Comparative Performance of Oat (*Avena Sativa* L.) Varieties Under Different Levels of Phosphorus and Nitrogen Fertilization

By

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B. Sc. (Agri.)

A Thesis submitted to the

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COMPARATIVE PERFORMANCE OF OAT (Avena sativa L.) VARIETIES UNDER DIFFERENT LEVELS OF PHOSPHORUS AND NITROGEN FERTILIZATION.

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in

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CERTIFICATE

This is to certify that the thesis entitled " Comparative Performance of Oats (Avena sativa L.) Varieties Under Different Levels of Phosphorus and Nitrogen Fertilization " submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist : Ahmednagar (Maharashtra) in partial fulfilment of the requirements for the degree of Master of Science (Agriculture) in Agronomy embodies the results of a piece of bona fide research work carried out by Shri J.G. Thokale, under my guidance and supervision. It is of sufficiently high standard to warrant its submission to the Vidyapeeth (University) for award of said degree. No part of the thesis has been submitted for any other degree, diploma or published in any other form.

The assistance and help received during the course of this investigation and source of literature referred to have been duly acknowledged.

Rahuri :

Dated : 16 th June 1975

B.B. Patil

(Dr. B.B. Patil)
Research Guide

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Dated : 16th June 1975

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INTRODUCTION

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CHAPTER I

INTRODUCTION

The agricultural prosperity in India is intimately related to the health of cattle which depends on adequate nutrition. Cattle in India provide the principal motive power in farming. The livestock population of India is the largest in the world being 400 million heads of cattle. In Maharashtra, the cattle population is 26.4 millions. The condition of this enormous cattle population is very poor, as the fodder resources of the country are insufficient for even half the existing number. Further, the cattle population is also continuously increasing by geometrical proportion. Inadequate fodder results in poor health of cattle. Not only the farmer is impoverished but the national wealth and productivity is also lowered.

Inspite of large livestock population, no systematic attention is yet paid towards their proper feeding. The feeding is known to be poor, which is devoid of essential nutrients. Animals are merely considered as scavengers of crop residues. Such a neglected feeding reflects on animal health and production too. The present livestock feeding is far from satisfactory to sustain optimum production. There is a general tendency of using dry fodder of cereal crop grown in kharif or rabi season.

A good feeding programme should include green fodder, in addition to dry fodder and concentrates, for

good health and optimum production of the livestock. However, limited amount of green fodder is available to meet the requirementsof the large number of cattle. With the adoption of the policy to develop hybrid cattle for high milk, meat or wool production, the requirement of green fodder will be ever increasing.

With the increasing demands for green fodder, the cultivation of Oats (Avena sativa, L.) has been recommended recently. Besides being a nutritious feed, it is very leafy, profuse tillering and quick growing. This makes oats a suitable forage crop during winter months. With the various advantages offered by oats, it is regarded as useful yet cheapest source of crude protein, carbohydrates and minerals in livestock feeding programme.

Oats can be used as green forage, pasture, hay or as silage. Oats have shown good promise in North India both in mixture with berseem and also as a sole crop. The dairy farmers in the state of Maharashtra have also recently realised the importance of oats and have turned to its use on large scale. Ever increasing pressure of population of both cattle and human being threatens food and feed supply in India. The problem of feed supply is becoming acute day by day. Thus, it is inviting increased attention of research workers engaged in forage crops. The efforts required have many facets needing careful, yet thoughtful, planning of research for increasing forage production.

[Oats being a cereal forage, respond favourably to the application of nitrogen fertilizers and the production as well as nutritive value is further enhanced when supplimented with phosphorus fertilization. The oats are adaptable to a cool climate which prevails in rabi (winter) season in India. It requires cool, dry, clear weather. This helps to encourage tillering. Dry sunny days and cool nights result in dew formation which is very helpfull to the crop. Hot and humid weather is harmfull as it encourages rapid spread of fungus diseases.]

[Experimental evidences indicate that it is a better feed for all livestock inclusive of milch cattle and horses. It is, therefore, essential to increase the forage production of oats. Oats require approximately 75 to 85 days to reach first cutting stage. A general survey of the published literature indicates very little information regarding suitable oat varieties, its fertilization and management to sustain high production. Practically, no research work is reported in Maharashtra on the performance of different oat varieties under various levels of phosphorus and nitrogen fertilization.]

The present investigation was, therefore, undertaken to study the performance of different varieties of oats under various levels of phosphorus and nitrogen fertilization and the effect of these on forage production and its nutritive value. The investigation in this behalf, was

undertaken to answer some of the problems in this area with the following objectives:

1. To select a suitable oat variety for high forage production.
2. To know the appropriate levels of phosphorus and nitrogen fertilization to sustain high production.
3. To assess the nutritive value of the forage.

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CHAPTER II

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

It is generally accepted that the yielding ability in a forage crop is a genetical character. However, yield per unit area can be improved through proper management practices under given agroclimatic conditions. The production of quality forage, therefore, is basically a function of suitable varieties and management practices in relation to agroclimatic conditions. The management practices include proper and adequate fertilization. Experimental evidence in the form of published literature pertaining to phosphorus and nitrogen fertilization on yield and nutritive value of oats varieties is reviewed in this chapter.

1. Effect of varieties on growth, yield and nutritive value of oat fodder:

Forage crop varieties show wide variation among themselves in yield and nutritive value.

Zern (1963) reported in yield trials, with ten varieties of yellow and white oats for 6 years that average yield of 70-77.5 hkg dry matter per hectare were obtained from all varieties.

Mukund Singh et al (1965) reported that the Wintok variety contained a higher percentage of nitrogen, potassium and calcium than Dubois and LeConte at the first three harvest dates.

Hischke et al.(1968) reported that the protein content and amino acid composition of seven varieties of oats ranged from 18.1 to 22.2 per cent.

Pal et al.(1970) reported highly significant differences in yields between the varieties and they found that the phosphorus rich varieties gave the maximum yield. The average yield of dry matter and crude protein in Pos 1/29 were 73.5 and 3.63 quintals per hectare respectively.

Nittler et al.(1971) observed that six oats varieties exhibited highly significant differences in the length of internodes.

Tiwari et al.(1971) observed the superiority of Kent over Brunker and . showed that the Kent variety has significantly superior yielding ability over Brunker. Saxena et al.(1971) also noted that Kent proved superior in forage production yielding more than 600 quintals of forage per hectare as against about 450 quintals per hectare by Avena byzantina.

2. Effect of phosphorus fertilization on growth, yield and nutritive value of oat fodder:

Most agronomic practices, particularly regarding use of fertilizers aim at improving crop yield. Genetically stable crop varieties are known to respond to fertilizer application favourably. Application of optimum level of phosphatic fertