the following objectives.

1. To study the performance of chilli variety, Pant-C.1 under varying levels of nitrogen, phosphorus and potassium in two seasons.
2. To find out the best season for getting maximum production.
3. To find out the optimum as well as economic dozes of nitrogen, phosphorus and potassium for chilli variety, Pant-C.1 under the agroclimatic conditions of Vellanikkara in two seasons.
4. To find out the total uptake of nitrogen, phosphorus and potassium by plants in two seasons.
5. To assess the impact of nitrogen, phosphorus and potassium fertilisation and various weather parameters on growth and yield of chilli.

Review of Literature

REVIEW OF LITERATURE

Though chilli is one of the oldest cultivated cash crops, only very little research has been done in our country on its seasonal nutrient requirements. The present review relates to the effect of different levels of nitrogen, phosphorus and potassium on growth and yield of chilli in two seasons.

Effect of nitrogen on growth components

Almost all the works carried out in chilli crop showed that application of nitrogen was beneficial in increasing the general growth and vigour of the plant. James *et al.* (1967) reported that significant increase in shoot yields and total dry matter were obtained from the application of nitrogen in chillies.

Mehrotra *et al.* (1968) observed significantly reduced branching in chilli crop by the deficiency of nitrogen. The influence of nitrogen on the vegetative growth in respect of branching and height of plants has been well recognised (Mohammed Kunju, 1970).

Lal *et al.* (1971) observed that with increase in the levels of nitrogen application, both height and number of branches per plant increased. Increased branching with nitrogen application at 250 kg/ha was reported by Gill et al. (1974). Stroehlein and Oebker (1979) found that moderate rates of nitrogen application (100-150 kg/ha) as ammonium nitrate produced the most desirable plant growth characteristics (a good size but not too leafy) and the highest yields.

Effect of nitrogen on earliness, yield attributes and quality of fruits.

Ivanic (1957) observed that nitrogen delayed flowering and prolonged the growing season in chillies. Gill et al. (1974) found that nitrogen dose alone increased the mean number of days required for first flowering from 47.17 to 51.70 days. Mohammed Kunju (1970) reported that there was no significant difference in the number of days required for the first flower opening due to any of the treatments in a trial with three levels each of nitrogen, phosphorus and potassium. Khan et al. (1977) noted that nitrogen made little difference in reducing the flowering time in chillies.

Maynard (1962) indicated an increasing trend in setting percentage by the application of nitrogen. Mohammed Kunju (1970) also observed increased fruit setting by the application of nitrogen at 75 kg/ha over a rate of 25 kg/ha.

Gill et al. (1974) observed that number of fruits per plant were significantly influenced by varying levels of nitrogen. Covarelli (1976) recorded good response of chilli crop to nitrogen application, nitrogen increased number of pods per plant and 100 pod weight. Khan and Suryanarayana, (1977) summarising the results of the manurial experiments on chillies reported that pod number, pod length, girth, and yields were highest with 120 kg nitrogen per hectare. Mohammed Kunju (1970) also reported that nitrogen at 75 kg/ha produced the maximum number of pods per plant and 100 pod weight, but there were no significant differences in pod length or girth of pods at any of the three levels of nitrogen tried. Similar results had also been reported by Murty and Murty (1963). They also found that addition of nitrogen in any form or at any level had considerably increased the yield of chilli pods. The 100 pod weight and number of pods per plant were also increased by nitrogen application where as the length and girth of pod did not vary much due to the treatment. Arora et al. (1965) summarising the results of manurial trials conducted at I.A.R.I on chilli crop reported that there was a progressive increase in the yield of chillies due to nitrogen fertilisation. Application of 60 kg nitrogen per hectare gave significantly more yield over control, though the difference between 60 kg and 120 kg nitrogen per hectare was not significant.

Breuils and Ginon (1970) observed that for rapid fruiting, well grown plants should be transplanted with a moderate nitrogen content and further nitrogen application should be made during vegetative growth period. Iruthayaraj and Kulandaivelu (1973) reported that there was significant increase in yield by the application of 120 kg nitrogen per hectare over no manuring and that nitrogen played a vital role in the yield of chilli.

Covarelli (1976) recorded good response of chilli crop to nitrogen application, nitrogen increased the number of pods and total yield. Feigin et al. (1978) reported that yields were greatly influenced by nitrogen application and a total yield of 75 tonne per hectare was obtained in plots manured with 90 tonne per hectare FYM + 90 kg ammonium suplhate. Approximately the same yields were obtained when 270 kg ammonium sulphate was used without organic manure.

Subbiah et al. (1982) reported that the yield of dry chilli pods was found to have significant positive relationship with the nutrient ratio of N:P/($r = 0.550^*$) and N:K+Mg+Ca ($r = 641^{**}$). The yield of dry chilli pod was found to have significant negative relationship with nutrient ratios of Ca : K ($r = -0.730^{**}$) and Ca : K + Mg ($r = -0.500^{*}$). The above positive and negative correlations indicate the importance of nitrogen and potassium respectively in influencing the yield of chilli.

Covarelli (1976) recorded good response of chilli crop to nitrogen application. Nitrogen increased the fruit ascorbic acid content. Khan and Suryanarayana (1977) also reported that fruit ascorbic acid content was increased by nitrogen application to a maximum of 54.5 mg/100 g pod.

Effect of phosphorus on growth components

James et al. (1976) observed that phosphorus application increased height and number of branches per plant. The same result was observed by Ozaki and Hortenstine (1963). Mehrotra et al. (1968) found that branching was significantly impaired in chilli crop by the deficiency of phosphorus. Mohammed Kunju (1970) noted that phosphorus application at 40 or 60 kg per hectare increased the height, number of branches and dry matter production per plant. Gill et al. (1974) also reported that phosphorus alone showed a tendency to increase the mean number of branches per plant. Application of 250 kg P_2O_5 per hectare was able to induce maximum number of branches per plant.

Effect of phosphorus on earliness, yield attributes and quality of fruits.

Mohammed Kunju (1970) observed that phosphorus showed a slight earliness in flowering at levels of 40 or 60 kg P_2O_5 per hectare. Gill et al. (1974) noted that phosphorus doses decreased the mean days required for flowering from 47.17 to 42.67 days with 187.5 kg P_2O_5 per hectare. Covarelli (1976) also observed that phosphorus increased the number of earliest fruits in chillies. Khan and Suryanarayana (1977) reported that number of days to flowering was reduced by phosphorus from 60 days to 53 and 45 days.

Mohammed Kunju (1970) observed that phosphorus application upto 40 kg P_2O_5 per hectare significantly increased fruit setting. Maximum number of pods per plant was observed at 60 kg P_2O_5 per hectare. He also noted that phosphorus did not affect significantly other yield contributing factors such as length of pods, girth of pods and 100 pod weight, but phosphorus at 40 and 60 kg P_2O_5 per hectare produced significantly higher yields. Iruthayaraj and Kulandaivelu (1973) observed significant increase in yield of pods at 60 kg P_2O_5 per hectare. Gill et al. (1974) noted that P_2O_5 alone increased the mean number of pods per plant and total yield.

In experiments with chillies Covarelli (1976) reported that phosphorus increased the number of pods per plant and 100 pod weight. Khan and Suryanarayana (1977) also reported to have got the highest number of pods per plant, length and girth of pods, and total yield by the application of 90 kg P_2O_5 per hectare. Another observation by Khan and Suryanarayana (1977) was that phosphorus did not affect the ascorbic acid content of chilli fruits.

Effect of potassium on growth components

Cazi (1961) reported that potash was useful for the chilli plant to resist the adverse effects of weather, to impart resistence to pest and diseases and to withstand drought conditions. Mehrotra et al. (1968) noted that branching in chilli was significantly impaired by the deficiency of potash, there being less number of branches per plant in potash deficient plants. Contrary to the above point, Mohammed Kunju (1970) observed that there was no significant difference in plant height, branching and drymatter per plant due to different levels of potassium in chillies. Significant increase in height of plants due to application of potash has also been reported by Ozaki et al. (1957).

Effect of potassium on earliness, yield attributes and quality of fruits.

Mehrotra *et al.* (1968) found that deficiencies of potash adversely affected the production of flowers and fruits in chillies. Similarly Pimpini (1967) observed that response to added potash was much lower in an area with high soil content of available potassium and application of 160 kg potash per hectare increased yield and promoted earliness in chillies.

Mohammed Kunju (1970) observed that application of different levels of potash had given no significant difference in setting percentage, number of pods per plant, girth and length of pods and earliness, but potash at 40 and 60 kg per hectare increased the weight of 100 pods significantly over 20 kg per hectare while 40 and 60 kg per hectare were on par.

Covarelli (1976) noted that potash had no obvious effect on earliness and number of fruits per plant. Contrary to the above finding Khan and Suryanarayana (1977) reported that pod number per plant, pod length and girth and yields were highest with 45 kg K_2O per hectare. They also reported that potash had no effect on fruit ascorbic content. Subbiah et al. (1982) noted that potash had significent effect on increasing yield of chilli.

Effect of combined application of nutrients on growth and yield.

Dhulappanavar (1965) noted that though chilli crop gave good response to nitrogen, the application of P_2O_5 gave small increase in yield and advocated the application of phosphoric acid and potash with a view to maintain soil fertility and also to obtain more yields in more favourable season. Pimpani (1967) observed that potash in combination with phosphorus increased fruit number per plant and average weight per fruit. Mohammed Kunju (1970) summarising the results of manurial trial on chillies found that nitrogen in combination with phosphorus increased the height, number of pods per plant and setting percentage.

Lal and Pundrik (1971) observed that highest yield was obtained in response to 80 kg nitrogen, 90 kg phosphorus and 50 kg potassium and all interactions had positive effects on yield. In a manurial trial on chilli, Bangash and Shaikh (1972) reported that a yield increase of 109% above control was obtained by a balanced fertilization ie. 100 kg/ha each of N, P_2O_5 and K_2O. Similarly Berenyi (1973) also got a result wherein combined application of nitrogen, phosphoric acid and potash gave higher yields. Phosphorus and potash alone increased yields, but the two together were still more effective.

Gill *et al.* (1974) recorded good response of chilli crop to balanced fertilisation. Nitrogen and phosphorus interactional effects were found to be significant in promoting earliness, number of pods per plant, and number of branches per plant. Subbiah (1982) showed that nitrogen in combination with potash tended to produce more yield in chillies.

Uptake of nitrogen, phosphorus and potassium

Ozaki and Hamilton (1954) reported that responses to nitrogen were obtained at higher levels of potash and responses to potash at higher nitrogen levels. Vleck and Polach (1963) worked out the ratio of nutrients ie.N, P_2O_5 and K_2O removed by chilli growth in gravel with a complete nutrient solution as 1 : 0.92 : 2.05.

Thomas and Heilman (1967) found that application of phosphorus increased nitrogen uptake and phosphorus uptake was increased with nitrogen application. Spaldon and Ivanic (1968) reported that uptake of phosphorus and potash increased with increasing potash rates and nitrogen uptake was highest with highest rate of potash applied.

Sanchezcorde (1970) in a manurial trial on chilli demonstrated the influence of nitrogen on potash absorption and also reported that plant potash and nitrogen contents were proportional to the potash and nitrogen application. Fernandes (1973) noted that a plant population of 25,000 removed 40.9 kg nitrogen, 3.8 kg phosphorus and 68.6 kg potassium per hectare. Ivanic and Strelec (1976) recorded that increasing potash rates increased nitrogen, phosphorus and potash uptake and improved their utilisation. They also found that the nutrient consumption of five varieties of chilli varied for nitrogen from 188.3 to 252.2 kg per hectare, P_2O_5 from 19.90 to 48.40 kg and K_2O from 287 to 387.7 kg per hectare. Patron (1976) reported that chilli plants utilised 56 kg nitrogen, 12 kg phosphorus and 68.5 kg potassium to produce 100 centners of fruits.

Effect of climatic factors on growth, yield and uptake of nutrients.

Ozaki *et al.* (1956) observed that in a season of good rainfall, highest yields of chilli was obtained by applying 300 lb nitrogen and 300 lb potash per acre. Under low rainfall conditions, yields of high grade fruits were reduced even at higher rates of fertilisation (360 lb N and 360 lb K_2O) owing to the frequent occurrence of a fruit defect called "injured".

Penzes (1956) from long term studies in the Szeged region of Hungery revealed that optimum conditions for good growth appeared to be an average air temperature of 17°C and soil temperature of 10°C. High rainfall increased yields but reduced capsicin content. Masuda and Hayashi (1957) noted that drought had little effect on fruit setting, but it considerably decreased the total number of flowers.

Studencova (1964) found that chilli crop grew more vigorously and gave higher yields in 12 hour-days than in natural 18 hour-days. Rajamoni and Nagarathnam (1964) reported that even distribution of rainfall throughout the growing period followed by dry fruiting period were necessary for maximum yields. Hamadeh (1967) recorded that temperature requirement for optimum fruiting comprised of a sequence of warm (70-80°F) prevailing in pre-anthesis stages followed by cool (50-60°F) to medium (60-70°F) during the post-anthesis stages. Thomas and Heilman (1967) noted that high soil moisture reduced nitrogen absorption at low levels of nitrogen. The inhibitory effect of high soil moisture on uptake of nitrogen was overcome by applying high rates of nitrogen. Breuils and Ginoux (1970) found that a difference of 6-7°C between day and night temperatures was seen best to ensure continued fruiting.

Michalik *et al.* (1975) observed that high rainfall and high temperature had an adverse effect on vitamin-C content in chillies. Song *et al.* (1976) reported that flower bud abscission was increased under high temperatures (28-33°C).

Materials and Methods

MATERIALS AND METHODS

The present investigation was undertaken with the object of studying the effects of graded doses of nitrogen, phosphorus and potash on growth, yield and quality of chilli variety Part-C.1 in two different seasons under the agroclimatic conditions of Vellanikkara.

MATERIALS

1.1 Site, climate and soil

The farm is situated at 12.32°N lattitude and 74.20°E longitude, at an altitude of 22.25 meters. This area enjoys a typical humid tropical climate.

The details of the meteorological observations for the two seasons are presented in Appendix-I and Fig-I.

The soil of the experimental area is moderately well drained clay loam. The chemical properties of the soil from the experimental area are given in Table-1.

TABLE 1

Chemical characteristics of soil

Constituent	Content in soil		Method used
	I crop area	II crop area	
Total nitrogen	0.0737%	0.0751%	Microkjeldahl method
Available P_2O_5	2.30 ppm	2.25 ppm	In Bray-I extract, chlorostannous reduced molybdo-phosphoric blue colour method
Available K_2O	87.5 ppm	90.15 ppm	In neutral ammonium acelate extract, flame photometric
p^H	5.1	5.0	1:2 soil:water ratio using a p^H meter

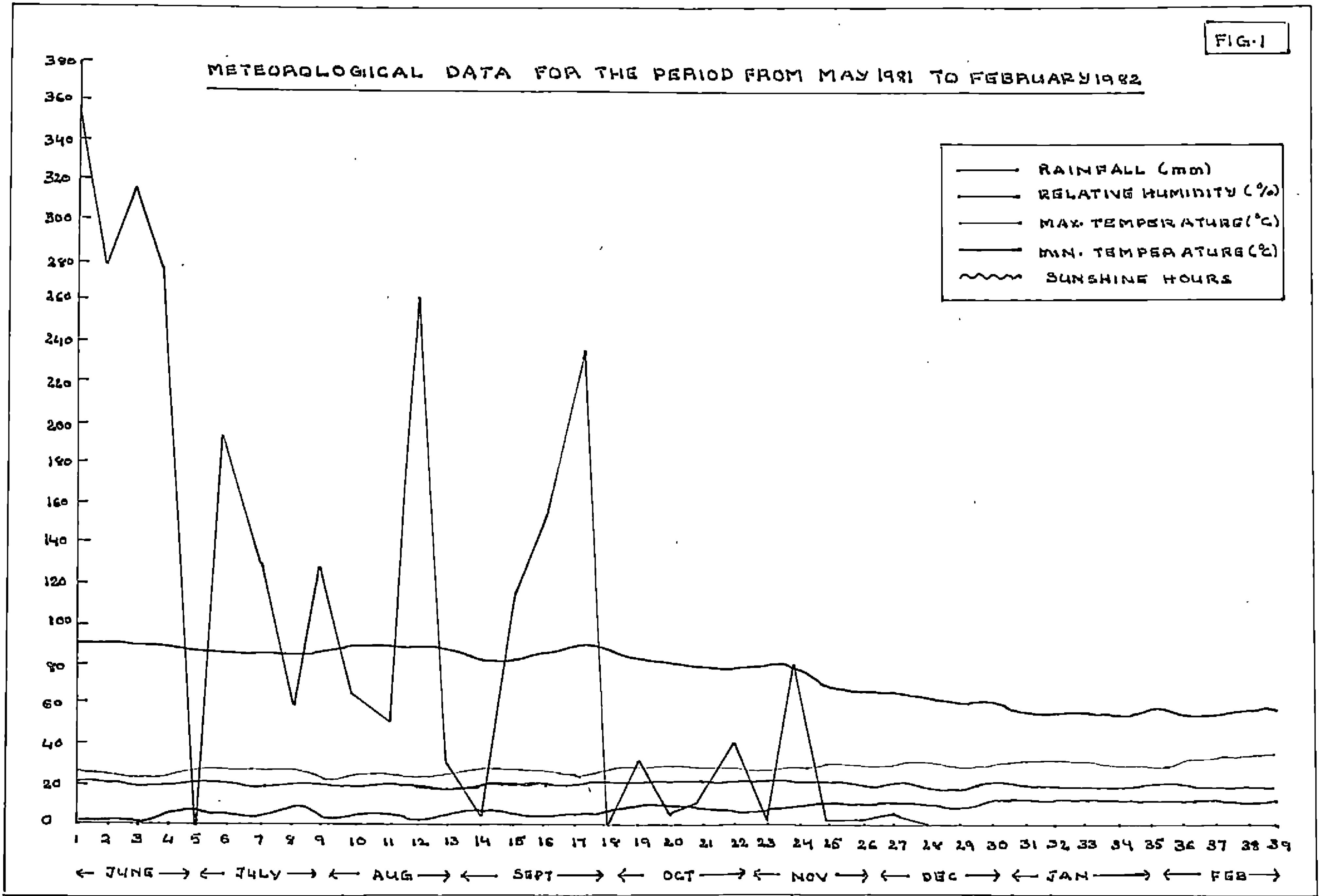


FIG. 1
METEOROLOGICAL DATA FOR THE PERIOD FROM MAY 1981 TO FEBRUARY 1982
RAINFALL (mm)
RELATIVE HUMIDITY (%)
MAX. TEMPERATURE (°C)
MIN. TEMPERATURE (°C)
SUNSHINE HOURS
380 360 340 320 300 280 260 240 220 200 180 160 140 120 100 80 60 40 20 0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
← JUNE → ← JULY → ← AUG → ← SEPT → ← OCT → ← NOV → ← DEC → ← JAN → ← FEB →

1.2 Season

The first crop was planted on 30th May 1981 and finally harvested on 15th September 1981 and the second crop was planted on 21st November 1981 and finally harvested on 20th February 1982.

1.3 Seeds

Pant-C.1, a high yielding variety of chilli was used for the experiment. The variety is of 5 months duration. Seeds of this variety were obtained from the Department of Olericulture of the College of Horticulture, Vellanikkara.

1.4 Manures and fertilisers

Urea, superphosphate and muriate of potash were used as the source of nitrogen, phosphorus and potassium respectively. Chemical analysis of the fertilisers showed the following compositions.

Urea	-	46% N
Superphosphate	-	16% P_2O_5
Muriate of potash	-	60% K_2O

II. Experimental details

2.1 Design and layout

The experiment was laid out in 3^3 confounded factorial design with two replications. The higher order interactions NP^2K and NPK^2 were partially confounded in replications I and II, respectively. The procedure followed for allocation of various treatments to different plots was

LAYOUT PLAN - 3^3 CONFOUNDED FACTORIAL DESIGN - CONFOUNDING NP^2K IN REP-I AND NPK^2 IN REP-II

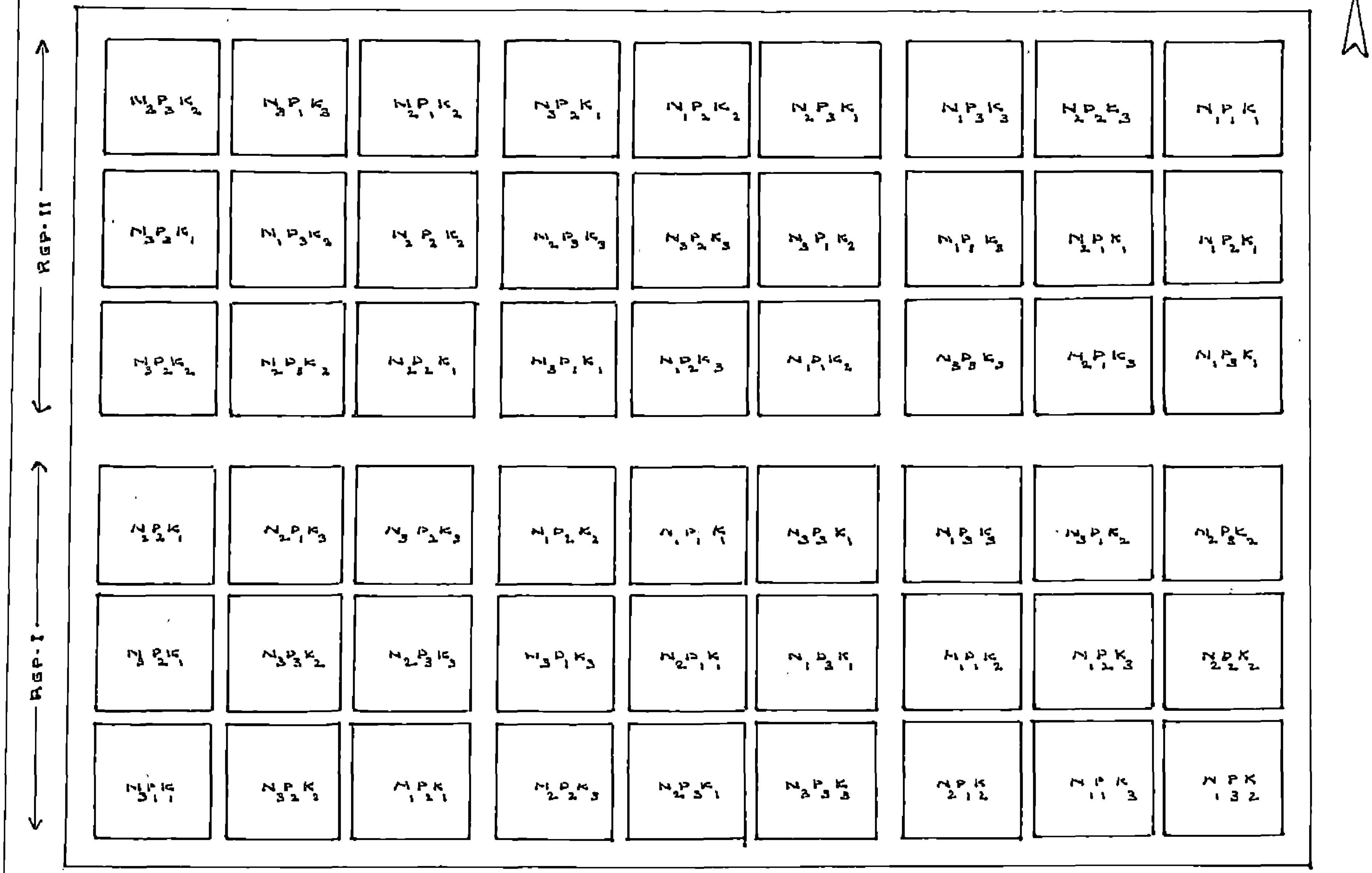


FIG 2

in accordance with Yates (1937). The design of the experiment is given in Figure-2.

2.2 Treatments

Treatments consisted of all possible 27 combinations of nitrogen, phosphorus and potassium at three levels each, as detailed below:

2.2.1 Levels of nitrogen

1. n_1 : 37.50 Kg N/ha
2. n_2 : 75.00 "
3. n_3 : 112.50 "

2.2.2 Levels of phosphorus

1. P_1 : 20 Kg P_2O_5/ha
2. P_2 : 40 "
3. P_3 : 60 "

2.2.3 Levels of potassium

1. K_1 : 10 Kg K_2O/ha
2. K_2 : 20 "
3. K_3 : 30 "

2.2.4 The treatment combinations are as follows:

1. $n_1\ P_1\ K_1$
2. $n_1\ P_1\ K_2$
3. $n_1\ P_1\ K_3$
4. $n_1\ P_2\ K_1$
5. $n_1\ P_2\ K_2$
6. $n_1\ P_2\ K_3$

7. $n_1\ P_3\ K_1$
8. $n_1\ P_3\ K_2$
9. $n_1\ P_3\ K_3$
10. $n_2\ P_1\ K_1$
11. $n_2\ P_1\ K_2$
12. $n_2\ P_1\ K_3$
13. $n_2\ P_2\ K_1$
14. $n_2\ P_2\ K_2$
15. $n_2\ P_2\ K_3$
16. $n_2\ P_3\ K_1$
17. $n_2\ P_3\ K_2$
18. $n_2\ P_3\ K_3$
19. $n_3\ P_1\ K_1$
20. $n_3\ P_1\ K_2$
21. $n_3\ P_1\ K_3$
22. $n_3\ P_2\ K_1$
23. $n_3\ P_2\ K_2$
24. $n_3\ P_2\ K_3$
25. $n_3\ P_3\ K_1$
26. $n_3\ P_3\ K_2$
27. $n_3\ P_3\ K_3$

2.2.5 Size of plots

Gross plot size	:	3.6 x 3.6 m
Net area of a plot	:	7.29 sq.m
Spacing	:	45 x 45 cm
Number of plants in gross plot	:	64
Number of plants in net plot	:	36
Replication	:	2

2.3 Nursery

Five hundred grams of seeds were sown in well prepared raised nursery beds. Beds were 1.2 m. wide and 15 cm high with channels between the beds to facilitate the drainage of excess water. A basal dressing of powdered cattle manure at the rate of 1 Kg/sq.meter was applied in the nursery beds.

The seeds for the first season crop were sown on 22.4.81 and on for the second season on 13.10.81. The seedlings were irrigated every day. Spraying with 1% Bordeaux mixture was done twice, first two weeks after sowing and the second 3 weeks after sowing. The seedlings were ready for transplanting in 35-40 days.

2.4 Field culture

The experimental area for the first crop was ploughed and harrowed three times to obtain a fine tilth. Plots of size 3.6 x 3.6 m were laid out. Ridges were formed at 45 cm apart for the first crop and thirty nine day old seedlings were planted on the ridges at 45 cm apart on 30.5.81

For the second season crop also the experimental area was ploughed and harrowed three times to obtain a fine tilth. Plots of size 3.6 x 3.6 m were laid out and seedlings of thirty nine days old were planted along the waterline on one side of the ridges made 45 cm apart on 21.11.81. Seedlings were given necessary shading in both seasons.

2.5 Manuring

The fertilisers were applied as per the schedule of treatments. The entire doses of phosphorus and potash and half the dose of nitrogen were given as basal dressing. The remaining half of nitrogen was applied as top dressing on the 28th day after transplanting in both seasons.

2.6 After cultivation and plant protection

The general stand of the crop was satisfactory throughout the period of growth. Three hand weedings at 22 days intervel were carried out for both crops. No irrigation was given to the first season crop. The second season crop was given daily irrigation for a period of three weeks after planting and thereafter irrigated only once in every three days.

Regular prophylatic sprayings with Rogor (0.05%), Bordeaux mixture (1%) and Pauzhamycin (250 ppm) were given to both crops. There was no serious attack of any pest or disease in the crops grown in the first season and second season.

2.7 Harvesting

The first season crop was ready for harvesting 76 days after planting and the second season crop 61 days after planting. The picking of ripe fruits continued for 30 days and 4 to 5 pickings were taken. Ripe fruits were picked along with stalks and were then dried in the sun for 4 to 5 days.

2.8 Observations recorded

A. Growth components

1. Height of plants

This observation was taken from ten plants at random in each treatment after eleminating border rows. The height of plants were measured from the base to the growing tip of the plants. Observations were recorded on the same plants at the three growth stages viz. 35^{th} day, 70^{th} day after planting and at the time of final harvest.

2. Number of branches

The total number of branches per plant at the time of final harvest was recorded from ten plants at random in each treatment after eleminating border rows.

3. Dry matter yield per plant

After eleminating the guard rows, the entire dry weights of shoot and fruits of ten plants from the sampling rows were recorded.

B. Earliness, yield and quality attributes

1. Days taken for first flower opening

The number of days taken for the first flower opening was recorded from the date of transplanting in 10 randemly selected plants after elbminating the border rows.

2. Percentage fruit set

This observation was calculated by dividing the total number of fruits formed on a plant with the total number of flowers produced in the same plant and this observation was taken in ten selected observation plants in each treatment.

3. Number of pods per plant

The total number of pods on the ten selected plants were noted and the average worked out.

4. Length of pods

From the above selected plants, ten pods taken at random were measured and their average length calculated in the second harvest.

5. Girth of pods

Pods used for measuring length were used for recording the girth of pods

6. Weight of 100 dry pods

From each treatment, 100 pods were drawn at random, and their weight recorded after uniform drying.

7. Yield of dry pods per hectare

The produce from each harvest was uniformly dried and total weight recorded for each treatment.

8. Ascorbic acid content of fresh fruits

Vitamin-C content of well riped fresh fruits was determined treatmentwise and expressed as mg/100 g of fruit.

C. Chemical analysis

Plant samples collected from the sampling rows at the time of final harvest were dried to constant weights at 70°C. Dried samples were ground to pass a 20 mesh sieve and subjected to chemical analyses for total nitrogen, phosphorus and potassium. Stem, fruits and leaves were seperately analysed for nitrogen, phosphorus and potassium.

1. Total nitrogen content of plant samples

The total nitrogen was estimated by the Microkjeldahl procedure as given by Jackson(1973)

2. Phosphorus content of plants

The phosphorus content of plants was estimated calorimetrically (Jackson 1973)

3. Potassium content of plants

The potassium content was estimated by flame photometry (Jackson 1973)

D. Uptake of nutrients at harvest

1. Total uptake of nitrogen

This was calculated from the nitrogen contents of stem, leaves and fruits and total dry weight of these plant samples.

2. Total uptake of phosphorus

From the phosphorus contents of stem, leaves and fruits of the sample plants and dry matter yield, the uptake of phosphorus was calculated.

3. Total uptake of potassium

The potassium uptake was calculated from the potassium contents of stem, leaves and fruits of the sample plants and total dry matter yield of these components.

2.9 Statistical analysis

The data relating to each character were analysed by applying the analysis of variance technique for 3^3 partially confounded factorial experiments in R.B.D as suggested by Panse and Sukhatme (1967)

To study the seasonal effects, on growth and yield attributes of this crop, the observations were compared by using the paired 't' test (Panse and Sukhatme 1967)

2.9.1 Estimation of optimum doses of nutrients by fitting response function

The optimum doses of nutrients were estimated by finding the partial derivatives of the response function and equating each of them to zero. The economic doses of the nutrients were obtained by equating the marginal revenue to marginal cost as shown below

$$\frac{dy}{dxi} = \frac{Pxi}{Py}$$

where $\frac{dy}{dxi}$ = partial derivative of yield with response to the nutrient xi

Pxi = Price of the nutrient

Py = Price of the output

xi = N, P_2O_5 or K_2O

As nitrogen, phosphorus and potash and the interaction between nitrogen and phosphorus were found to have significant effect on yield in the first season, a quadratic surface response function was fitted in the following form.

$$Y = a_0 + a_1N + a_2P + a_3NP + a_4K + a_5N^2 + a_6P^2 + a_7K^2$$

In the second season, in addition to the above factors, interaction between phosphorus and potassium also significantly affected yield. Hence the form of the quadratic surface response function used was

$$Y = a_0 + a_1N + a_2P + a_3NP + a_4K + a_5PK + a_6N^2 + a_7P^2 + a_8K^2$$

Results

EXPERIMENTAL RESULTS

The present investigation was undertaken to evaluate the response of the chilli variety Pant-C1 to graded doses of nitrogen, phosphorus and potassium in two seasons. The experimental results are presented below.

1. Growth characters

1.1. Height of plants

The data on mean height of plants at the different stages of growth are presented in Tables 2 and 3 and graphical representation in Fig.3 and the analyses of variances in Appendices II and III.

The effect of nitrogen on plant height was found to be significant at all the three stages of observations in both seasons. At the 35th day after planting, nitrogen at 75 kg/ha was found to be significantly superior to 37.5 kg and 112.5 kg/ha levels in both seasons. At the 70th day after planting, nitrogen at levels of 75 kg and 112.5 kg/ha were found to be significantly superior to the 37.5 kg level in the first season crop. However, the difference between 75 and 112.5 kg levels of nitrogen was not significant in the same season crop. But, nitrogen

Table 2. Effect of different levels of nitrogen, phosphorus and potassium on height of plants (in cm) at various growth stages of chilli during the first crop season.

Treatments	35[th] day after planting	70[th] day after planting	Final harvest
Levels of N kg/ha			
37.5	20.57	33.83	38.31
75.0	24.62	40.32	47.19
112.50	24.27	40.90	48.31
'F'test	Sig.	Sig.	Sig.
SEm±	0.11	0.34	0.38
CD (0.05)	0.34	0.99	1.11
Levels of P_2O_5 kg/ha			
20	22.22	36.85	41.91
40	23.70	38.77	45.57
60	23.53	39.45	46.33
'F'test	Sig.	Sig.	Sig.
SEm±	0.11	0.34	0.38
CD (0.05)	0.34	0.99	1.11
Levels of K_2O kg/ha			
10	23.09	38.38	43.59
20	23.21	38.41	45.41
30	23.16	38.27	44.81
'F'test	NS	NS	Sig.
SEm±	0.11	0.34	0.38
CD (0.05)	-	-	1.11

Table 3. Effect of different levels of nitrogen, phosphorus and potassium on height of plants (in cm) at various growth stages of chilli during the second crop season.

Treatments	35th day after planting	70th day after planting	Final harvest
Levels of N kg/ha			
37.50	19.48	34.20	40.54
75.00	24.31	41.68	51.13
112.50	23.55	43.49	51.69
'F' test	Sig.	Sig.	Sig.
SEm±	0.11	0.39	1.41
CD (0.05)	0.31	1.15	4.16
Levels of P_2O_5 kg/ha			
20	21.63	38.64	46.33
40	22.78	39.96	47.38
60	22.92	40.77	49.66
'F' test	Sig.	Sig.	NS
SEm±	0.11	0.39	1.41
CD (0.05)	0.31	1.15	-
Levels of K_2O kg/ha			
10	22.41	39.51	48.33
20	22.42	39.80	46.59
30	22.51	40.06	48.44
'F' test	NS	NS	NS
SEm±	0.11	0.39	1.41
CD (0.05)	-	-	-

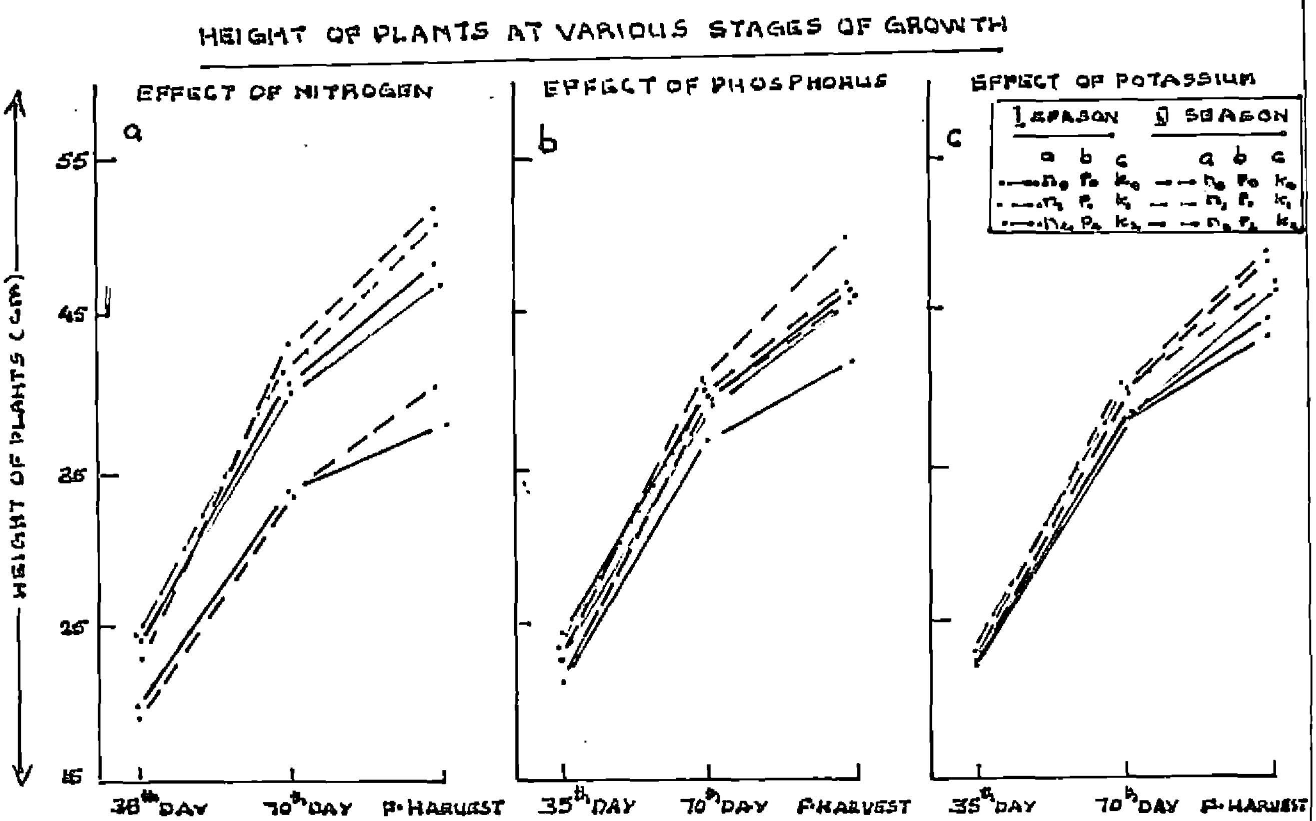


FIG. 3

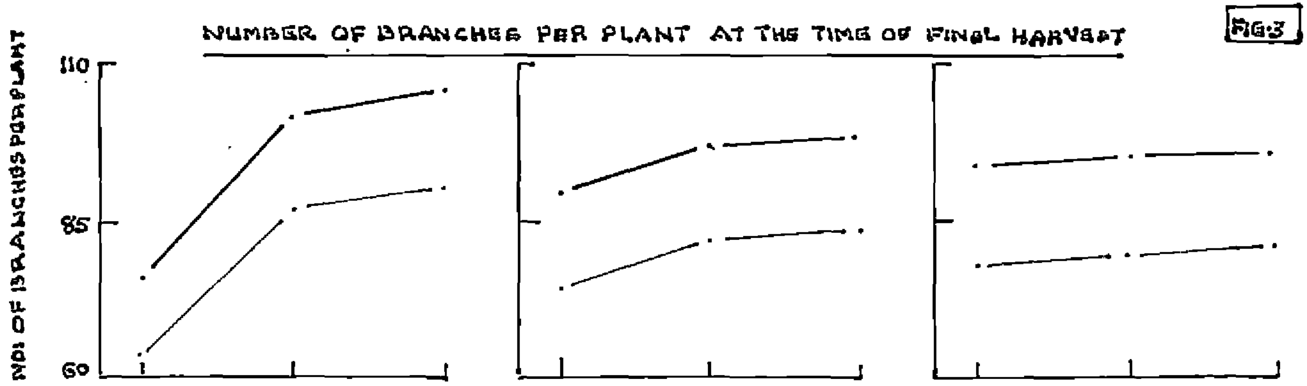


FIG. 4

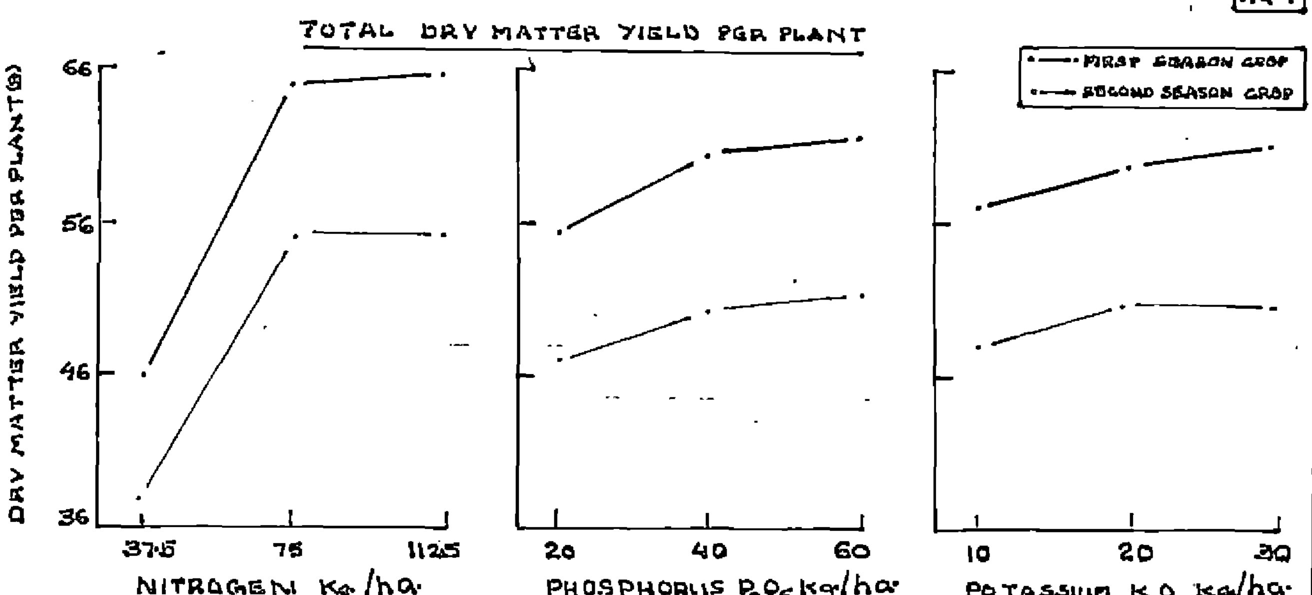


FIG. 5

at 112.5 kg/ha was found to be significantly superior to 37.5 kg and 75 kg/ha levels of nitrogen on the height of plants at 70th day after planting in the second crop.

At the time of final harvest, nitrogen at 112.5 kg/ha was found to be significantly superior to 37.5 kg and 75 kg/ha levels of nitrogen in the first crop, whereas, in the second crop nitrogen at 75 kg/ha and 112.5 kg/ha were found to be significantly superior to 37.5 kg N/ha. However, the difference between 75 kg and 112.5 kg N/ha was not significant.

The application of phosphorus produced significant effect on the height of plants. At 35th day after planting in both the seasons, phosphorus at 40 kg/ha and 60 kg/ha were found to have significant influence on the height of plants, the difference between 40 and 60 kg/ha levels of P_2O_5 was statistically not significant. Application of phosphorus at 60 kg P_2O_5/ha was found to be significantly superior to 20 kg P_2O_5/ha at 70th day after planting, but was on par with 40 kg P_2O_5/ha in both the seasons.

At the time of final harvest, phosphorus at 40 kg P_2O_5/ha and 60 kg P_2O_5/ha were found to be significantly superior to 20 kg P_2O_5/ha in the first crop.

Table 4. Combined effect of nitrogen and phosphorus on height of plants (in cm) at 70 days after planting during the second crop season.

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
20	34.47	38.73	42.73	38.64
40	33.80	42.50	43.57	39.96
60	34.33	43.80	44.17	40.77
Mean	34.20	41.68	43.49	-
SEm±	0.67			
CD (0.05)	1.98			

Table 5. Combined effect of phosphorus and potash on height of plants (in cm) at 70 days after planting during the first crop season.

Levels of K_2O kg/ha	Levels of P_2O_5 kg/ha			Mean
	20	40	60	
10	38.13	37.93	39.07	38.38
20	36.07	37.98	40.20	38.41
30	36.36	39.33	39.10	38.27
Mean	36.85	38.77	39.45	-
SEm±	0.58			
CD (0.05)	1.71			

Table 6. Combined effect of phosphorus and potassium on height of plants (in cm) at 70 days after planting during the second crop season.

Levels of K_2O kg/ha	Levels of P_2O_5 kg/ha			Mean
	20	40	60	
10	39.17	38.10	41.27	39.51
20	38.27	40.57	40.57	39.80
30	38.50	41.20	40.47	40.06
Mean	38.64	39.96	40.77	-
SEm±	0.67			
CD (0.05)	1.98			

However, the difference between 40 and 60 kg P_2O_5/ha was not statistically significant. In the second crop, various levels of phosphorus did not produce any significant effect on height of plants at the time of final harvest.

Effect of potash on the height of plants was significant only at the time of final harvest in the first season. Potash at 20 kg/ha and 30 kg/ha were found to be significantly superior to 10 kg level of potash at the time of final harvest in the first season. The difference between 20 kg K_2O/ha and 30 kg K_2O/ha was not statistically significant. The different levels of potassium did not produce any significant effect on the height of plants during the second season.

The interaction between nitrogen and phosphorus was found to be significant at 70^{th} day after planting in the second season, (Table 4). The maximum height of 44.17 cm was recorded with 112.5 kg nitrogen and 60 kg P_2O_5 per hectare and the minimum height of 33.80 cm recorded with 37.5 kg nitrogen and 40 kg P_2O_5 per hectare at 70^{th} day after planting.

The interactional effect of phosphorus and potassium was significant at 70^{th} day after planting in

Table 7. Seasonal effect on the mean height of plants (cm)

Treatments	35^{th} day after planting			70^{th} day after planting		
	season I	season II	difference	season I	season II	difference
n_1 p_1 k_1	19.8	18.2	1.6	33	32.5	0.5
n_1 p_1 k_2	19.1	18.7	0.4	32.6	32.6	0
n_1 p_1 k_3	19.2	18.9	0.3	33	32.4	0.6
n_1 p_2 k_1	21.1	19.9	1.2	33	34.2	-1.2
n_1 p_2 k_2	22.1	19.7	2.4	33.3	34.8	-1.5
n_1 p_2 k_3	21	19.9	1.1	34.4	34.4	0
n_1 p_3 k_1	20	20	0	35.2	34.2	1
n_1 p_3 k_2	21.2	19.9	1.3	35.5	34.4	1.1
n_1 p_3 k_3	21.6	20.1	0.5	34.5	35	-0.5
n_2 p_1 k_1	24.2	23.7	0.5	38	40.3	-2.3
n_2 p_1 k_2	23.7	23.7	0	37.2	40.9	-3.7
n_2 p_1 k_3	24	23.4	0.6	38.1	40.9	-2.8
n_2 p_2 k_1	25.2	24.7	0.5	40.5	42.8	-2.3
n_2 p_2 k_2	25.1	24.65	0.45	41.6	43.8	-2.2
n_2 p_2 k_3	24.7	24.5	0.2	41.3	44.5	-3.2
n_2 p_3 k_1	24.8	24.8	0	41.3	43.8	-2.5
n_2 p_3 k_2	24.7	24.6	0.1	43.4	43.1	0.3
n_2 p_3 k_3	25.2	24.7	0.5	41.5	44.2	-2.7
n_3 p_1 k_1	23.4	22.15	1.25	38.4	42	-3.6
n_3 p_1 k_2	23.3	22.5	0.8	38.4	42	-3.6
n_3 p_1 k_3	23.3	23.4	-0.1	38	41	-3
n_3 p_2 k_1	24.7	23.8	0.9	40.3	44.7	-4.4
n_3 p_2 k_2	24.7	24	0.7	42	45	-3
n_3 p_2 k_3	24.7	23.9	0.8	42.3	44.9	-2.6
n_3 p_3 k_1	24.6	24.4	0.2	40.7	43.7	-3
n_3 p_3 k_2	25	24	1	41.7	43.9	-2.2
n_3 p_3 k_3	24.7	23.8	0.9	41.3	43.8	-2.5
't' Value			6.13*			5.29*

* (P = 0.05)

Table 8. Seasonal effect on the mean height of plants (cm).

Treatments	At the time of final harvest		
	Season I	Season II	Difference
$n_1\ p_1\ k_1$	36.5	37.65	-1.15
$n_1\ p_1\ k_2$	35	37	-2
$n_1\ p_1\ k_3$	35.6	36	-0.4
$n_1\ p_2\ k_1$	38.1	39.25	-1.15
$n_1\ p_2\ k_2$	38.2	38.8	-0.6
$n_1\ p_2\ k_3$	41	39.2	0.8
$n_1\ p_3\ k_1$	38.7	40.45	-1.75
$n_1\ p_3\ k_2$	41.4	40.3	1.1
$n_1\ p_3\ k_3$	40.3	41.25	-0.95
$n_2\ p_1\ k_1$	42.6	46.05	-3.45
$n_2\ p_1\ k_2$	44.6	46.7	-2.1
$n_2\ p_1\ k_3$	45.3	47.2	-1.9
$n_2\ p_2\ k_1$	47.3	51.7	-4.4
$n_2\ p_2\ k_2$	49.95	49.9	0.05
$n_2\ p_2\ k_3$	48.8	50.5	-1.7
$n_2\ p_3\ k_1$	47.6	50.7	-3.1
$n_2\ p_3\ k_2$	48.9	51.3	-2.4
$n_2\ p_3\ k_3$	49.7	51.1	-1.4
$n_3\ p_1\ k_1$	44.65	49.8	-5.15
$n_3\ p_1\ k_2$	48.3	50.75	-2.45
$n_3\ p_1\ k_3$	44.7	50.65	-5.95
$n_3\ p_2\ k_1$	49	52.1	-3.1
$n_3\ p_2\ k_2$	49.4	52.5	-3.1
$n_3\ p_2\ k_3$	48.4	52.5	-4.1
$n_3\ p_3\ k_1$	47.9	52.25	-4.35
$n_3\ p_3\ k_2$	53	52.1	0.9
$n_3\ p_3\ k_3$	49.5	52.45	-2.95
't' Value			6.01*

* (P=0.05)

both the seasons, (Tables 5 and 6). In the first season maximum height of 40.20 cm was recorded with 60 kg P_2O_5 and 20 kg K_2O per hectare, whereas the minimum height of 36.07 cm was noted in plots receiving a combination of 20 kg P_2O_5/ha and 20 kg K_2O/ha. In the second season, the maximum height of 41.27 cm was noted with 60 kg P_2O_5 and 10 kg K_2O per hectare and the minimum height of 38.10 cm was recorded with 40 kg P_2O_5 and 10 kg K_2O per hectare.

Between seasons there was difference in the mean height of plants at all the stages of observations. The mean height of plants at 35^{th} day after planting in the first season was 23.15 cm, whereas in the second season the mean height was 22.41 cm. At 70^{th} day after planting the mean height of plants for the first and second seasons were 38.35 cm and 39.79 cm and at the time of final harvest the corresponding figures were 44.60 and 47.78 cm respectively. The mean differences in mean heights of plants between seasons were statistically significant at each of the three stages of observations, (Tables 7 and 8).

1.2. Number of branches

The mean number of branches per plant at the time of final harvest for various treatments are shown in

Table 9 Effect of different levels of nitrogen, phosphorus, and Potassium on the number of branches per plant at the time of final harvest and dry matter per plant during the first crop season

Treatments	Number of branches	Dry matter yield per plant(g)
Levels of N kg/ha		
37.50	76.57	45.73
75.00	102.39	65.05
112.50	104.91	65.36
'F'test	Sig.	Sig.
SEm +	0.72	0.18
CD (0.05)	2.11	0.53
Levels of P_2O_5 kg/ha		
20	88.79	55.14
40	97.25	60.09
60	97.84	60.93
'F'test	Sig.	Sig.
SEm +	0.72	0.18
CD (0.05)	2.11	0.53
Levels of K_2O kg/ha		
10	93.88	56.71
20	94.71	59.35
30	95.28	60.09
'F'test	NS	Sig.
SEm +	0.72	0.18
CD (0.05)		0.53

Table 10 Effect of different levels of nitrogen, phosphorus and potassium on the number of branches per plant at the time of final harvest and dry matter per plant during the second crop season

Treatments	Number of branches	Dry matter yield per plant (g)
Levels of N kg/ha		
37.50	62.82	38.14
75.00	87.18	54.97
112.50	90.42	54.74
'F' test	Sig.	Sig.
SEm ±	0.90	0.15
CD (0.05)	2.65	0.45
Levels of P_2O_5 kg/ha		
20	75.09	47.28
40	81.97	49.86
60	83.36	50.71
'F' test	Sig.	Sig.
SEm ±	0.90	0.15
CD (0.05)	2.65	0.45
Levels of K_2O kg/ha		
10	79.19	48.12
20	80.26	49.75
30	80.98	49.98
'F' test	NS	Sig.
SEm ±	0.90	0.15
CD (0.05)		0.45

Tables 9 and 10 and graphical representation in Fig.4 and the analyses of variances in Appendices II and III.

The data reveal significant effect of nitrogen on the number of branches per plant in both the seasons. The differences amongst the various levels of nitrogen were significant in both the seasons. Nitrogen at 112.5 kg/ha produced in highest number of branches (104.91) in the first season, whereas the same level of nitrogen produced only 90.42 branches, the highest number of branches per plant in the second season.

Application of phosphorus was found to have significant effect on the number of branches per plant. In this respect phosphorus at 40 kg and 60 kg P_2O_5/ha were significantly superior to 20 kg P_2O_5/ha and effects of P_2O_5 at 40 kg and 60 kg/ha levels were on par in both the seasons. Phosphorus at 60 kg P_2O_5/ha produced a maximum of 97.84 branches in the first season, whereas the same level of phosphorus produced the maximum of 83.36 branches per plant in the second season.

Potassium did not produce any significant effect on the number of branches per plant in both the seasons.

The interaction between nitrogen and phosphorus was found to be significant in the first season (Table 11).

Table 11 Combined effect of nitrogen and phosphorus on the number of branches per plant at the time of final harvest during the first crop season

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
20	72.17	94.03	100.17	88.79
40	78.42	107.73	105.60	97.25
60	79.13	105.42	108.97	97.84
Mean	76.57	102.39	104.91	--
SEm ±	1.56			
CD (0.05)	3.65			

Table 12. Seasonal effect on the mean number of branches per plant and dry matter production per plant.

Treatments	Mean number of branches per plant			Dry matter production per plant (g)		
	Season I	Season II	Difference	Season I	Season II	Difference
$n_1\ p_1\ k_1$	70.3	58	12.3	39.595	35.380	4.215
$n_1\ p_1\ k_2$	69.4	58.5	10.9	42.155	37.245	4.910
$n_1\ p_1\ k_3$	76.8	61.3	15.5	42.925	36.380	6.545
$n_1\ p_2\ k_1$	76.4	62.6	13.8	45.420	38.050	7.37
$n_1\ p_2\ k_2$	80.6	66.3	14.3	47.460	38.505	8.955
$n_1\ p_2\ k_3$	78.25	64.6	13.65	48.505	40.310	8.195
$n_1\ p_3\ k_1$	79.7	64.3	15.4	47.735	38.005	9.73
$n_1\ p_3\ k_2$	77.7	64.4	13.3	48.320	39.310	9.01
$n_1\ p_3\ k_3$	80	65.4	14.6	49.530	40.105	9.425
$n_2\ p_1\ k_1$	95.1	80.6	14.5	59.375	50.265	9.11
$n_2\ p_1\ k_2$	95.1	80.7	14.4	62.855	53.190	9.665
$n_2\ p_1\ k_3$	91.9	81.3	10.6	62.455	52.445	10.01
$n_2\ p_2\ k_1$	106.2	88.8	17.4	63.695	54.165	9.53
$n_2\ p_2\ k_2$	107.3	88.2	19.1	67.430	56.680	10.75
$n_2\ p_2\ k_3$	109.7	93.1	16.6	68.375	57.185	11.19
$n_2\ p_3\ k_1$	105.05	90.2	14.85	64.710	56.570	8.14
$n_2\ p_3\ k_2$	105.4	91.5	13.9	67.800	57.150	10.65
$n_2\ p_3\ k_3$	105.8	90.2	15.6	68.835	57.065	11.77
$n_3\ p_1\ k_1$	101.1	87.2	13.9	60.455	51.825	8.63
$n_3\ p_1\ k_2$	101.3	86.4	14.9	62.355	54.215	8.14
$n_3\ p_1\ k_3$	98.1	86.8	11.3	64.070	54.580	8.49
$n_3\ p_2\ k_1$	103.3	90	13.3	64.120	53.055	11.065
$n_3\ p_2\ k_2$	106.5	91.6	14.9	67.775	55.070	12.705
$n_3\ p_2\ k_3$	107	92.5	14.5	68.405	55.705	12.7
$n_3\ p_3\ k_1$	107.8	96	11.8	65.315	55.775	9.54
$n_3\ p_3\ k_2$	109.1	94.7	14.4	68.195	56.350	11.845
$n_3\ p_3\ k_3$	110	93.6	16.4	68.130	55.815	12.315
't' Value			41.89*			23.22*

* ($P = 0.05$)

In the first season the combination of 112.5 kg N/ha and 60 kg P_2O_5/ha produced the highest number of 108.97 branches per plant and the lowest number of 72.17 branches per plant was noted in plots receiving 37.5 kg N/ha and 20 kg P_2O_5/ha.

The mean number of branches produced per plant in the first season was 94.62 and the same for the second season was 80.14. The difference in mean numbef of branches per plant between the two seasons was found to be significant (Table 12).

1.3. Total dry matter production per plant.

The data on the dry matter yield per plant are presented in Tables 9 and 10 and graphical presentation in Fig.5. The analyses of variances of the data are shown in Appendices II and III.

The effect of nitrogen on total dry matter yield per plant was found to be significant in both the seasons. In the first season a maximum of 65.36 g dry matter per plant was produced by nitrogen at 112.5 kg/ha. The difference between 75 and 112.5 kg levels of nitrogen was not significant, but nitrogen at levels of 75 and 112.5 kg/ha were significant to 37.5 kg N/ha. In the second season, nitrogen at 75 kg/ha produced the maximum of 54.97 g dry matter per plant. The effect of nitrogen

Table 13 Combined effect of nitrogen and phosphorus on the dry matter production per plant (g) during the first crop season

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
20	41.55	61.56	62.29	55.14
40	47.13	66.50	66.63	60.09
60	48.53	67.12	67.15	60.93
Mean	45.73	65.05	65.36	--
SEm ±	0.31			
CD (0.05)	0.92			

Table 14 Combined effect of nitrogen and phosphorus on the dry matter production per plant (g) during the second crop season

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
20	36.34	51.97	53.54	47.28
40	38.96	56.01	54.61	49.86
60	39.14	56.93	56.06	50.71
Mean	38.14	54.97	54.74	--
SEm ±	0.27			
CD (0.05)	0.79			

at levels of 75 and 112.5 kg/ha were on par. However, both these levels of nitrogen were significantly superior to nitrogen at 37.5 kg/ha.

With regard to the effect of phosphorus, the differences among the three levels of P_2O_5 were significant. Phosphorus at 60 kg P_2O_5/ha produced maximum dry matter yield per plant in both the seasons, the corresponding figures were 60.93 g and 50.91 g for the first and second seasons respectively.

Application of potash was found to have significant effect on dry matter production per plant in both the seasons. Potash at 30 kg/ha produced the maximum dry weight of 60.09 kg/plant in the first season and the differences among all the three levels of potash were significant. In the second season, eventhough Potash at 30 kg/ha produced the maximum dry weight of 49.98 g per plant, the effect of 20 kg potash was on par with that of 30 kg potash and both the above higher levels of potash were significantly superior to potash at 10 kg/ha.

The interaction between nitrogen and phosphorus was significant in both the seasons (Tables 13 and 14). The maximum dry matter yield of 67.15 g per plant was recorded with 112.5 kg N/ha and 60 kg P_2O_5/ha in the first seasons whereas the minimum dry matter yield of

Table 15 Combined effect of phosphorus and potassium on the dry matter production per plant (g) during the second crop season

Levels of K_2O kg/ha	Levels of P_2O_5 kg/ha			Mean
	20	40	60	
10	45.82	48.42	50.12	48.12
20	48.22	50.09	50.94	49.75
30	47.80	51.07	51.08	49.98
Mean	47.28	49.86	50.71	--
SEm $\pm$	0.27			
CD (0.05)	0.79			

41.55 g per plant was noted in plots receiving 37.5 kg N/ha and 20 kg P_2O_5/ha. In the second season, a combination of 75 kg N/ha and 60 kg P_2O_5/ha produced the maximum of 56.93 g dry matter per plant and the minimum yield of 36.34 g per plant was recorded with 37.5 kg N/ha and 20 kg P_2O_5/ha.

The interactional effect of phosphorus and potassium was significant in the second season (Table 15). Plots receiving 60 kg P_2O_5/ha and 30 kg K_2O/ha produced the maximum of 51.08 g dry matter per plant and the minimum of 45.82 g dry matter per plant was recorded with 20 kg P_2O_5/ha and 10 kg K_2O/ha.

The mean dry weight produced per plant in the first season was 58.72 g and that in the second season was 49.28 g. The difference in mean dry matter production per plant between the two seasons was found to be statistically significant (Table 12).

2. <u>Effect of Nitrogen, Phosphorus and Potassium on Earliness and Yield attributes</u>

2.1. <u>Number of days taken for first flower opening:</u>

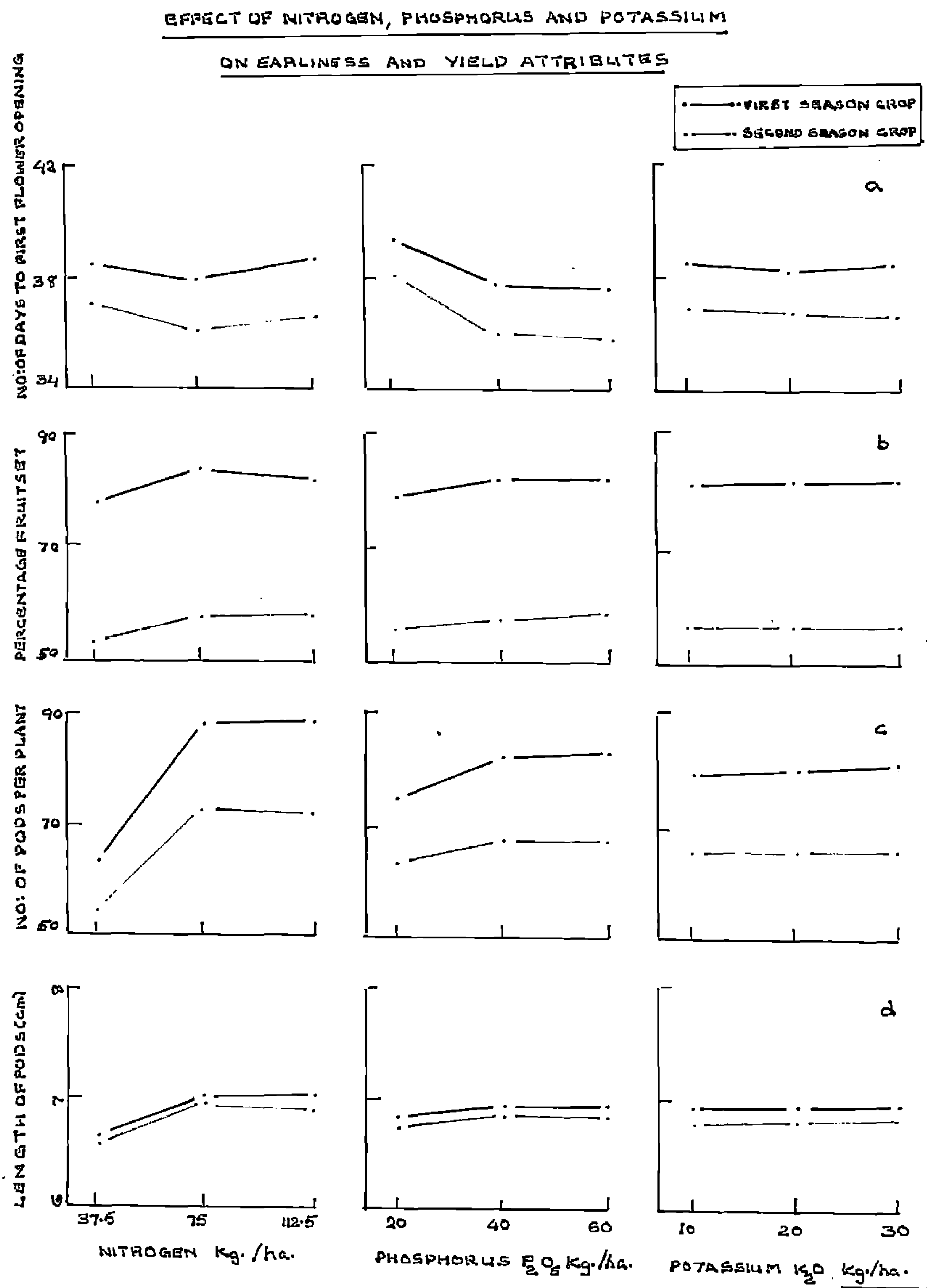
The summary of data on mean number of days taken for first flower opening are given in Tables 16 and 17 and their graphical representation in Fig.6 (a) and the analyses of variances in Appendices IV and VI.

Table 16 Effect of levels of nitrogen, phosphorus and potassium on earliness and yield attributes during the first crop season

Treatments		Days taken for first flower opening	Percentage of fruit set	Number of pods per plant	Length of fruits (cm)
Levels of N kg/ha					
	37.50	38.50	77.68	63.25	6.65
	75.00	37.91	84.01	88.15	7.03
	112.50	38.68	83.60	88.63	7.00
	'F'test	Sig.	Sig.	Sig.	Sig.
	SEm ±	0.17	0.43	0.31	0.01
	CD(0.05)	0.51	1.24	0.90	0.04
Levels of P_2O_5 kg/ha					
	20	39.62	79.42	74.75	6.84
	40	37.79	82.81	82.10	6.91
	60	37.68	83.11	83.18	6.92
	'F'test	Sig.	Sig.	Sig.	Sig.
	SEm ±	0.17	0.43	0.31	0.01
	CD(0.05)	0.51	1.24	0.90	0.04
Levels of K_2O kg/ha					
	10	38.43	81.50	79.62	6.89
	20	38.19	81.62	79.97	6.89
	30	38.47	82.22	80.46	6.90
	'F'test	NS	NS	NS	NS
	SEm +	0.17	0.43	0.31	0.01
	CD(0.05)	--	--	--	--

Table 17. Effect of levels of nitrogen, phosphorus and potassium on earliness and yield attributes during the second crop season

Treatments	Days taken for first flower opening	Percentage of fruit set	Number of pods per plant	Length of fruits (cm)
Levels of N kg/ha				
37.50	37.14	52.06	51.90	6.56
75.00	36.10	56.70	73.38	6.92
112.50	36.74	57.03	71.98	6.88
'F' test	Sig.	Sig.	Sig.	Sig.
SEm ±	0.16	0.29	0.21	0.03
CD (0.05)	0.48	0.84	0.60	0.10
Levels of P_2O_5 kg/ha				
20	38.32	53.99	63.23	6.70
40	35.94	55.63	66.94	6.84
60	35.72	56.17	67.07	6.81
'F' test	Sig.	Sig.	Sig.	Sig.
SEm ±	0.16	0.29	0.21	0.03
CD (0.05)	0.48	0.84	0.60	0.10
Levels of K_2O kg/ha				
10	37.03	55.22	65.60	6.77
20	36.60	55.21	65.64	6.78
30	36.36	55.36	66.01	6.81
'F' test	Sig.	NS	NS	NS
SEm ±	0.16	0.29	0.21	0.03
CD (0.05)	0.48	--	--	--


EFFECT OF NITROGEN, PHOSPHORUS AND POTASSIUM
ON EARLINESS AND YIELD ATTRIBUTES
FIRST SEASON CROP
SECOND SEASON CROP
NO: OF DAYS TO FIRST FLOWER OPENING
42
38
34
a
PERCENTAGE FRUITSET
90
70
50
b
NO: OF PODS PER PLANT
90
70
50
c
LENGTH OF PODS (cm)
8
7
6
d
37.5
75
112.5
20
40
60
10
20
30
NITROGEN Kg./ha.
PHOSPHORUS P2O5 Kg./ha.
POTASSIUM K2O Kg./ha.
FIG. 6

The effect of nitrogen was significant in inducing earliness in both the seasons. Nitrogen at 75 kg/ha significantly reduced the mean number of days required for first flower opening in both the seasons. Maximum earliness of 37.91 days and 36.10 days were noted in plots receiving 75 kg N/ha in the first and second seasons respectively. The effect of nitrogen at 37.5 kg and 112.5 kg/ha were on par in both the seasons.

In the case of phosphorus there was significantly earlier flowering at 60 kg P_2O_5/ha in both the seasons, but the effect of phosphorus at 40 kg and 60 kg P_2O_5/ha were on par. With increase in the level of applied phosphorus, earliness in flowering was noted in both the seasons. The maximum earliness of 37.68 days in the first season and 35.72 days in the second season were noted at 60 kg P_2O_5/ha.

The effect of potash on earliness was not significant in the first season, whereas in the second season potash at 30 kg/ha significantly reduced the mean number of days required for first flower opening. The effect of potash at 10 and 20 kg/ha were on par, but the difference between 20 and 30 K_2O/ha was not significant.

Table 18. Combined effect of nitrogen and phosphorus on earliness during the second crop season

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
20	38.20	38.30	38.47	38.32
40	36.70	34.90	36.23	35.94
60	36.53	35.10	35.53	35.72
Mean	37.14	36.10	36.74	--
SEm ±	0.29			
CD (0.05)	0.83			

Table 19. Seasonal effect on earliness and percentage fruit set.

Treatments	Days taken for first flower opening			Percentage fruit set		
	Season I	Season II	Difference	Season I	Season II	Difference
$n_1\ p_1\ k_1$	40.30	39	1.3	75.66	50.71	24.95
$n_1\ p_1\ k_2$	39.10	37.60	1.5	76	50.54	25.46
$n_1\ p_1\ k_3$	39.50	38	1.5	75.83	50.60	25.23
$n_1\ p_2\ k_1$	37.40	36.85	0.55	77.33	51.77	25.56
$n_1\ p_2\ k_2$	38.20	36.70	1.5	77.66	52.36	25.3
$n_1\ p_2\ k_3$	38.30	36.55	1.75	79.33	52.61	26.72
$n_1\ p_3\ k_1$	37.60	36.50	1.1	78.66	53.41	25.25
$n_1\ p_3\ k_2$	37.70	36.40	1.3	80	53.39	26.61
$n_1\ p_3\ k_3$	38.40	36.70	1.7	78.66	53.21	25.45
$n_2\ p_1\ k_1$	39.90	39.10	0.8	81.33	55.14	26.19
$n_2\ p_1\ k_2$	39.70	38.10	1.6	82.83	54.88	27.95
$n_2\ p_1\ k_3$	39.00	37.70	1.3	80.83	56.08	24.75
$n_2\ p_2\ k_1$	37.10	35	2.1	83.16	57.23	25.93
$n_2\ p_2\ k_2$	36.95	35.20	1.75	85.3	57.04	28.26
$n_2\ p_2\ k_3$	37.30	34.50	2.8	85.49	57.77	27.72
$n_2\ p_3\ k_1$	37.20	35.30	1.9	87.16	56.79	30.37
$n_2\ p_3\ k_2$	36.90	34.90	2	84.16	57.80	26.36
$n_2\ p_3\ k_3$	37.15	35.10	2.05	85.83	57.55	28.28
$n_3\ p_1\ k_1$	39.30	38.10	1.2	79.66	56.48	23.18
$n_3\ p_1\ k_2$	39.90	38.40	1.5	79.16	55.74	23.42
$n_3\ p_1\ k_3$	39.90	38.90	1	83.49	55.75	27.74
$n_3\ p_2\ k_1$	38.60	36.60	2	86.33	57.17	29.16
$n_3\ p_2\ k_2$	38.20	36.40	1.8	85.49	57.33	28.16
$n_3\ p_2\ k_3$	38.10	35.70	2.4	85.16	57.30	27.86
$n_3\ p_3\ k_1$	38.50	36.80	1.7	84.16	58.25	25.91
$n_3\ p_3\ k_2$	37.10	35.70	1.4	83.99	57.74	26.25
$n_3\ p_3\ k_3$	38.60	34.10	4.5	85.33	57.42	27.91
't' Value			12.05*			8.47*

* (P = 0.05)

The interaction between nitrogen and phosphorus was significant in the second season (Table 18). The maximum earliness of 34.90 days was noted in plots receiving 75 kg N/ha and 40 kg P_2O_5/ha and the highest number of days (38.47) taken for first flower opening was recorded with 112.5 kg N/ha and 20 kg P_2O_5/ha. The mean number of days taken for first flower opening in the first and second seasons were 38.36 and 36.66 respectively. The difference in mean number of days taken for first flower opening between the two seasons was found to be statistically significant (Table 19).

2.2. Percentage fruit set

The data on percentage fruit set are given in Tables 16 and 17 and graphical representation in Fig.6(b). Appendices IV and VI give the analyses of variances.

Nitrogen exerted significant effect on percentage fruit set in both the seasons. Nitrogen at 75 kg/ha recorded the maximum percentage fruit set of 84.01 in the first season, but the effect of nitrogen at 75 kg and 112.5 kg/ha were on par. Nitrogen at 75 kg and 112.5 kg/ha were significantly superior to 37.5 kg N/ha. In the second season, maximum fruit set of 57.03% was recorded at 75 kg N/ha. However, the effects of nitrogen at 75 kg and 112.5 kg/ha were on par and also were significant over 37.5 kg N/ha.

Setting percentage increased with increasing levels of phosphorus in both the seasons. The effects of P_2O_5 at 40 kg and 60 kg/ha were on par in both the seasons. The maximum setting percentages noted were 83.11 and 56.17 in the first season and second season respectively at 60 kg P_2O_5/ha.

Application of potash did not produce any significant response on the setting percentage. The interactional effects of nitrogen, phosphorus and potassium were not significant.

The mean setting percentages observed in the first season was 81.77 and that for the second season was 55.26. The difference in mean setting percentages between the two seasons was found to be statistically significant (Table 19).

2.3. <u>Number of pods per plant</u>

The data on the number of pods per plant are given in Tables 16 and 17 and their graphical representation in Fig.6(c). Appendices IV and VI give the analyses of variances.

Nitrogen exerted marked influence on the number of pods per plant, with 75 kg and 112.5 kg levels of nitrogen producing more number of pods per plant compared to 37.5 kg N/ha in the first season. The effects of nitrogen at 75 kg and 112.5 kg/ha were on par. The maximum number of 88.63 pods per plant in the first season was noted in plots receiving 112.5 kg N/ha. In the second season nitrogen at 75 kg/ha produced significantly higher number of pods per plant compared to that at 37.5 kg and 112.5 kg levels. The maximum number of 73.38 pods per plant was recorded with 75 kg N/ha in the second season.

The effect of phosphorus was significant in increasing the number of pods per plant in both the seasons. Phosphorus at 60 kg P_2O_5/ha was significantly superior to the other two levels in the first season and the maximum number of pods per plant recorded at 60 kg P_2O_5/ha was 83.18. In the second season also P_2O_5 at 60 kg/ha produced the maximum number of pods (67.07) per plant, but the effects of P_2O_5 at 40 and 60 kg levels were on par.

Application of potash did not produce any significant response.

Table 20. Combined effect of nitrogen and phosphorus on the number of pods per plant during the second crop season

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
20	49.20	69.63	70.87	63.23
40	52.93	75.43	72.47	66.94
60	53.57	75.07	72.60	67.07
Mean	51.90	73.38	71.98	--
SEm ±	0.36			
CD (0.05)	1.04			

Table 21. Seasonal effect on mean number of pods per plant and length of pods.

Treatments	Number of pods per plant			Length of pods (cm)		
	Season I	Season II	Difference	Season I	Season II	Difference
$n_1 p_1 k_1$	55.8	49.1	6.7	5.565	6.50	0.065
$n_1 p_1 k_2$	57	49.7	7.3	6.505	6.55	-0.045
$n_1 p_1 k_3$	57.5	48.8	8.7	6.635	6.465	0.17
$n_1 p_2 k_1$	64.5	53	11.5	6.685	6.64	0.045
$n_1 p_2 k_2$	65.5	51.7	13.8	6.66	6.585	0.075
$n_1 p_2 k_3$	66.3	54.1	12.2	6.56	6.67	-0.11
$n_1 p_3 k_1$	67.8	53.4	14.4	6.755	6.45	0.305
$n_1 p_3 k_2$	67.1	53.5	13.6	6.7	6.595	0.105
$n_1 p_3 k_3$	67.8	53.8	14	6.785	6.625	0.16
$n_2 p_1 k_1$	83	69.2	13.8	6.955	6.85	0.105
$n_2 p_1 k_2$	83.64	69.7	13.94	7.045	6.65	0.395
$n_2 p_1 k_3$	82.3	70	12.3	6.98	6.95	0.03
$n_2 p_2 k_1$	89.1	74.8	14.3	7.09	6.94	0.15
$n_2 p_2 k_2$	90.8	75.5	15.3	7.1	7.025	0.075
$n_2 p_2 k_3$	91.8	76	15.8	7.105	6.915	0.19
$n_2 p_3 k_1$	90.5	74.4	16.1	7	7	0
$n_2 p_3 k_2$	90.7	75.5	15.2	6.965	6.99	-0.025
$n_2 p_3 k_3$	91.6	75.3	16.3	7.035	6.925	0.11
$n_3 p_1 k_1$	84.9	70.1	14.8	7.02	6.75	0.27
$n_3 p_1 k_2$	83.5	70.6	12.9	6.945	6.8	0.145
$n_3 p_1 k_3$	85.2	71.9	13.3	6.98	6.79	0.19
$n_3 p_2 k_1$	89.7	73.4	16.3	6.99	6.925	0.065
$n_3 p_2 k_2$	90.7	71.5	19.2	7.05	6.925	0.125
$n_3 p_2 k_3$	90.55	72.5	18.05	7	6.975	0.025
$n_3 p_3 k_1$	91.3	73	18.3	6.95	6.875	0.105
$n_3 p_3 k_2$	90.8	73.1	17.7	7.05	6.89	0.16
$n_3 p_3 k_3$	91.1	71.7	19.4	7.03	6.975	0.055
't' Value			23.19*			4.34*

* ($P=0.05$)

The interaction between nitrogen and phosphorus was significant in the second season (Table 20). The highest number of 75.43 pods per plant was recorded with 75 kg N/ha and 40 kg P_2O_5/ha. The lowest number of 49.20 pods per plant was noted in plots receiving a combination of 37.5 kg N/ha and 20 kg P_2O_5/ha.

The mean number of pods per plant recorded in the first season and second season were 80.01 and 65.75 respectively. The difference in mean number of pods per plant between the two seasons was found to be statistically significant (Table 21).

2.4. <u>Length of pods</u>

Tables 16 and 17 give the data on mean length of pods and their graphical representation is given in Fig.6(d). Appendices IV and VI give the analyses of variances.

It is seen from Tables 16 and 17 that nitrogen at 75 kg/ha produced the maximum pod lengths of 7.03 cm and 6.92 cm in the first and second seasons respectively, though the effects of nitrogen at 75 and 112.5 kg/ha were on par. The differences between 37.5 kg N/ha and the other two levels of nitrogen were significant in both the seasons.

Table 22. Combined effect of nitrogen and phosphorus on the length of fruits during the first crop season (cm)

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
20	6.57	6.99	6.97	6.84
40	6.63	7.09	7.01	6.91
60	6.74	7.00	7.01	6.92
Mean	6.65	7.03	7.00	--
SEm ±	0.02			
CD (0.05)	0.07			

Application of phosphorus produced significant effect on the length of pods in both the seasons. Phosphorus at 60 kg P_2O_5/ha produced the maximum length of 6.92 cm in the first season, whereas in the second season, P_2O_5 at 40 kg/ha recorded the maximum length of 6.84 cm. However, the effects of P_2O_5 at 40 kg and 60 kg/ha were on par in both the seasons, but were significantly superior to 20 kg P_2O_5/ha.

The influence of potassium on this yield attribute was not significant at any of the levels in both the seasons.

The interaction between nitrogen and phosphorus was significant in the first season (Table 22). A combination of 75 kg N/ha and 40 kg P_2O_5/ha produced the maximum fruit length of 7.09 cm and the minimum pod length of 6.57 cm was recorded in plots receiving 37.5 kg nitrogen and 20 kg P_2O_5/ha.

The mean length of pods recorded in the first season was 6.89 cm and the same in the second season was 6.78 cm. The difference in mean length of pods between the two seasons was found to be statistically significant (Table 21).

2.5. Girth of pods

The mean girth of pods for various treatments are shown in Tables 23 and 24 and their graphical representation in Fig.7(a). Appendices V and VII give the analyses of variances.

The effect of nitrogen was significant in increasing the girth of pods in both the seasons. The maximum girths of 3.69 cm in the first season and 3.50 cm in the second season were noted in plots receiving 112.5 kg N/ha. The effects of 75 kg and 112.5 kg levels of nitrogen were on par in both the seasons and also were significantly superior to 37.5 kg N/ha.

Application of phosphorus produced significant increase in the girth of pods in both the seasons. Maximum girth of 3.60 cm was recorded in plots receiving both 40 kg and 60 kg P_2O_5/ha in the first season. The differences between 20 and 40 and that between 20 and 60 kg levels of P_2O_5 were significant in the first season. In the second season the differences among all the three levels of phosphorus were significant and the maximum girth of 3.49 cm was recorded in plots receiving 60 kg P_2O_5/ha.

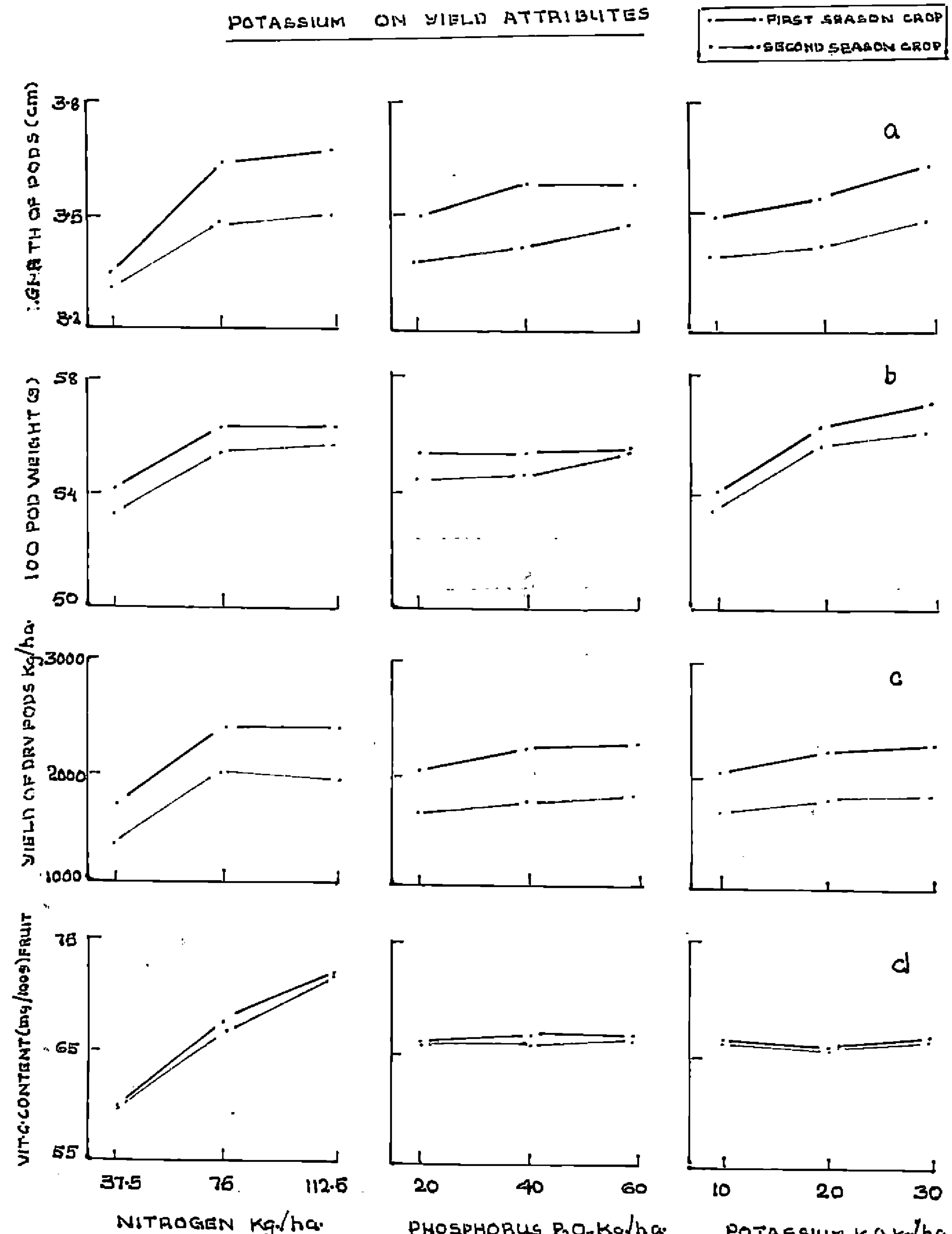
The influence of potassium on girth of pods was seen significant in both the seasons. Application of potash at 30 kg/ha recorded the maximum girths of 3.65 cm

Table 23. Effect of levels of nitrogen, phosphorus and potassium on yield attributes and quality of fruits during the first crop season

Treatments	Girth of pods (cm)	Weight of 100 dry pods (g)	Yield of dry pods kg/ha	Ascorbic acid content of fresh fruits mg/100 g fresh fruit
Levels of N kg/ha				
37.50	3.36	54.55	1700.702	60.12
75.00	3.67	56.38	2437.960	68.05
112.50	3.69	56.42	2471.019	72.96
'F' test	Sig.	Sig.	Sig.	Sig.
SEm ±	0.02	0.12	10.71	0.30
CD (0.05)	0.05	0.37	31.41	0.88
Levels of P_2O_5 kg/ha				
20	3.51	55.77	2065.912	66.49
40	3.60	55.74	2248.002	67.20
60	3.60	55.85	2295.766	67.42
'F' test	Sig.	NS	Sig.	NS
SEm ±	0.02	0.12	10.71	0.30
CD (0.05)	0.05	--	31.41	--
Levels of K_2O kg/ha				
10	3.51	54.03	2112.173	67.05
20	3.57	56.27	2237.451	66.85
30	3.65	57.06	2260.046	67.21
'F' test	Sig.	Sig.	Sig.	NS
SEm ±	0.02	0.12	10.71	0.30
CD (0.05)	0.05	0.37	31.41	--

Table 24. Effect of levels of nitrogen, phosphorus and potassium on yield attributes and quality of fruits during the second crop season

Treatments	Girth of pods (cm)	Weight of 100 dry pods (g)	Yield of dry pods kg/ha	Ascorbic acid content of fresh fruits mg/100 g fresh fruit
Levels of N kg/ha				
37.50	3.32	53.48	1364.380	60.21
75.00	3.47	55.66	2011.619	67.22
112.50	3.50	55.87	1978.340	72.23
'F' test	Sig.	Sig.	Sig.	Sig.
SEm ±	0.01	0.19	6.04	0.19
CD (0.05)	0.04	0.57	17.705	0.55
Levels of P_2O_5 kg/ha				
20	3.37	54.66	1708.026	65.88
40	3.43	54.84	1811.373	66.64
60	3.49	55.50	1834.939	67.14
'F' test	Sig.	Sig.	Sig.	Sig.
SEm ±	0.01	0.19	6.04	0.19
CD (0.05)	0.04	0.57	17.705	0.55
Levels of K_2O kg/ha				
10	3.39	53.40	1730.166	66.57
20	3.42	55.62	1803.938	66.59
30	3.49	55.98	1820.234	66.50
'F' test	Sig.	Sig.	Sig.	NS
SEm ±	0.01	0.19	6.04	0.19
CD (0.05)	0.04	0.57	17.705	--



EFFECT OF NITROGEN PHOSPHORUS AND POTASSIUM ON YIELD ATTRIBUTES

FIG·7

Table 25. Combined effect of nitrogen and potassium on the girth of pods (cm) during the second crop season

Levels of K_2O/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
10	3.26	3.42	3.51	3.39
20	3.31	3.51	3.43	3.42
30	3.40	3.49	3.53	3.49
Mean	3.32	3.47	3.50	--
SEm ±	0.03			
CD (0.05)	0.08			

Table 26. Seasonal effect on mean girth of pods and weight of 100 dry pods.

Treatments	Girth of pods (cm)			Weight of 100 dry pods (g)		
	Season I	Season II	Difference	Season I	Season II	Difference
n_1 p_1 k_1	3.16	3.16	0	52.07	51.55	0.52
n_1 p_1 k_2	3.32	3.25	0.07	54.74	54.345	0.395
n_1 p_1 k_3	3.40	3.375	0.025	55.805	53.554	2.251
n_1 p_2 k_1	3.39	3.3	0.09	53.175	52.055	1.1205
n_1 p_2 k_2	3.36	3.275	0.085	54.875	54.185	0.69
n_1 p_2 k_3	3.45	3.405	0.045	55.92	54.745	1.175
n_1 p_3 k_1	3.36	3.325	0.035	53.55	52.248	1.3025
n_1 p_3 k_2	3.44	3.40	0.04	54.987	53.58	1.407
n_1 p_3 k_3	3.42	3.425	-0.005	55.985	55.062	0.9225
n_2 p_1 k_1	3.50	3.475	0.025	54.64	53.172	1.4675
n_2 p_1 k_2	3.64	3.405	0.235	56.95	56.075	0.875
n_2 p_1 k_3	3.60	3.425	0.175	58.037	56.32	1.717
n_2 p_2 k_1	3.65	3.525	0.125	54.63	53.113	1.517
n_2 p_2 k_2	3.80	3.585	0.215	56.80	56.149	0.6505
n_2 p_2 k_3	3.79	3.475	0.315	57.425	56.696	0.7285
n_2 p_3 k_1	3.57	3.48	0.09	54.5	56.157	-1.657
n_2 p_3 k_2	3.66	3.525	0.135	57.70	56.245	1.455
n_2 p_3 k_3	3.85	3.525	0.325	57.7	56.995	0.705
n_3 p_1 k_1	3.68	3.475	0.205	54.675	53.732	0.9425
n_3 p_1 k_2	3.58	3.375	0.205	57.225	56.717	0.5075
n_3 p_1 k_3	3.745	3.55	0.195	57.83	56.53	1.3
n_3 p_2 k_1	3.60	3.475	0.125	54.36	3.415	0.9445
n_3 p_2 k_2	3.65	3.4	0.25	56.81	56.559	0.251
n_3 p_2 k_3	3.79	3.5	0.29	57.7	56.67	1.029
n_3 p_3 k_1	3.64	3.59	0.05	54.705	55.18	-0.475
n_3 p_3 k_2	3.70	3.525	0.175	57.282	56.778	0.5045
n_3 p_3 k_3	3.83	3.65	0.18	57.27	57.285	-0.015
't' Value			6.61*			5.70*

* (P=0.05)

in the first season and 3.49 cm in the second season and K_2O at 30 kg/ha was statistically superior to all the other levels of potash in both the seasons. The differences among all the three levels of potash were significant in the first season, whereas in the second season the effects of potash at 10 kg and 20 kg/ha were on par.

The interaction between nitrogen and potassium was found to be significant in the second season (Table 25). A combination of 112.5 kg N/ha and 30 kg K_2O/ha recorded the maximum girth of 3.53 cm and the minimum girth of 3.26 cm was noted in plots receiving 37.5 kg N/ha and 10 kg K_2O/ha.

The mean girths of pods recorded in the first season was 3.56 cm and in the second season mean girth noted was 3.43 cm. The difference in mean girth of pods between the two seasons was found to be statistically significant (Table 26).

2.6. <u>Weight of 100 dry pods</u>

The data on mean weight of 100 dry pods are given in Tables 23 and 24 and the graphical representation in Fig.7(b). The analyses of variances are given in Appendices V and VII.

The effect of nitrogen was significant in increasing the weight of 100 dry pods in both the seasons. Nitrogen at 112.5 kg/ha recorded the maximum dry weight of 56.42 g per 100 pods in the first season and 55.87 g/100 pods in the second season. The effects of nitrogen at 75 kg and 112.5 kg/ha were on par and nitrogen at 37.5 kg/ha was significantly inferior to the higher two levels of nitrogen in both the seasons.

Phosphorus did not show significant effect on weight of 100 dry pods in the first season. But in the second season phosphorus at 60 kg P_2O_5/ha was significantly superior to 20 kg and 40 kg levels of P_2O_5 and the effects of P_2O_5 at 20 kg and 40 kg/ha were on par.

Significant effect was recorded by graded doses of potash in both the seasons. In the first season, with increase in the level of application of potash dry weight of 100 pods also increased and the differences among all the levels of potash were significant. The highest dry weight of 57.06 g/100 pods was recorded in plots receiving 30 kg K_2O/ha in the first season. In the second season the effect of potash at 20 kg and 30 kg/ha were on par. The maximum dry weight of 55.98 g/100 pods was noted at 30 kg K_2O/ha in the second crop.

The interactional effects of nitrogen, phosphorus and potassium were not significant.

The mean dry weights of 100 pods recorded in the first season and second season were 55.78 g and 55.0 g respectively. The difference in mean dry weights of 100 pods between the two seasons was found to be statistically significant (Table 26).

2.7. Yield of dry pods (kg/ha)

The data on mean yields of dry pods are given in Tables 23 and 24 and graphical representation in Fig.7(c). Analyses of variances are given in Appendices V and VII.

The effect of nitrogen was significant in increasing the yield of chilli in both the seasons. The differences among all the levels of nitrogen were significant in the first season and the highest yield of 2471.02 kg/ha was recorded in plots receiving 112.5 kg N/ha. In the second season, application of nitrogen at 75 kg/ha registered the highest yield of 2011.63 kg/ha and it was statistically superior to all the other levels of nitrogen. The difference between 112.5 kg and 37.5 kg levels of nitrogen was significant in the second season.

There was significant increase in yield with graded doses of phosphorus upto 60 kg P_2O_5/ha in both the seasons. The maximum yields of 2295.77 kg/ha and 1834.94 kg/ha

Table 27. Combined effect of nitrogen and phosphorus on yield of dry pods (kg/ha) during the first crop season

Levels of P_2O_5 kg/ha	Levels of M kg/ha			Mean
	37.50	75.00	112.50	
20	1522.623	2311.260	2363.852	2065.912
40	1757.354	2469.798	2516.855	2248.002
60	1822.127	2532.822	2532.349	2295.766
Mean	1700.702	2437.960	2541.019	---
SEm ±	18.55			
CD (0.05)	54.41			

Table 28. Combined effect of nitrogen and phosphorus on the total yield of dry pods (kg/ha) during the second crop season

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
20	1288.962	1891.757	1943.359	1708.026
40	1393.982	2058.998	1981.139	1811.373
60	1410.196	2084.101	2010.521	1834.939
Mean	1364.380	2011.619	1978.340	--
SEm ±	10.45			
CD (0.05)	30.665			

Table 29. Combined effect of phosphorus and potassium on the yield of dry pods (kg/ha) during the second crop season

Levels of K_2O kg/ha	Levels of P_2O_5 kg/ha			Mean
	20	40	60	
10	1638.834	1747.560	1804.103	1730.66
20	1741.552	1820.728	1849.534	1803.938
30	1743.692	1865.831	1851.181	1820.234
Mean	1708.026	1811.373	1834.939	--
SEm ±	10.45			
CD(0.05)	30.665			

were obtained at 60 kg P_2O_5/ha in the first and second seasons respectively. In both the seasons, differences among all the three levels of phosphorus were significant.

Influence of potassium on yield of dry pods was significant in both the seasons. With increase in the levels of potash, yield also increased and highest yields of 2260.05 kg/ha and 1820.23 kg/ha in the first season and second season respectively were observed in plots receiving 30 kg K_2O/ha. The effects of potash at 20 and 30 kg/ha were on par in both the seasons. Potash at 10 kg/ha was significantly inferior to the higher two levels of potash in both the seasons.

The interactional effect between nitrogen and phosphorus was significant in both the seasons (Tables 27 and 28). The maximum yield of 2532.82 kg/ha was noted with 75 kg N/ha and 60 kg P_2O_5/ha in the first season and the minimum yield of 1522.62 kg/ha was noted in plots receiving a combination of 37.5 kg N/ha and 20 kg P_2O_5/ha. In the second season highest yield of 2084.10 kg/ha was recorded in plots receiving 75 kg N/ha and 60 kg P_2O_5/ha and the minimum yield of 1288.96 kg/ha was noted with 37.5 kg N/ha and 20 kg P_2O_5/ha.

The interaction between phosphorus and potassium was found to be significant in the second season (Table 29).

Table 30. Seasonal effect of mean yield of dry podes per hectare and fruit ascorbic acid content.

Treatments	Yield of dry pods (kg/ha)			Fruit ascorbic acid content (mg/100g fresh fruit)		
	Season I	Season II	Difference	Season I	Season II	Difference
$n_1\ p_1\ k_1$	1430.61	1249.62	180.99	58.785	59.895	-1.11
$n_1\ p_1\ k_2$	1549.62	1330.61	219.01	59.43	59.37	0.06
$n_1\ p_1\ k_3$	1587.64	1286.66	300.98	59.265	58.735	0.53
$n_1\ p_2\ k_1$	1675.05	1351.60	323.45	60.15	60.025	00.125
$n_1\ p_2\ k_2$	1772.09	1376.78	395.31	60.68	61.025	-0.345
$n_1\ p_2\ k_3$	1824.93	1453.57	371.36	61.1	60.795	0.305
$n_1\ p_3\ k_1$	1788.14	1366.90	421.24	61.35	61.05	0.30
$n_1\ p_3\ k_2$	1813.82	1412.83	400.99	59.25	60.66	-1.41
$n_1\ p_3\ k_3$	1864.43	1450.85	413.58	61.11	60.3	0.81
$n_2\ p_1\ k_1$	2216.04	1814.31	401.73	67.205	66.43	0.775
$n_2\ p_1\ k_2$	2366.90	1920.26	446.64	66.91	66.2	0.71
$n_2\ p_1\ k_3$	2350.85	1940.48	410.37	67.4	66.605	0.795
$n_2\ p_2\ k_1$	2378.75	1961.22	417.53	68	66.92	1.08
$n_2\ p_2\ k_2$	2559.49	2094.31	465.18	68.055	66.795	1.26
$n_2\ p_2\ k_3$	2606.16	2121.47	484.69	67.96	67.75	0.21
$n_2\ p_3\ k_1$	2416.49	2054.06	362.43	68.685	67.9	0.785
$n_2\ p_3\ k_2$	2564.18	2102.46	461.72	68.75	68.655	0.095
$n_2\ p_3\ k_3$	2617.76	2095.79	521.97	69.31	67.735	1.575
$n_3\ p_1\ k_1$	2266.90	1853.07	413.83	73.155	71.92	1.235
$n_3\ p_1\ k_2$	2368.13	1973.57	392.56	73.28	72.145	1.135
$n_3\ p_1\ k_3$	2456.53	2003.94	452.59	72.995	71.6	1.395
$n_3\ p_2\ k_1$	2394.80	1929.86	464.94	73.35	72.205	1.145
$n_3\ p_2\ k_2$	2561.71	1991.10	570.61	72.53	71.79	0.74
$n_3\ p_2\ k_3$	2594.06	2022.46	571.6	72.98	72.565	0.415
$n_3\ p_3\ k_1$	2437.76	1991.35	446.41	72.79	72.79	0
$n_3\ p_3\ k_2$	2581.22	2033.32	547.9	72.79	72.65	0.0196
$n_3\ p_3\ k_3$	2573.07	2006.90	566.17	72.81	72.48	0.1089
't' Value			23.13*			3.60*

* (P=0.05)

The maximum yield of 1865.83 kg/ha was recorded with 40 kg P_2O_5/ha and 30 kg K_2O/ha and the minimum yield of 1638.83 kg/ha was noted in plots receiving a combination of 20 kg P_2O_5/ha and 10 kg K_2O/ha.

The mean yields of dry pods recorded in the first and second seasons were 2203.23 kg/ha and 1784.48 kg/ha respectively. The difference in mean yields between the two seasons was found to be statistically significant (Table 30).

2.8. Fruit ascorbic acid content

Analyses of variances for the fruit ascorbic acid content are given in Appendices V and VII and the graphical representation in Fig.7(d).

It is seen from Tables 23 and 24 that the ascorbic acid content of fruits increased with increasing levels of nitrogen. The differences among the various levels of nitrogen were significant in both the seasons. The maximum contents of ascorbic acid recorded at 112.50 kg N/ha were 72.96 mg/100 g fresh fruit in the first season and 72.23 mg/100 g fresh fruit in the second season.

The influence of phosphorus on fruit ascorbic acid content was significant only in the second season. The effects of phosphorus at 40 kg P_2O_5/ha and 60 kg P_2O_5/ha were on par, though the maximum content of fruit ascorbic acid was noted at 60 kg P_2O_5/ha. The differences between 20 kg and 40 kg levels of P_2O_5 and also that between 20 kg and 60 kg P_2O_5/ha were significant.

The influence of potash on this quality aspect was not significant.

The interactions between nitrogen, phosphorus and potassium were not significant.

The mean fruit ascorbic acid contents recorded in the first and second seasons were 67.04 mg/100 g fresh fruit and 66.55 mg/100 g fresh fruit respectively. The difference in mean ascorbic acid contents of fruits between the two seasons was found to be statistically significantly (Table 30)

3. TOTAL UPTAKE OF NUTRIENTS BY PLANTS

3.1. Uptake of nitrogen

The data on the total uptake of nitrogen by plants are presented in Tables 31 and 32 and Fig.8. The analyses of variences of the same are given in Appendices VIII and IX.

With increase in the level of applied nitrogen, uptake of nitrogen by plants increased in both the seasons. The highest total uptakes of 52.84 kg/ha and 43.39 kg/ha were recorded at 112.5 kg N/ha in the first and second seasons respectively. But the effects of nitrogen at 75 kg and 112.5 kg levels were on par in both the seasons and the above two levels

Table 31. Effect of levels of nitrogen, phosphorus and potassium on the total uptakes of nitrogen, phosphorus and potassium (in kg/ha) by the plant at final harvest during the first crop season

Treatments	Uptake of nitrogen	uptake of phosphorus	Uptake of potassium
Levels of N kg/ha			
37.50	35.74	6.01	54.33
75.00	52.41	8.95	79.15
112.50	52.84	8.86	79.66
'F'test	Sig.	Sig.	Sig.
SEm ±	0.19	0.03	0.33
CD(0.05)	0.55	0.08	0.96
Levels of P_2O_5 kg/ha			
20	44.08	7.25	67.02
40	48.11	8.20	73.15
60	48.81	8.39	72.97
'F'test	Sig.	Sig.	Sig.
SEm ±	0.19	0.03	0.33
CD(0.05)	0.55	0.08	0.96
Levels of K_2O kg/ha			
10	45.35	7.76	67.15
20	47.77	8.12	71.92
30	47.87	7.94	74.07
'F'test	Sig.	Sig.	Sig.
SEm ±	0.19	0.03	0.33
CD(0.05)	0.55	0.08	0.96

Table 32. Effect of levels of nitrogen, phosphorus and potassium on the total uptakes of nitrogen, phosphorus and potassium in (kg/ha) by the plant at final harvest during the second crop season

Treatments	Uptake of nitrogen	Uptake of phosphorus	Uptake of potassium
Levels of N kg/ha			
37.50	28.72	4.83	44.95
75.00	43.32	7.32	66.37
112.50	43.39	7.09	66.37
'F' test	Sig.	Sig.	Sig.
SEm ±	0.18	0.02	0.19
CD (0.05)	0.53	0.07	0.55
Levels of P_2O_5 kg/ha			
20	36.64	5.96	57.07
40	39.05	6.61	59.71
60	39.73	6.67	60.91
'F' test	Sig.	Sig.	Sig.
SEm ±	0.18	0.02	0.19
CD (0.05)	0.53	0.07	0.55
Levels of K_2O kg/ha			
10	37.62	6.32	57.58
20	38.66	6.47	59.75
30	39.15	6.46	60.35
'F' test	Sig.	Sig.	Sig.
SEm ±	0.18	0.02	0.19
CD (0.05)	0.53	0.07	0.55

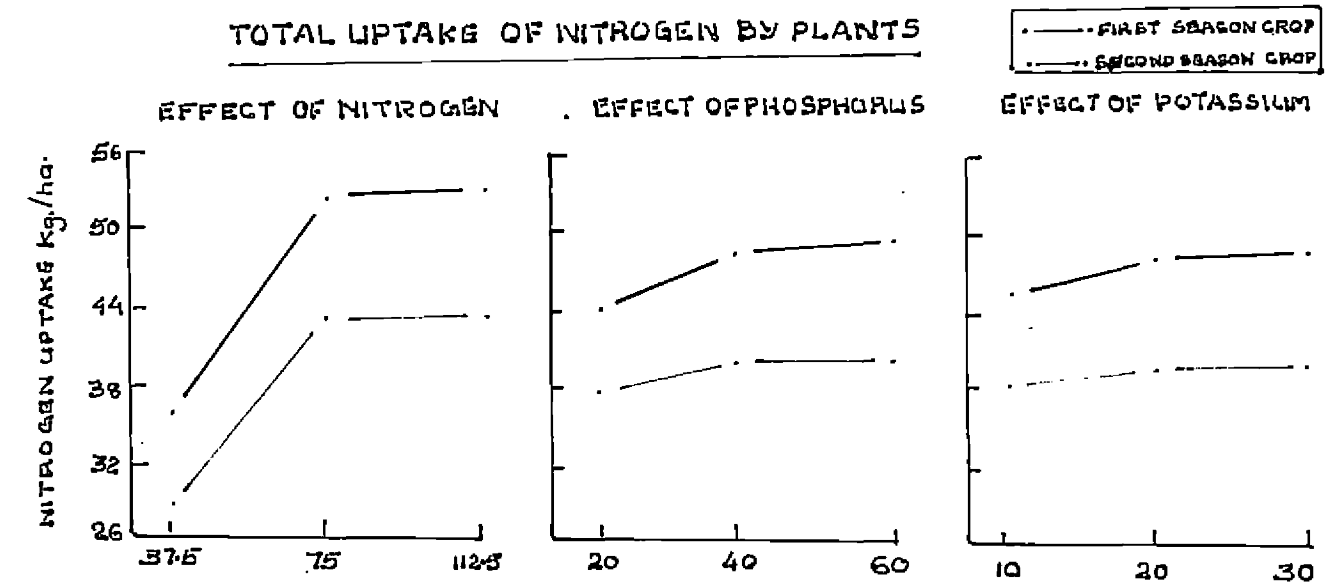


FIG. 8

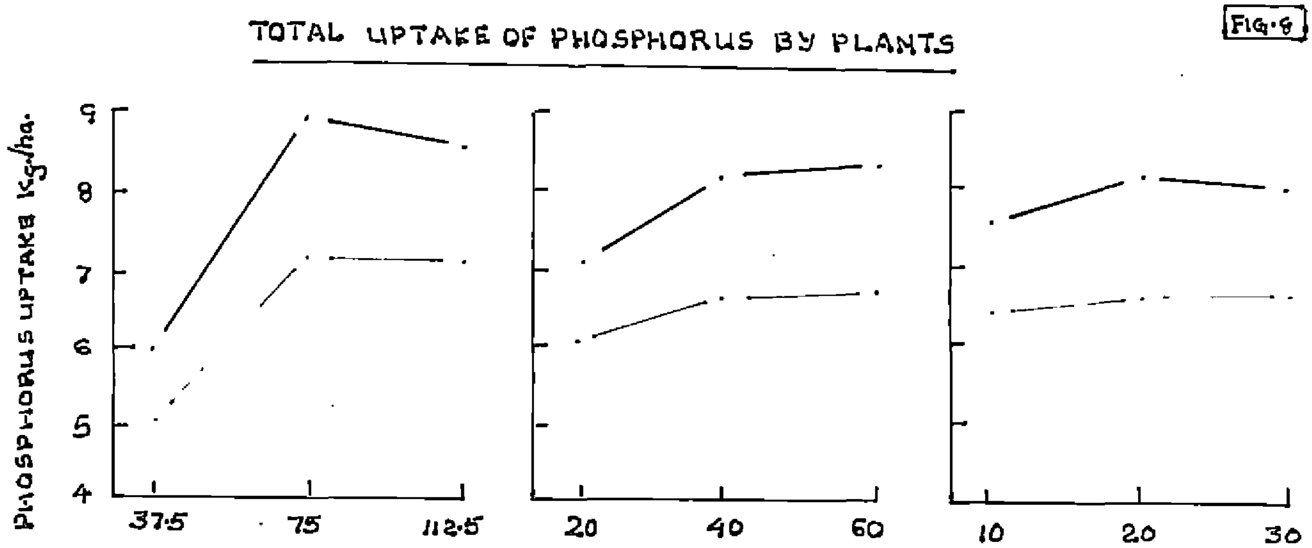


FIG. 9

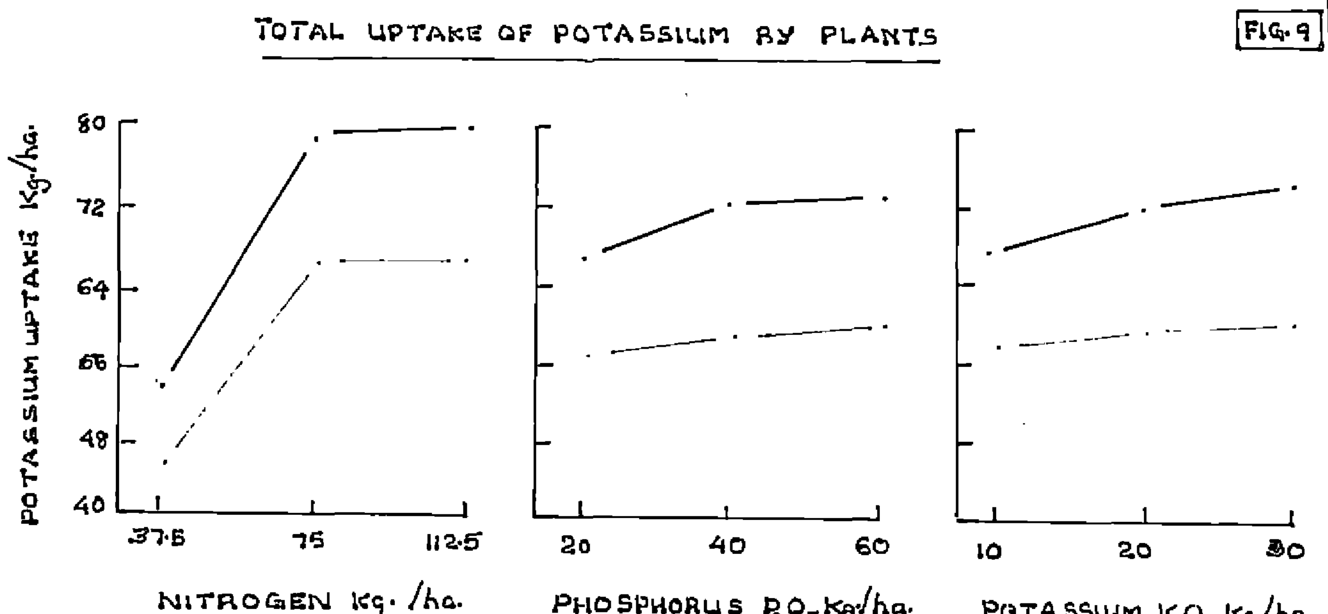


FIG. 10

Table 33. Combined effect of nitrogen and phosphorus on the total uptake of nitrogen (kg/ha) during the second crop season

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.5	75.0	112.50	
20	26.90	40.51	42.53	36.64
40	29.53	44.44	43.17	39.05
60	29.73	45.02	44.46	39.73
Mean	28.72	43.32	43.39	--
SEm ±	0.31			
CD (0.05)	0.92			

of nitrogen were significantly superior to nitrogen at 37.5 kg/ha in both the seasons.

The influence of phosphorus on the uptake of nitrogen by plants was significant in both the seasons. With increase in the level of applied phosphorus, uptake of nitrogen also increased and the highest total uptakes of 48.81 kg/ha and 39.73 kg/ha were recorded at 60 kg P_2O_5/ha in the first and second seasons respectively. The differences among all the three levels of phosphorus were significant in both the seasons.

The influence of potassium on the total uptake of nitrogen by plants also was significant in both the seasons. Uptake of nitrogen by plants increased with increasing levels of potash and the highest total uptakes of 47.87 kg/ha and 39.15 kg/ha were recorded at 30 kg K_2O/ha in the first and second seasons respectively. However, the effects of potash at 20 kg and 30 kg levels were on par in both the seasons.

The interaction between nitrogen and phosphorus was significant on the uptake of nitrogen in the second season (Table 33). The highest total uptake of 45.02 kg N/ha was recorded with 75 kg N/ha and 60 kg P_2O_5/ha and the minimum total uptake of 26.90 kg N/ha was noted in plots receiving a combination of 37.5 kg N/ha and 20 kg P_2O_5/ha.

The mean total uptakes of nitrogen in the first and second seasons were 46.98 kg N/ha and 38.48 kg N/ha

Table 34. Seasonal effect on the mean total uptake of nitrogen and phosphorus.

Treatments	Total uptake of nitrogen (kg/ha)			Total uptake of phosphorus (kg/ha)		
	Season I	Season II	Difference	Season I	Season II	Difference
$n_1\ p_1\ k_1$	30.510	25.754	4.756	4.77	4.541	0.229
$n_1\ p_1\ k_2$	32.810	27.775	5.035	5.04	4.486	0.554
$n_1\ p_1\ k_3$	33.830	27.160	6.67	5.40	4.442	0.958
$n_1\ p_2\ k_1$	34.690	28.575	6.115	5.97	4.952	1.018
$n_1\ p_2\ k_2$	37.160	29.305	7.855	6.59	4.965	1.625
$n_1\ p_2\ k_3$	37.550	30.770	6.78	6.33	5.019	1.311
$n_1\ p_3\ k_1$	37.660	29.075	8.585	6.58	4.892	1.688
$n_1\ p_3\ k_2$	37.970	29.915	8.055	6.66	5.101	1.559
$n_1\ p_3\ k_3$	38.560	29.950	8.61	6.51	5.101	1.409
$n_2\ p_1\ k_1$	47.720	39.375	8.345	7.95	6.438	1.512
$n_2\ p_1\ k_2$	50.980	40.975	10.005	8.49	6.719	1.771
$n_2\ p_1\ k_3$	49.740	41.165	8.575	8.199	6.712	1.478
$n_2\ p_2\ k_1$	51.290	42.480	8.81	9.23	7.414	1.816
$n_2\ p_2\ k_2$	54.690	44.865	9.825	9.47	7.555	1.915
$n_2\ p_2\ k_3$	54.900	45.960	8.94	9.31	7.736	1.574
$n_2\ p_3\ k_1$	53.850	44.500	9.35	9.10	6.849	1.251
$n_2\ p_3\ k_2$	55.100	45.370	9.73	9.58	7.828	1.752
$n_2\ p_3\ k_3$	55.180	45.200	9.98	9.18	7.752	1.428
$n_3\ p_1\ k_1$	48.940	42.22	6.72	8.37	6.588	1.782
$n_3\ p_1\ k_2$	50.650	42.00	8.65	8.29	6.895	1.395
$n_3\ p_1\ k_3$	51.540	43.365	8.175	8.52	6.839	1.681
$n_3\ p_2\ k_1$	51.710	42.180	9.53	8.83	6.977	1.853
$n_3\ p_2\ k_2$	54.980	43.430	11.55	9.17	7.540	1.63
$n_3\ p_2\ k_3$	55.100	43.420	11.68	8.92	7.353	1.567
$n_3\ p_3\ k_1$	52.640	43.965	8.675	9.16	7.216	1.944
$n_3\ p_3\ k_2$	55.630	44.315	11.315	9.58	7.097	2.483
$n_3\ p_3\ k_3$	54.420	45.105	9.315	9.14	7.317	1.823
't' Value			25.41*			17.687*

* $(P=0.05)$

respectively. The difference in mean total uptakes of nitrogen between the two seasons was found to be statistically significant(Table 34)

3.2. Total uptake of phosphorus

The data on mean total uptake of phosphorus by plants are presented in Tables 31 and 32 and Fig.9. The analyses of variances of the same are given in Appendices VIII and IX.

The significant superiority of 75 kg N/ha over 37.5 kg and 112.5 kg levels of nitrogen on the total uptake of phosphorus by plants was well pronounced in both the seasons. The highest total uptakes of 8.95 kg and 7.32 kg phosphorus per hectare were recorded at 75 kg N/ha in the first and second seasons respectively. The differences between 37.5 kg and 112.5 kg N/ha were significant in both the seasons.

Application of phosphorus also significantly increased the uptake of phosphorus by plants. Phosphorus at 60 kg P_2O_5/ha recorded the highest total uptakes of 8.39 kg/ha and 6.67 kg/ha phosphorus in the first and second seasons respectively and the difference between 40 kg and 60 kg P_2O_4/ha was significant only in the first season. The effects of phosphorus at 20 kg P_2O_5/ha were

Table 35. Combined effect of nitrogen and phosphorus on the total uptake of phosphorus by plants (kg/ha) during the first crop season

Levels of P_2O_5/ha	Levels of nitrogen kg/ha			Mean
	37.5	75.0	112.5	
20	5.15	8.21	8.39	7.25
40	6.29	9.34	8.97	8.20
60	8.58	9.29	9.29	8.39
Mean	6.01	8.95	8.86	--
SEm ±	0.05			
CD (0.05)	0.15			

Table 36. Combined effect of nitrogen and phosphorus on the total uptake of phosphorus (kg/ha) during the second crop season

Levels of P_2O_5 kg/ha	Levels of nitrogen kg/ha			Mean
	37.5	75.0	112.50	
20	4.49	6.63	6.77	5.96
40	4.98	7.56	7.29	6.61
60	5.03	7.78	7.21	6.67
Mean	4.83	7.32	7.21	--
SEm ±	0.04			
CD (0.05)	0.11			

significantly inferior to the same at the other two levels of phosphorus in both the seasons.

The effect of potash on the total uptake of phosphorus was significant in both the seasons. The effect of potash at 20 kg/ha was significantly superior to all the other two levels of potash on the uptake of phosphorus in the first season and the highest total uptake of 8.12 kg phosphorus per hectare was recorded at 20 kg K_2O/ha. The difference between 10 kg and 30 kg K_2O/ha were significant in the same season. In the second season highest total uptake of 6.47 kg phosphorus per hectare was noted in plots receiving 20 kg K_2O/ha and the effects of potash at 20 and 30 kg levels were on par. The effects of potash at 10 kg/ha were significantly inferior to the same at the other two higher levels of potash in both the seasons.

The interaction between nitrogen and phosphorus on the total uptake of phosphorus was significant in both the seasons. (Tables 35 and 36). The highest total uptake of 9.34 kg phosphorus per hectare was recorded with 75 kg N/ha and 40 kg P_2O_5/ha and the lowest total uptake of 5.15 kg phosphorus per hectare was recorded in plots receiving 37.5 kg N/ha and 20 kg P_2O_5/ha in the first season. In the second season the highest total uptake of 7.78 kg phosphorus per hectare was noted with

Table 37. Combined effect of phosphorus and potassium on the total uptake of phosphorus by plants (kg/ha) during the first crop season

Levels of K_2O kg/ha	Levels of P_2O_5 kg/ha			Mean
	20	40	60	
10	7.03	8.01	8.28	7.76
20	7.35	8.41	8.61	8.12
30	7.38	8.19	8.28	7.94
Mean	7.25	8.20	8.39	--
SEm ±	0.05			
CD (0.05)	0.15			

Table 38. Combined effect of phosphorus and potassium on the total uptake of phosphorus (kg/ha) during the second crop season

Levels of K_2O /ha	Levels of P_2O_5 kg/ha			Mean
	20	40	60	
10	5.85	6.44	6.65	6.32
20	6.04	6.68	6.68	6.47
30	5.99	6.70	6.69	6.46
Mean	5.96	6.61	6.67	--
SEm ±	0.04			
CD (0.05)	0.11			

75 kg N/ha and 60 kg P_2O_5/ha and the lowest total uptake of 4.49 kg phosphorus per hectare was recorded in plots receiving 37.5 kg N/ha and 20 kg P_2O_5/ha.

The interactional effect of phosphorus and potassium on the uptake of phosphorus was significant in both the seasons (Tables 37 and 38). The highest total uptake of 8.61 kg phosphorus per hectare was recorded with 60 kg P_2O_5/ha and 20 kg K_2O/ha and the lowest total uptake of 7.03 kg of the same was recorded in plots receiving a combination of 20 kg P_2O_5/ha and 10 kg K_2O/ha in the first season. In the second season the highest total uptake of 6.70 kg phosphorus per hectare was recorded with 40 kg P_2O_5/ha and 30 kg K_2O/ha and the lowest total uptake of 5.85 kg of the same was noted in plots receiving 20 kg P_2O_5/ha and 10 kg K_2O/ha.

The mean total uptakes of phosphorus in the first and second seasons were 7.94 kg/ha and 6.41 kg/ha respectively. The difference in mean total uptakes of phosphorus by plants between the two seasons was found to be statistically significant (Table 34).

3.3. Total uptake of potassium

The data on mean total uptake of potassium by plants are given in Tables 31 and 32 and Fig.10. The analyses of variances of the same are given in Appendices VIII and IX.

The influence of nitrogen on the total uptake of potassium by plants was significant in both the seasons. The highest total uptake of 79.66 kg potassium per hectare was noted at 112.5 kg N/ha in the first season and the effects of nitrogen at 75 and 112.5 kg levels were on par in the same season. In the second season the highest total uptakes of 66.37 kg potassium per hectare were noted both at 75 kg and 112.5 kg N/ha. In both the seasons the effect of nitrogen at 37.5 kg/ha were inferior to the same at the other two higher levels of nitrogen applied.

With regard to the effect of phosphorus on potassium uptake, the highest total uptake of 73.15 kg potassium per hectare was noted at 40 kg P_2O_5/ha in the first season. However, the effects of phosphorus at 40 kg and 60 kg P_2O_5 levels were on par in the same season and also were significantly superior to 20 kg P_2O_5/ha. In the second season the highest total uptake of 60.91 kg potassium per hectare was recorded at 60 kg P_2O_5/ha and the differences among all the three levels of phosphorus were significant.

Levels of potassium exerted significant effect on the uptake of potassium by plants. With increase in the level of applied potash, uptake of potash also increased. The highest total uptakes of 74.07 kg and 60.35 kg potassium per hectare were noted at 30 kg K_2O/ha in the first and

Table 39. Combined effect of nitrogen and phosphorus on the total uptake of potassium by plants (kg/ha) during the first crop season.

Levels of P_2O_5 kg/ha	Levels of N kg/ha			Mean
	37.5	75.0	112.5	
20	49.52	74.86	76.70	67.02
40	56.17	81.77	81.51	73.15
60	57.29	80.83	80.77	72.97
Mean	54.33	79.15	79.66	--
SEm ±	0.57			
CD (0.05)	1.67			

Table 40. Combined effect of nitrogen and phosphorus on the uptake of potassium by plants(kg/ha) during the second crop season

Levels of P_2O_5 kg/ha	Levels of N kg/ha			Mean
	37.5	75.0	112.5	
20	43.45	62.46	69.25	55.07
40	44.98	67.60	66.56	59.71
60	46.92	69.06	67.26	60.91
Mean	44.95	66.37	66.37	--
SEm ±	0.32			
CD (0.05)	0.95			

Table 41. Combined effect of nitrogen and potassium on the uptake of Potassium (kg/ha) during the second crop season

Levels of K_2O kg/ha	Levels of nitrogen kg/ha			Mean
	37.50	75.00	112.50	
10	43.24	64.25	65.26	57.58
20	45.12	67.65	66.49	59.75
30	46.48	67.21	67.35	60.35
Mean	44.95	66.37	66.37	--
SEm ±		0.32		
CD (0.05)		0.95		

Table 42. Combined effect of phosphorus and potassium on the uptake of potassium (kg/ha) during the second crop season

Levels of K_2O kg/ha	Levels of P_2O_5 kg/ha			Mean
	20	40	60	
10	54.40	57.76	60.60	57.58
20	58.69	59.95	60.52	59.75
30	58.10	61.43	61.52	60.35
Mean	57.07	59.71	60.91	--
SEm ±		0.32		
CD (0.05)		0.95		

second seasons respectively. The differences among all the three levels of potash were significant in both the seasons.

The interactional effects of nitrogen and phosphorus on the uptake of potassium were significant in both the seasons (Tables 39 and 40). In the first season the highest total uptake of 81.77 kg potassium per hectare was recorded with 75 kg N/ha and 40 kg P_2O_5/ha and the lowest total uptake of 49.52 kg of the same was recorded in plots receiving a combination of 37.5 kg N/ha and 20 kg P_2O_5/ha.

In the second season the highest total uptake of 69.25 kg potassium per hectare was recorded with 112.5 kg N/ha and 20 kg P_2O_5/ha and the lowest total uptake of 43.45 kg of the same was noted in plots receiving 37.5 kg N/ha and 20 kg P_2O_5/ha.

The interactional effect of nitrogen and potassium was significant in the second season (Table 41). The highest total uptake of 67.65 kg potassium per hectare was recorded with 75 kg N/ha and 20 kg K_2O/ha and the lowest total uptake of 43.24 kg of the same was noted in plots receiving 37.5 kg N/ha and 10 kg K_2O/ha.

The interaction between phosphorus and potassium also was significant in the second season (Table 42). The highest total uptake of 61.52 kg potassium per hectare was noted in plots receiving 60 kg P_2O_5/ha and 30 kg K_2O/ha and the lowest total uptake of 54.40 kg of the same was recorded

Table 43. Seasonal effect on the mean total uptake of potassium.

Treatments	Total uptake of Potassium (kg/ha)		
	Season I	Season II	Difference
n_1 p_1 k_1	46.49	41.870	4.62
n_1 p_1 k_2	49.85	44.570	5.28
n_1 p_1 k_3	52.25	43.93	8.32
n_1 p_2 k_1	52.92	42.70	10.22
n_1 p_2 k_2	56.69	45.21	11.48
n_1 p_2 k_3	58.91	47.07	11.84
n_1 p_3 k_1	54.49	45.16	9.33
n_1 p_3 k_2	57.56	45.61	11.95
n_1 p_3 k_3	59.84	48.47	11.37
n_2 p_1 k_1	70.65	58.53	12.12
n_2 p_1 k_2	76.40	65.42	10.98
n_2 p_2 k_3	77.49	63.43	14.06
n_2 p_2 k_1	76.81	64.93	11.88
n_2 p_2 k_2	83.48	68.40	15.08
n_2 p_2 k_3	85.01	69.45	15.56
n_2 p_3 k_1	77.03	69.29	7.74
n_2 p_3 k_2	80.15	69.12	11.03
n_2 p_3 k_3	85.31	68.76	15.55
n_3 p_1 k_1	73.05	62.80	10.25
n_3 p_1 k_2	77.20	66.10	11.1
n_3 p_1 k_3	79.85	66.96	12.89
n_3 p_2 k_1	76.59	65.64	10.95
n_3 p_2 k_2	82.87	66.25	16.62
n_3 p_2 k_3	85.06	67.78	17.28
n_3 p_3 k_1	76.31	67.35	8.96
n_3 p_3 k_2	83.03	67.12	15.91
n_3 p_3 k_3	82.98	67.32	15.66
't' Value			18.596*

* (P=0.05)

with 20 kg P_2O_5/ha and 10 kg K_2O/ha.

The mean total uptakes of potassium by plants in the first and second seasons were 71.05 kg/ha and 59.23 kg/ha respectively. The difference in mean total uptakes of potassium by plants between the two seasons was found to be statistically significant (Table 43).

D. Response Surface

The quadratic response equation developed from the yield data of the first season crop is as follows:

$$Y = 1428.979 + 1152.797\ N + 312.704\ P - 33.169\ NP + 169.977\ K - 367.373\ N^2 - 82.443\ P^2 - 44.130\ K^2$$

For the second season crop the quadratic response equation used is given below:

$$Y = 1202.165 + 1000.083\ N + 176.498\ P - 13.558\ NP + 122.129\ K - 16.157\ PK - 339.309\ N^2 - 41.670\ P^2 - 30.482\ K^2$$

D.1. Optimum dose of nutrients

The optimum doses of nitrogen, phosphorus and potash for the first season crop are 94, 52 and 30 kg/ha respectively and that for the second season crop being 92, 52 and 26 kilograms per hectare. The predicted yields at the optimum doses of nitrogen, phosphorus and potassium are in the order of 2704.648 and 2159.647 kilograms per hectare for the first and second seasons respectively.

D.3. Economic doses of nutrients

The economic doses of nitrogen, phosphorus and potash were estimated at the prevailing market rates of Rs.7.00 per kilogram of chilli pods, Rs.4.44 per kilogram of nitrogen, Rs.5.44 per kilogram of phosphate and Rs.1.87 per kilogram of potash. The economic doses of nitrogen, phosphate and potash can be fixed at 94, 52 and 30 kilograms per hectare for the first season crop. The predicted total yield at the above economic doses of the nutrients is 2704.648 kilograms of dry pods per hectare, fetching a profit of Rs.7948.02.

For the second season crop, the economic doses of nitrogen, phosphorus and potash are fixed at 92, 52 and 26 kg per hectare. The predicted yield at the above economic combinations of the three nutrients is 2159.647 kilograms per hectare and thereby getting a profit of Rs.4127.82.

D.4. Analysis of weather data

An analysis of the weather data for the two seasons are presented in Appendix-I.

During the first crop season a total rainfall of 2437.4 mm was received in 79 rainy days, whereas during the second crop season the total rainfall received was only 2.2 mm and there was only a single rainy day. The rainfall was well distributed during the first crop season.

The weekly mean maximum temperature ranged between 27.5° C to 30.4° C during the first crop season, while the weekly mean minimum temperature ranged between 21.5° C to 23.4° C. During the second crop season the weekly mean maximum temperature ranged between 30.9° C to 37.1° C, whereas the weekly mean minimum temperature ranged between 19.3° C to 23.4° C.

During the first crop season the weekly mean sunshine hours ranged between 0.4 to 6.3 hours per day and the range of the same recorded during the second season crop was between 6.7 to 10.2 hours per day. The mean hours of sunshine per day were high during the second crop season compared to that recorded during the first crop season.

The range of weekly mean relative humidity during the first season crop was between 79 to 92%, while the range for the same noted during the second crop season was between 52 to 69%.

The weekly mean evaporation ranged between 0.2 to 3.4 mm during the first crop season, whereas during the second crop season the range of the same was between 3.9 to 8.1 mm. The mean evaporation rate per day was high during the second crop season compared to that recorded during the first crop season.

As is evident from Appendix-I, the range of weekly mean wind speed recorded during the first crop season ranged between 0.6 to 5.1 km/hr, while the range recorded for the same during the second crop season was between 1.4 to 16.4 km/hr

Discussion

DISCUSSION

An investigation was carried out at the Instructional Farm, Vellanikkara, to study the effects of nitrogen, phosphorus and potassium on the growth and yield of chilli variety Pant-C.1 in two seasons.

The data relating to various observations taken were statistically analysed. The results obtained from the present study are discussed below.

1. Height of plants

The data presented in Tables 2 and 3 clearly showed that nitrogen increased the height of plants at all the stages of observations in both the seasons. The increase in height is attributable to the rapid meristamatic activity in plants due to nitrogen as reported by crowther (1935). The significant increases noted in the height of plants by the application of nitrogen in both the seasons is in confirmity with the findings of Mohammed Kunju (1970) and Lal et al (1971).

The results also indicated significant effect of phosphorus on the height of plants in both the seasons. At 35th and 70th day after planting in both the seasons and at the time of final harvest in the first crop, phosphorus at higher levels were significantly superior over that of lower level. At the time of final harvest in the second crop, the levels of phosphorus had no significant influence on height of plants.

Since phosphorus is a constituent of cell nucleus it is closely associated with cell division and meristamatic activity as noted by Bear (1935). Its application at the higher rates resulted in increased availability resulting in high meristamatic activity, hence there is increase in the height of plants at the early stages of plant growth.

Potash has not significantly influenced the height at any of the stages of observations except at the time of final harvest in the first season. This may due to the lesser absorption of potash by plants in the early stages of growth. The limited absorption of potash in the early stages is in agreement with the findings of Mohammed Kunju (1970).

The interaction between nitrogen and phosphorus was significant on the height of plants at 70^{th} day after planting in the second season. This may be due to the influence of nitrogen on phosphorus at 70^{th} day after planting. So also the interactional effects of phosphorus and potash also were significant at 70^{th} day after planting in both the seasons. This may be due to the combined effect of P_2O_5 and potash at 70th day after planting.

The differences in mean heights of plants in the two seasons were significant at all the stages of observations. At 35th day after planting the mean height of plants was significantly higher in the first season. However at 70th day after planting and at the time of final harvest the mean heights of plants were significantly higher in the second season. This may be due to the fact that climatic conditions were more favourable for the initial vigorous growth during the first season with well distributed rain fall and favourable temperature ranges, whereas conditions were not so favourable in the second season and hence the growth was only gradual.

2. <u>Number of branches per plant</u>

As seen in Tables 9 and 10 nitrogen applied at a level of 112.5 kg/ha produced significantly more number of branches per plant in both the seasons. As stated earlier nitrogen being a key element of plant growth, its effect on vegetative growth is reflected on the number of branches per plant. Similar results of increased branching at higher levels of nitrogen application have been reported by Lal *et al* (1971) and Gill *et al* (1974) in chillies.

Phosphorus application increased the number of branches per plant significantly at higher levels of P_2O_5 over the lower level, but the differences between 40 kg and 60 kg P_2O_5/ha were not significant in both the seasons. Since phosphorus is a constituent of cell nucleus it is closely associated with cell division and meristamatic activity as shown by Bear (1935). Its application at higher levels might have contributed to higher rates of availability leading to an increase in the number of branches per plant. Similar results have also been reported by Gill et al (1974).

The effect of potassium in increasing the number of branches per plant was not statistically significant in both the seasons. The lack of response to applied potash may be due to the fact that the soil in which the experiment was conducted was not limiting in native potash.

The interactional effect of nitrogen and phosphorus was significant on the number of branches per plant in the first season. The combination of 112.5 kg N/ha with 60 kg P_2O_5/ha produced the maximum number of 108.97 branches per plant. This may be due to the favourable influence of nitrogen on phosphorus.

The mean number of branches produced per plant was significantly higher in the first season. This may be due to the fact that rainy season was more favourable for vigorous vegetative growth.

3. Total dry matter production per plant

The data presented in Tables 9 and 10 revealed significant effect of nitrogen, phosphorus and potassium on the dry matter production per plant. Effect of nitrogen at levels of 75 kg and 112.5 kg/ha were on par, but were significantly superior to 37.5 kg/ha nitrogen application. The application of increased doses of nitrogen has not only increased the plant height but also increased the number of branches and number of fruits per plant. Thus the increased dry matter production at higher levels of nitrogen may be attributed to the more vegetative growth produced by higher levels of nitrogen. This finding is in confirmity with the results of Mohammed Kunju (1970) who observed significant increase in the total dry matter production due to increased nitrogen application.

Phosphorus also significantly influenced by dry matter production per plant in both the seasons, though the response was not so marked as that of nitrogen. Phosphorus at 60 kg P_2O_5/ha recorded the maximum dry matter production in both the seasons and the differences among all the three levels of phosphorus were significant. The increase in the total dry matter production per plant by the application of higher doses of phosphorus is due to the increase in height of the plants, number of branches per plant and more number of pods per plant produced at higher levels of phosphorus. Similar results have also been recorded by James et al (1967) and Mohammed Kunju (1970).

Potash has also shown significant effect on the dry matter production per plant in both the seasons. Effect of potash at higher levels was significantly superior to that at lower level. This may be due to the fact that higher levels of potash enhanced higher uptake of nitrogen and phosphorus and resulted in more vigorous growth and yield of pods per plant. Experiments conducted by Fernandes (1973) also revealed that increasing potash rates increased potash and also nitrogen and phsophorus uptake and improved their utilisation.

The interaction effect of nitrogen and phosphorus was significant in both the seasons. This was due to the fact that nitrogen in combination with phosphorus produced more vigorous growth in respect of height, number of branches and number of pods per plant. The interaction between phosphorus and potassium was significant only in the second season.

Weather parameters during the first season were favourable for increased dry matter production per plant compared to that of the second season. Significantly maximum number of branches and pods per plant were produced in the first season compared to that in the second season and hence dry matter production per plant was more in the first season.

4. Number of days taken for first flower opening

There was significant reduction in the number of days taken for first flower opening due to the application of 75 kg N/ha in both the seasons. Joachin et al (1939) has reported similar behaviour of nitrogen at higher levels of application.

With regard to the effect of phosphorus on earliness, higher doses of phosphorus favoured earliness in flowering in both the seasons. Phosphorus at 60 kg P_2O_5/ha took the minimum number of days, ie. 37.68 and 35.72 days in the first and second seasons respectively. The effects of phosphorus at 40 kg and 60 kg P_2O_5/ha were on par in both the seasons. Similar results of inducing earliness to flowering due to the application of higher doses of phosphorus have also been reported by Gill et al (1974), Covarelli (1976) and Khan and Suryanarayana (1977).

Influence of potash on earliness of flowering was not significant in the first season. But in the second season potash at higher levels had significant influence over that

that of lower level of 10 kg/ha in inducing earliness of flowering. Pimpini (1967) observed early flowering in chillies by the application of higher levels of potash, while other workers like Mohammed Kunju (1970) and Covarelli (1976) observed no earliness to flowering in chillies due to the application of higher doses of potash.

Interactional effect of nitrogen and phosphorus was significant in the second season. A combination of nitrogen at 75 kg/ha and P_2O_5 at 40 kg/ha recorded significant earliness (34.90 days) to flowering. Similar results have also been reported by Gill *et al* (1974) in chillies.

Significant earliness to flowering was noted in the second season when compared to that in the first season. This might be due to the availability of more bright sunshine hours per day in the second season.

5. Percentage fruit set

Nitrogen exerted significant effect on increasing fruit setting percentage in both the seasons. The maximum fruit set of 84.01% noted in the first season was observed in plots receiving 75 kg N/ha, whereas the maximum setting percentage of 57.03 was noted in 112.5 kg N/ha in the second season. The effects of nitrogen at 75 and 112.5 kg levels were on par. Similar observations have also been reported by Maynard (1962) and Mohammed Kunju (1970).

In the case of phosphorus also there was significant increase in fruit setting upto 40 kg P_2O_5/ha in both the seasons. The difference between 40 and 60 kg P_2O_5/ha was not significant, though P_2O_5 at 60 kg/ha has given the maximum setting percentage in both the crops. Since phosphorus has been considered essential for seed formation and found in large quantities in seeds and fruits (Tisdale and Nelson, 1965), this element might have influenced the fruit formation in this crop. Similar results have also been reported by Mohammed Kunju (1970).

The effect of potash in increasing the setting percentage in chillies was not found to be significant, though there was an increasing trend upto the level of 30 kg per hectare in both the seasons. Similar results regarding the effect of potash have been reported by Mohammed Kunju (1970).

Setting percentage was significantly higher in the first season. The mean setting percentages observed in the first and second seasons were 81.77 and 55.26% respectively. This was due to the increased flower abscission in the second season. Song et al (1976) noted that flower abscission was increased under higher temperatures (28-33°C). Temperature range during flowering period in the first season was from 27 to 30°C, while the same during the second season was from

30 to 35^{o}C. Hence the higher temperature range observed during the flowering period in the second season might have contributed for increased flower abscission in the second season.

6. Number of pods per plant

The data (Tables 16 and 17) clearly shows the beneficial influence of nitrogen in increasing the number of pods produced per plant. The mean number of pods produced per plant under the various levels of nitrogen, ie. 37.5 kg, 75 kg and 112.5 kg N/ha were in the order of 63.25, 88.15 and 88.63 in the first season and 51.90, 73.38 and 71.98 in the second season. Nitrogen at 75 kg/ha was found to be superior in the second season, whereas in the first season the effects of nitrogen at 75 kg and 112.5 kg per hectare were on par. This increase in the number of pods per plant by the application of higher doses of nitrogen was due to the increased fruit setting recorded at higher levels of nitrogen. Similar results of increasing number of pods per plant by the application of higher doses of nitrogen have been reported by workers like Gill et al (1974), Covarelli (1976) and Khan and Suryanarayana (1977) in chillies.

The influence of phosphorus in increasing the pod production in chillies was found to be significant in both the seasons. The difference between phosphorus at 40 kg and 60 kg P_2O_5/ha was significant in the first season, whereas in the second season the same difference was not significant. Increased number of pods per plant at higher levels of phosphorus application was due to the significant effect of phosphorus in increasing setting percentage at higher levels of its application. Similar results have also been reported in chillies by Mohammed Kunju (1970) and Iruthayaraj and Kulandaivelu (1973).

Potash was not found to influence much in the number of pods per plant in both the seasons in chillies. Potash did not show any significant effect in increasing the setting percentage. Covarelli (1976) noted that potash had no obvious effect on number of pods per plant.

The combined effect of nitrogen and phosphorus was found significant in the second season. The maximum number of 75.43 pods per plant was noted in the plots receiving a combination of 75 kg nitrogen per hectare and 40 kg P_2O_5/ha. Similar results of favourable effects of nitrogen in combination with phosphorus on the number of pods per plant in chillies have also been reported by Mohammed Kunju (1970) and Gill <u>et al</u> (1974).

Maximum number of pods per plant observed in the first season was mainly due to the significantly higher setting percentage observed in that season. In the second season percentage fruit setting was lower compared to that in the first season and hence the number of pods per plant also was lower in the second season. The evenly distributed rainfall and favourable temperature ranges obtained in the first season may be the factors which have contributed for the observed higher fruit setting and more number of pods per plant in the same season.

7. Length of pods

The data (tables 17 and 17) reveal that nitrogen has an influence in increasing the length of pods. Nitrogen at 75 kg/ha produced the maximum length of pods in both the seasons though the differences between 75 and 112.5 kg N/ha were not significant. Increased length of pods due to nitrogen application has been reported by Khan and Suryanarayana (1977).

The effect of phosphorus on length of pods was significant in both the seasons. The effects of phosphorus at levels of 40 and 60 kg P_2O_5/ha on the length of pods were on par in both the seasons. Similar results of increased pod length in chillies due to application of phosphorus has also been reported by Khan and Suryanarayana (1977).

Potash has not significant influenced the length of pods in chillies. This may be due to the fact that potash has no role in increasing the length of pods. Similarly Mohammed Kunju (1970) noted that Potash applied at any level failed to show significant effect on length of pods.

The interactional effect of nitrogen and phosphorus on length of pods was significant in the first season. This shows the favourable influence of nitrogen and phosphorus combination on length of pods in chillies.

The influence of favourable climatic conditions for better growth may be the reason for the observed higher fruit length in the first season compared to that in the second season.

8. Girth of pods

The results showed that there was significant increase in girth of pods at higher levels of nitrogen in both the seasons. Maximum girth of pods was observed at 112.5 kg N/ha in both the seasons. Increase in girth of pods by the application of higher levels of nitrogen have also been reported by Khan and Suryanarayana (1977).

Phosphorus application also significantly influenced the girth of pods in both the seasons. Phosphorus at

60 kg P_2O_5/ha was found to be significantly superior to 20 and 40 kg P_2O_5/ha in increasing the girth of pods in the second season, whereas in the first season the effects of P_2O_5 at 40 and 60 kg per hectare were on par. Khan and Suryanarayana (1977) have also observed such increase in in the girth of pods due to application of higher doses of phosphorus.

The response to potash at 30 kg K_2O/ha was significantly higher than that at 10 and 20 kg levels of potash in both the seasons. Thus potash has favourable influence on increasing the girth of pods. Similar observations of nicrease in girth of pods by potash application at 45 kg K_2O/ha has been reported by Khan and Suryanarayana (1977).

The interaction between nitrogen and potassium was significant in the second season. A combination of nitrogen at 112.5 kg/ha and 30 kg K_2O/ha recorded the maximum girth of 3.53 cm.

The mean girth of pods recorded in the first season was higher than that recorded in the second season. This may be due to the availability of more favourable climatic conditions for vigorous growth of pods in the first season.

9. Weight of 100 dry pods

The data (Tables 23 and 24) revealed that there was significant increase in the dry weight of 100 pods due to the application of nitrogen in both the seasons. Nitrogen at 112.5 kg/ha recorded the maximum dry weight of 100 pods in both the seasons, but the differences between nitrogen levels at 75 and 112.5 kg/ha were not significant. Such an increase in dry pod weight can be attributed to the succulence and plumpiness of the fruits and to the increased rate of synthesis of carbohydrates at higher levels of nitrogen application. Similar observations of increase in the dry pod weight due to the application of higher doses of nitrogen have been reported by Murty and Murty (1963) and Mohammed Kunju (1970) in chillies.

Phosphorus did not show any significant increase in the dry weight of 100 pods in the first season, whereas in the second season P_2O_5 at 60 kg/ha was found to be significantly superior over the lower levels of phosphorus. Hence phosphorus has favourable effect on increasing the dry weight of pods. Mohammed Kunju (1970) reported that phosphorus had no effect on increasing the dry weight of 100 pods in chillies. But Pimpini (1967) noted that phosphorus in combination with potash increased the average pod weight per pod in chillies.

There was significant increase in dry weight of 100 pods due to the application of higher doses of potash in both the seasons. This may possibly be due to the role of potash in the formation and translocation of carbohydrates as reported by Tisdale and Nelson (1965) thereby resulting in an increase in dry pod weight. Mohammed Kunju (1970) also noted increasing trend in the dry weight of 100 pods due to the application of higher levels of potash.

The higher mean length and girth of pods recorded in the first season may be the reason for the higher value of dry weight of 100 pods in the first season compared to the same in the second season. More succulence and plumpiness of pods observed in the first season whe more favourable climatic conditions were obtained might have contributed for the noted increase in the dry weight of 100 pods in the first season.

10. Yield of dry pods (kg/ha)

The data (Tables 23 and 24) revealed significant effect of graded doses of nitrogen, phosphorus and potassium on total yield of dry pods per hectare in both the seasons. In the first season the highest yield of 2471.02 kg dry pods per hectare was obtained in plots receiving 112.5 kg N/ha, whereas in the second season the highest yield of 2011.62 kg dry pods per hectare was noted at 75 kg N/ha. Nitrogen at higher levels have significantly increased the setting percentage, number of pods per plant and dry weight of 100 pods. Hence these factors might have contributed to the observed significant effect of higher doses of nitrogen on yield of dry pods per hectare. The influence of nitrogen in increasing the yield of chillies has been proved conclusively on the basis of trials conducted by Mohammed Kunju (1970), Covarelli (1976) and Khan and Suryanarayana (1977).

The beneficial effects of graded doses of phosphorus in increasing the height, branching, setting percentage and number of pods per plant might have together contributed to an increase in yield. The magnitude of response due to phosphorus application was much lower than that of nitrogen. Application of phosphorus at 20, 40 and 60 kg P_2O_5/ha has given the average yields of 2065.91, 2248.00 and 2295.76 kg per hectare in the first season and the corresponding figures for the second season were 708.02, 1811.37 and 1834.94 kg per hectare. Increase in yields due to phosphate application were observed by Iruthayaraj and Kulandaivelu (1973), Covarelli (1976) and Khan and Suryanarayana (1977).

It is evident from the results that graded doses of potash have significantly increased the yield of dry chilli per hectare in both the seasons. The average yields of dry pods per hectare due to 10, 20 and 30 kg potash per hectare were 2112.17, 2237.46 and 2260.04 kg per hecatare in the first season and the corresponding figures for the second season were 1730.16, 1803.93 and 1820.23 kg per hectare. Potash has shown significant effect on girth of pods and dry weight of 100 pods and together with these factors the beneficial effect of potash on nitrogen and phosphorus uptake and its utilization may be the factors responsible for the beneficial effect of Potash on yield of chillies. Khan and Suryanarayana (1977) and Subbiah (1982) reported that chilli could give higher yields at higher levels of potash application.

The interaction between nitrogen and phosphorus was significant in both the seasons. In the first season nitrogen at 75 kg/ha with 60 kg P_2O_5/ha produced the maximum yield of 2532.82 kg dry pods per hectare and in the second season also the same combination produced the maximum yield of 2084.10 kg dry pods per hectare. Several workers like Lal and Pundrick (1971), Gill <u>et al</u> (1974) have reported increased yields by the application of nitrogen in combination with phosphorus.

The interaction between phosphorus and potassium was significant in the second season. The highest yield of

1865.83 kg per hectare was recorded by 40 kg P_2O_5/ha with 30 kg potash per hectare. This is in agreement with the findings of Lal and Pundrick (1971).

The mean yields of dry pods recorded for the first and second seasons were 2203.03 and 1784.48 kg per hectare respectively. This is because factors like number of branches per plant, percentage fruit set, number of pods per plant, length and girth of pods, and dry weight of 100 pods showed significantly higher values in the first season compared to the same in the second season. Hence first season is highly favourable for producing more yield in chillies. This can be attributed to the more favourable climatic conditions such as evenly distributed rainfall and to the optimum temperature range obtained in the first season.

11. Fruit ascorbic acid content

The data presented in Tables 23 and 24 revealed that nitrogen exerted significant effect on fruit ascorbic acid content in both the seasons. There was significant increase in the content of fruit ascorbic acid with levels of nitrogen upto 112.5 kg per hectare in both the seasons. This is in agreement with the findings of Covarelli (1976) and Khan and Suryanarayana (1977).

Phosphorus showed no significant effect on fruit ascorbic acid content in the first season, whereas in the second season there was significant increase in the fruit ascorbic acid content upto 40 kg P_2O_5/ha. Maximum content of fruit ascorbic was noted at 60 kg P_2O_5/ha per hectare in the same crop.

Potash has no significant effect on fruit ascorbic acid content. Khan and Suryanarayana (1977) also reported that potash had no effect on fruit ascorbic acid content.

The mean fruit ascorbic acid content noted in the first season was significantly higher than the same observed in the second season. Hence rainfed season is favourable for a higher content of ascorbic acid in fruits.

12. Total uptake of nitrogen

There was significant increase in the total uptake of nitrogen in both the seasons. The maximum uptake of 52.84 kg per hectare was observed at 112.5 kg N/ha in the first season, whereas in the second season the maximum uptake of 43.39 kg N/ha also was noted at 112.5 kg N/ha. Hence total uptake of nitrogen increased with increased doses of nitrogen application. Similar results of increase in the total uptake of nitrogen with increasing doses of nitrogen have also been reported by Thomas and Heilman (1967).

The influence of phosphorus on the uptake of nitrogen was significant upto 60 kg P_2O_5/ha in both the seasons. The maximum amounts of 48.81 kg and 39.73 kg nitrogen per hectare were taken up by chilli plants at 60 kg P_2O_5/ha in first and second seasons respectively. The beneficial effects of higher levels of phosphorus in increasing the uptake of nitrogen have been noted by Thomas and Heilman (1967).

Potash application upto 20 kg/ha significantly influenced the uptake of nitrogen in both the seasons, maximum uptakes of 47.87 and 39.15 kg N/ha were noted at 30 kg K_2O/ha in the first and second seasons respectively. Similar results of increase in the uptake of nitrogen by the application of graded doses of potash were noted by Ozaki and Hamilton (1954), Spaldon and Ivanic (1968) and Ivanic and Strelec (1976).

The interaction between nitrogen and phosphorus was significant in the second season. Nitrogen at 75 kg/ha with 60 kg P_2O_5/ha recorded the maximum uptake of 45.02 kg nitrogen per hectare.

It is seen that crop planted in May had higher nitrogen uptake than the crop planted in November.

All growth components except height of plants at 70^{th} day after planting and the same at the time of final harvesting and all yield components recorded significantly higher values in the first season comapred to the same in the second season. All these factors contributed to the observed higher dry matter yield in the first season and hence the total uptake of nitrogen also was more in the first season.

13. Total uptake of phosphorus

It is evident from Tables 31 and 32 that nitrogen has a profound influence in increasing the uptake of phosphorus by plants. Nitrogen at 75 kg/ha was significantly superior to 37.5 and 112.5 kg levels of nitrogen on its effect on uptake of phosphorus in both the seasons. The highest uptake of 8.95 and 7.32 kg phosphorus per hectare were noted at 75 kg N/ha in the first and second seasons respectively. Increased uptake of phosphorus with increasing levels of applied nitrogen have also been reported by Thomas and Heilman (1967). The reason for increased uptake of phosphorus by nitrogen application may be due to the synergetic effect of nitrogen-phosphorus interaction which augmented the absorption of more phosphorus by plants.

Increased uptake of phosphorus with increasing levels of applied phosphorus was noted in both the seasons. The highest quantities of phosphorus take up by plants were in the order of 8.39 and 6.67 kg per hectare in the first and second seasons respectively. Increased uptake of phosphorus with increasing levels of applied phosphorus was reported by Thomas and Heilman (1967).

Potash at 20 kg/ha significantly influenced the total uptake of phosphorus over 10 and 30 kg levels of potash in the first season, whereas in the second season effects of potash at 20 and 30 kg/ha were on par. Several workers like Spaldon and Ivanic (1968) and Ivanic and Strelec (1976) have reported increased uptake of phosphorus bythe application of higher levels of potash.

The interactional effect of nitrogen and phosphorus was significant in both the seasons. In the first season, the highest uptake of 9.34 kg phosphorus per hectare was recorded in plots receiving 75 kg nitrogen per hectare and 40 kg P_2O_5 per hectare and in the second season the highest uptake of 7.78 kg phosphorus per hectare was noted at 75 kg N/ha with 60 kg P_2O_5/ha.

The interaction between phosphorus and potassium was significant in both the seasons. The highest total uptake of 8.61 kg phosphorus per hectare was recorded with 60 kg P_2O_5/ha and 20 kg K_2O/ha in the first season and in the second season the highest total uptake of 6.70 kg phosphorus per hectare was noted in plots receiving 40 kg P_2O_5/ha and 30 kg K_2O/ha.

It is seen that crop planted in May had higher phosphorus uptake than the crop planted in November. All growth and yield components recorded significantly higher values in the first season compared to the same in the second season. Since total dry matter production per hectare was more in the first season total uptake of phosphorus by plants was also higher in the first season.

14. Total uptake of potassium

From the data (Tables 31 and 32) it is clear that nitrogen significantly influenced the total uptake of potash upto 75 kg N/ha in both the seasons. The differences between 75 and 112.5 kg levels of nitrogen were not significant, even though at 112.5 kg N/ha maximum uptake of potash have been noted in both the seasons. Increased uptake of potash with increasing levels of applied nitrogen have also been reported by workers like Ozaki and Hamilton (1954) and Sanchezcorde (1970). The synergetic effect of nitrogen-potassium interaction may be the probable reason which augmented the higher uptake of potash with increasing levels of applied nitrogen.

The effect of phosphorus on uptake of potassium by plants was significant in both the seasons. Hence phosphorus has a favourable effect on the uptake of applied potash.

The applied graded doses of potash exerted significant effect on total uptake of potash by plants in both the seasons. The highest uptakes of 74.07 and 60.35 kg potassium per hectare were noted at 60 kg applied potash in the first and second seasons respectively. The beneficial effects of higher levels of potash application in increasing its uptake have also been reported by Spaldon and Ivanic (1968), Sanchezcorde (1970) and Ivanic and Strelic (1976).

Interaction between nitrogen and phosphorus was significant in both the seasons. In the first season a combination of 75 kg N/ha with 40 kg P_2O_5/ha recorded the highest uptake of 81.77 kg potassium per hectare, while in the second season the highest uptake of 69.25 kg potassium was recorded with 112.5 kg N/ha and 20 kg P_2O_5/ha. The interactions between nitrogen and potassium and also that between phosphorus and potassium also were significant in the second season.

It is seen from (Tables 31 and 32) that the crop planted in May had higher uptake of potash than the crop planted in November. This is because all growth and yield components recorded significantly higher values in the first season and hence total dry matter yield was more in the first season contributing to a higher uptake of potassium in that season.

15. Optimum and economic doses of nutrients

Estimated optimum doses of nutrients did not vary much during the two seasons. Economic doses and optimum doses were nearly identical for both the crops. This is because of the high price received for chillies. So it is advantageous to increase production for maximising profit from chilli cultivation. The recommendation for the nutrient for chillies as given in the package of practice is 75:40:20 kg nitrogen, phosphate and potash respectively. The present findings are almost in agreement with the package of practice recommendations. It seems that under the Agro-climatic conditions of Vellanikkara increased yield of chilli can be obtained by applying slightly higher doses of all the nutrients than those given in the package of practice recommendations. The expected yields at the optimum (economic) doses during the two seasons are 2704.65 kg and 2159.65 kg per hectare respectively giving profits of Rs.7948.02 for the first season crop and Rs.4128.82 for the second season crop.

Weather data

The yield of dry chilli pods obtained in the first crop season was significantly higher than that obtained in the second crop season. This was mainly because of the favourable climatic conditions prevailed during that season. The distribution of rainfall was even during the first crop season. So also the temperature and humidity ranges were favourable for getting a warm humid climatic condition during the first crop season and such a condition is highly favourable for the best growth of chillies. The evaporation rate wind speed etc. were also less during the first crop season.

There was only a single rainy day during the second crop season. The temperature and humidity ranges were not favourable to provide chillies with a warm humid climate. Similarly the mean evaporation rate and wind speed recorded per day were high during the second season and all these unfavourable climatic conditions might have contributed for the observed poor performance of chilli crop during the second crop season.

Summary

SUMMARY

Field experiments were conducted at the Instructional Farm, attached to the College of Horticulture, Vellanikkara during the periods from May to September 1981 and November 1981 to February 1982 to study the effects of graded doses of nitrogen, phosphorus and potassium on the growth and yield of chilli, variety Pant C.1 in two seasons. The treatments comprised of three levels each of nitrogen (37.5, 75 and 112.5 kg N/ha), phosphorus (20, 40 and 60 kg P_2O_5/ha) and potassium (10, 20 and 30 kg K_2O/ha). The experiments were laid out in a 3^3 confounded factorial design confounding NP^2K and NPK^2 in replications 1 and II respectively in both the seasons. The objectives of the investigation were as follows. (1) To find out the uptake and optimum requirements of nitrogen, phosphorus and potassium in two seasons (2) To find out the effects of various weather parameters on growth and yield of chillies. The findings are summarised below.

1. Incremental doses of nitrogen increased the height of plants at all the stages of observations in both the seasons. Application of graded doses of phosphorus also increased the height of plants at all the growth stages except at the time of final harvest in the second season and potash exerted no appreciable effect on height of

plants except at the time of final harvest in the first season. Mean heights of plants were more at 35th day after planting in the first season, while at 70th day after planting and at the time of final harvest mean heights of plants were significantly higher in the second season.

2. Branching was significantly increased by nitrogen and phosphorus in both the seasons. The maximum number of branches per plant were noticed in the treatment combinations of 112.5 kg nitrogen and 60 kg phosphorus per hectare in both the seasons and potash had no significant effect on branching. The number of branches produced per plant was significantly higher in the first season compared to that in the second season.

3. Higher doses of nitrogen, phosphorus and potassium significantly increased the total dry matter yield per plant in both the seasons. Significantly more dry matter production per plant was noted in the first season compared to that in the second season.

4. Significant earliness of flowering was recorded at 75 kg nitrogen per hectare in both the seasons. Similarly significant earliness of flowering was noted at 60 kg phosphorus per hectare in both the seasons. Effect of

potash on earliness of flowering was not significant in the first season, but in the second season its effect was significant. Significant earliness of flowering was noted in the second season compared to the same in the first season.

5. Setting percentage was significantly increased by the application of graded doses of nitrogen and phosphorus in both the seasons. Potash had no significant influence on setting percentage. The mean setting percentage recorded in the first season was significantly higher than that observed in the second season.

6. Number of pods produced per plant was significantly increased by nitrogen application upto 112.5 kg per hectare in the first season, whereas in the second season 75 kg nitrogen per hectare produced significantly more number of pods per plant. Higher doses of phosphorus significantly increased the number of pods per plant in both the seasons and potash had not influenced the number of pods per plant. Number of pods per plant was significantly more in the first season.

7. Application of graded doses of nitrogen upto 75 kg and phosphorus upto 40 kg per hectare increased the length of pods significantly in both the seasons and beyond the above levels there was reduction in the mean length of pods

except at 60 kg phosphorus per hectare in the first season. Potash had no significant effect on length of pods and the mean length of pods observed in the first season was significantly more than that noted in the second season.

8. Higher doses of nitrogen, phosphorus and potassium significantly increased the girth of pods in both the seasons and the difference in the mean girth of pods observed between the two seasons was significant.

9. The dry weight of 100 pods was increased by graded doses of nitrogen and potassium in both the seasons. The effect of phosphorus on dry weight of 100 pods was not significant in the first season, whereas in the second season its effects was significant. The observed mean dry weight of 100 pods was significantly higher in the first season compared to the same observed in the second season.

10. The yield of dry pods was significantly increased by the application of graded doses of nitrogen upto 112.5 kg per hectare in the first season, whereas significantly increased yield was obtained at 75 kg nitrogen per hectare in the second season. Yield of dry pods was significantly increased by increased levels of phosphorus and potassium in both the seasons. Significantly higher yield of pods was obtained in the first season compared to the yield obtained in the second season.

11. Incremental doses of nitrogen significantly increased ascorbic acid content of fruits. Phosphorus exerted no significant influence on fruit ascorbic acid content in the first season, whereas in the second season incremental doses of phosphorus increased the same. Potash had no significant effect on fruit ascorbic acid content. Higher values of fruit ascorbic acid content was noted in the first season compared to that in the second season.

12. Total uptake of nitrogen by plants was significantly increased by the increased doses of all the three nutrients in both the seasons. The mean total uptake of nitrogen recorded in the first season was significantly higher than that recorded in the second season.

13. Effect of nitrogen at 75 kg per hectare was significantly superior over the effects of other levels of nitrogen in increasing the total uptake of phosphorus by plants in both the seasons. Phosphorus uptake was significantly increased by the application of phosphorus upto 60 kg per hectare. Application of graded doses of potash upto 20 kg per hectare significantly increased the total uptake of phosphorus and beyond which uptake of phosphorus decreased in both the seasons. Uptake of phosphorus was significantly higher in the first season compared to the total uptake recorded in the second season.

14. Nitrogen at 75 and 112.5 kg per hectare and phosp at 40 and 60 kg per hectare significantly increased the total uptake of potash in both the seasons. Total uptake of potash by plants was significantly more in the first season compared to the total uptake of the same noted in the second season.

15. The estimated optimum doses of nitrogen, phosphorus and potassium for the first season crop were in the order of 92, 52 and 30 kg per hectare and the same for the second season crop were 92, 52 and 26 kg per hectare respectively.

16. The estimated economic doses of nitrogen, phosphorus and potassium for maximum profit were in the order of 94, 52 and 30 kilograms per hectare for the first season crop and the same for the second season crop were 92, 52 and 26 kg per hectare respectively.

The economic and optimum doses of nutrients were nearly identical for both the crops because of the high price received for chillies. The expected yields estimated as at the optimum (economic) doses for the first and second seasons were 2704.65 kg and 2159.65 kg per hectare respectively giving profits of Rs.7,948.02 for the first season crop and Rs.4,128.82 for the second season crop.

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Appendices

APPENDIX - I

Weather data (weekly averages) from 30th May 1981 to 26th February 1982.

Evaporation mm/day	Date		Weeks	Temp. °C		Relative humidity	Total rain fall mm.	Number of rainy days	Number of hours of bright sunshine	Wind speed km/hour
				Max.	Min.					
0.4	May 30 -	June 5	1	28.6	22.74	91	360.2	7	0.4	1.8
0.8	June 6 -	June 12	2	29.9	22.95	92	280.7	7	1.6	1.0
0.2	June 13 -	June 19	3	27.5	22.2	91	319.4	7	0.6	0.6
0.7	June 20 -	June 26	4	28.1	22.1	88	276.6	7	3.5	3.0
1.2	June 26 -	July 3	5	29.9	22.7	86	-	-	5.5	1.5
0.9	July 4 -	July 10	6	29.2	22.5	87	194.5	7	3.7	2.0
1.5	July 11 -	July 17	7	29.3	22.0	86	127.3	5	3.8	2.1
3.4	July 18 -	July 24	8	30.0	23.4	86	61.0	3	6.2	5.1
0.6	July 25 -	July 31	9	27.9	22.8	90	130.1	5	1.8	3.1
2.6	Aug. 1 -	Aug. 7	10	28.9	21.6	91	68.6	4	4.1	3.2
1.2	Aug. 8 -	Aug. 14	11	28.4	22.4	87	50.0	4	2.8	2.2
0.7	Aug. 15 -	Aug. 21	12	27.5	22.3	89	257.1	7	1.6	2.0
3.2	Aug. 22 -	Aug. 28	13	29.8	21.5	84	29.2	2	5.4	2.8
3.4	Aug. 29 -	Sept. 4	14	30.4	23.4	79	3.0	1	6.3	3.0
1.2	Sept. 5 -	Sept.11	15	29.24	22.9	84	117.6	6	3.2	1.8
1.8	Sept.12 -	Sept.18	16	28.9	22.5	87	162.1	7	2.8	1.1
0.6	Sept.19 -	Sept.25	17	28.1	23.0	91	240.1	7	2.6	0.9
3.6	Sept.26 -	Oct. 2	18	30.6	22.9	82	-	-	5.8	2.4
3.5	Oct. 3 -	Oct. 9	19	30.9	22.5	77	331.2	2	6.9	1.6
2.5	Oct. 10 -	Oct. 16	20	30.8	23.0	79	5.0	1	5.9	1.1
1.5	Oct. 17 -	Oct. 23	21	31.7	23.0	79	10.2	1	5.4	1.0
1.6	Oct. 24 -	Oct. 30	22	29.7	22.9	79	48.0	3	4.2	3.5
2.2	Oct. 31 -	Nov. 6	23	30.4	22.5	82	1.6	1	4.8	1.3
3.0	Nov. 7 -	Nov. 13	24	31.2	22.1	73	76.4	3	7.3	1.1

(Contd..)

APPENDIX – I (CONTINUED)

Evaporation mm/day	Date	Weeks	Temp. °C Max.	Temp. °C Min.	Relative humidity	Total rain fall mm.	Number of rainy days	Number of hours of bright sunshine	Wind speed km/hour
3.6	Nov. 14 – Nov. 20	25	32.3	22.6	68	–	–	9.4	4.3
3.9	Nov. 21 – Nov. 27	26	31.9	20.2	66	–	–	7.7	1.4
4.7	Nov. 28 – Dec. 4	27	31.0	23.4	67	2.2	1	9.0	8.4
3.8	Dec. 5 – Dec. 11	28	32.7	19.3	61	–	–	10.0	2.4
5.2	Dec. 12 – Dec. 18	29	31.2	19.6	62	–	–	6.7	7.1
8.1	Dec. 19 – Dec. 25	30	30.9	23.4	65	–	–	9.8	16.4
6.4	Dec. 26 – Jan. 1	31	31.9	22.0	57	–	–	9.8	10.9
7.7	Jan. 2 – Jan. 8	32	31.5	21.5	55	–	–	9.9	14.3
5.8	Jan. 9 – Jan. 15	33	32.3	20.3	59	–	–	10.1	8.2
7.5	Jan. 16 – Jan. 22	34	32.7	20.7	52	–	–	10.1	8.5
6.8	Jan. 23 – Jan. 29	35	33.2	22.5	69	–	–	9.9	10.8
7.2	Jan. 30 – Feb. 5	36	34.6	21.7	55	–	–	9.5	10.1
6.3	Feb. 6 – Feb. 12	37	36.0	21.3	54	–	–	9.9	5.3
4.7	Feb. 13 – Feb. 19	38	35.9	21.3	62	–	–	9.9	4.0
7.7	Feb. 20 – Feb. 26	39	37.1	20.7	53	–	–	10.2	5.8

APPENDIX - II

Analyses of variances for growth components (first season)

Source	D.F.	Mean squares			Number of branches at the time of final harvest	Drymatter yield per plant.
		Height of plants in cm				
		35 days after planting	70 days after planting	At the time of final harvest		
Block	5	0.43	3.41	5.36	11.39	55.71**
N	2	90.79**	277.13**	540.85**	4428.64**	2274.58**
P	2	11.79**	32.50**	100.34**	461.52**	176.41**
NP	4	0.45	5.06	0.49	33.76*	1.77*
K	2	0.07	0.10	15.50**	8.92	56.72**
NK	4	0.21	1.22	5.89	4.85	1.17
PK	4	0.69	6.52*	2.03	5.52	0.50
NPK	2	0.02	1.44	9.46	16.50	1.36
NPK^2	2	0.49	0.57	1.99	2.31	0.07
NP^2K	2	0.40	2.71	0.47	8.92	1.14
NP^2K^2	2	0.10	1.96	0.58	17.69	0.04
Error	22	0.25	2.04	2.58	9.29	0.59

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

APPENDIX - III

Analyses of variances for growth components (second season)

Source	D.F.	Mean squares: Height of plants in cm: 35 days after planting	70 days after planting	At the time of final harvest.	Number of branches per plant at final harvest.	Drymatter yield per plant.
Block	5	0.02	4.20	32.98	8.16	6.45**
N	2	121.38**	436.44**	710.29**	4096.44**	1675.58**
P	2	9.09**	20.64**	51.91	353.36**	57.41**
NP	4	0.05	12.38**	40.92	13.29	4.40**
K	2	0.06	1.34	19.38	14.28	18.48**
NK	4	0.11	6.45	40.34	1.02	0.28
PK	4	0.25	8.60*	42.76	5.57	1.83*
NPK	2	0.32	4.42	72.41	4.92	1.04
NPK^2	2	0.20	1.05	0.07	2.29	0.16
NP^2K	2	0.09	16.54**	35.42	2.07	0.01
NP^2K^2	2	0.14	9.56*	10.53	7.35	1.24
Error	22	0.20	2.75	36.15	14.64	0.43

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

APPENDIX - IV

Analyses of variances for earliness, yield attributes (first season)

Source	D.F.	Number of days for first flower opening	% fruit set	Number of pods per plant	Length of pods
Block	5	0.169	5.93*	146.28**	0.0048
N	2	2.96**	227.22**	4794.24**	0.8090**
P	2	21.33**	75.37**	378.58**	0.0329**
NP	4	0.48	3.59	7.71**	0.0202**
K	2	0.41	2.67	3.20	0.0001
NK	4	0.17	1.71	0.62	0.0033
PK	4	0.45	0.88	1.35	0.0037
NPK	2	0.45	2.21	1.58	0.0100
NPK^2	2	0.87	2.36	0.02	0.0008
NP^2K	2	1.49	1.16	2.25	0.0027
NP^2K^2	2	1.27	2.62	0.17	0.0015
Error	22	0.54	3.26	1.69	0.0034

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

APPENDIX - V

Analyses of variances for yield attributes and quality of fruits (first season)

Source	D.F.	Mean squares			
		Girth of fruits	Weight of 100 dry pods	Yield of dry pods kg/ha	Ascorbic acid content mg/100 g fruit
Block	5	0.0039	0.168	96027.358**	0.63
N	2	0.6069**	20.574**	3414095.360**	755.15**
P	2	0.0486**	0.057	264814.276**	4.29
NP	4	0.0114	0.384	7209.978*	2.32
K	2	0.0922	44.464**	114220.039**	0.59
NK	4	0.0086	0.166	3373.335	0.21
PK	4	0.0013	0.220	1068.155	0.35
NPK	2	0.0121	0.224	2845.800	0.20
NPK^2	2	0.0155	0.049	1727.431	0.11
NP^2K	2	0.0218	0.077	3084.347	0.89
NP^2K^2	2	0.0030	0.084	1537.092	0.52
Error	22	0.0050	0.281	2064.766	1.64

* Significant at 5% level.

** Significant at 1% level.

APPENDIX - VI

Analyses of variances for earliness and yield attributes (second season)

Source	D.F.	Mean squares			
		Number of days for first flower opening	% fruit set	Number of pods per plant	Length of pods
Block	5	0.26	1.37	14.64**	0.08
N	2	4.99**	138.65**	2599.12**	0.67**
P	2	37.39**	23.21**	85.71**	0.10*
NP	4	1.79*	0.62	8.29**	0.01
K	2	2.05*	0.13	0.92	0.01
NK	4	0.25	0.59	0.75	0.01
PK	4	0.28	0.34	1.49	0.003
NPK	2	0.54	0.03	1.03	0.04
NPK^2	2	1.18	0.46	0.25	0.01
NP^2K	2	0.92	0.76	3.00*	0.002
NP^2K^2	2	0.87	0.04	0.39	0.02
Error	22	0.49	1.48	0.76	0.02

* Significant at 5% level.

** Significant at 1% level.

APPENDIX - VII

Analyses of variances for yield attributes and quality of fruits (second season)

Source	D.F.	Mean squares			
		Girth of pods	Weight of 100 pods	Yield of dry pods kg/ha	Ascorbic acid content (mg/100gfruit)
Block	5	0.015*	0.14	10073.57**	2.01
N	2	0.17**	31.56**	2390916.18**	656.45**
P	2	0.06**	3.50*	82029.11**	7.23**
NP	4	0.008	0.64	8179.17**	0.68
K	2	0.04**	35.21**	41460.97**	0.04
NK	4	0.02**	0.15	868.96	0.21
PK	4	0.006	1.85	2874.23**	0.64
NPK	2	0.002	0.47	3693.59*	0.04
NPK^2	2	0.001	0.09	506.76	0.40
NP^2K	2	0.002	0.32	457.61	0.34
NP^2K^2	2	0.003	0.87	1320.08	0.39
Error	22	0.004	0.68	655.84	0.63

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

APPENDIX - VIII

Analyses of variances for total uptake of nitrogen, phosphorus and potassium (first season).

Source	D.F.	Mean squares		
		Nitrogen uptake kg/ha	Phosphorus uptake kg/ha	Potassium uptake kg/ha
Block	5	41.313**	1.208**	73.258**
N	2	1712.748**	50.660**	3774.427**
P	2	117.291**	6.697**	218.338**
NP	4	1.294	0.217**	6.022*
K	2	36.536**	0.546**	225.817**
NK	4	1.305	0.036	2.920
PK	4	0.468	0.062*	0.888
NPK	2	2.390	0.136**	2.223
NPK^2	2	0.048	0.027	3.362
NP^2K	2	1.128	0.021	0.472
NP^2K^2	2	0.021	0.004	2.009
Error	22	0.625	0.016	1.933

* Significant at 5% level.

** Significant at 1% level.

APPENDIX - IX

Analyses of variances for total uptake of nitrogen, phosphorus and potassium (second season).

Source	D.F.	Mean squares		
		Nitrogen uptake kg/ha	Phosphorus uptake kg/ha	Potassium uptake kg/ha
Block	5	3.44**	0.11*	7.51**
N	2	1284.64**	34.00**	2752.76**
P	2	47.46**	2.79**	69.69**
NP	4	4.76**	0.23**	10.80**
K	2	10.92**	0.13**	38.14**
NK	4	0.74	0.02	2.45*
PK	4	0.51	0.03*	8.26**
NPK	2	0.88	0.07**	0.73
NPK^2	2	0.16	0.002	4.86**
NP^2K	2	2.24	0.04*	0.17
NP^2K^2	2	0.09	0.02	1.15
Error	22	0.59	0.009	0.63

* Significant at 5% level.

** Significant at 1% level.

NITROGEN PHOSPHORUS AND POTASSIUM REQUIREMENTS OF CHILLI (*Capsicum annuum* L.) VARIETY PANT. C - I

BY

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ABSTRACT OF A THESIS

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ABSTRACT

Field experiments were conducted at the Instructional Farm, Vellanikkara during the periods from May to September 1981 and November 1981 to February 1982 to study the effects of graded doses of nitrogen, phosphorus and potassium on the growth and yield of chilli variety Pant.C.1 in two seasons.

The experiments were laid out in a 3^3 confounded factorial design confounding NP^2K and NPK^2 in replications 1 and II respectively in both the seasons.

The study revealed that plant height increased with incremental doses of nitrogen and phosphorus in both the seasons. Branching was significantly increased by nitrogen and phosphorus in both the seasons. Higher doses of nitrogen and phosphorus and potassium significantly increased the dry matter yield per plant in both the seasons. Significant earliness of flowering was recorded at 75 kg nitrogen per hectare and also at 60 kg phosphorus per hectare in both the seasons. Setting percentage and number of pods per plant were significantly increased by the application of graded doses of nitrogen in both the seasons.

Nitrogen and phosphorus application increased the length and girth of pods in both the seasons. Potash had

also increased the girth of pods. The dry weight of 100 pods was increased by graded doses of nitrogen and potassium in both the seasons and the effect of phosphorus on this aspect was significant only in the second season. Nitrogen at 112.5 kg/ha produced significantaly higher yield in the first season, whereas in the second season nitrogen at 75 kg per hectare gave significantly higher yields over other levels of nitrogen. Yield of dry pods was significantly increased by increased levels of phosphorus and potassium in both the seasons. Nitrogen exerted significant influence on fruit ascorbic acid content in both the seasons.

Total uptake of nitrogen was significantly increased at higher levels of nitrogen, phosphorus and potassium application in both the seasons. Similar trends were also noted in the total uptake of phosphorus and potassium by plants in both the seasons.

The estimated optimum and economic doses of nitrogen, phosphorus and potassium were nearly identical for both the seasons because of the higher prices received for chillies. The optimum (economic) doses of nitrogen, phosphorus and potassium estimated for the first season crop was 94 : 52 : 30 kg per hectare and the same for the second crop was 92 : 52 : 26 kg per hectare respectively. The expected profits at the above optimum (economic) doses for the first and second season crops were Rs.7,948.02 and Rs.4,128.82 respectively. Cultivation of chillies in the first season gave more net profit.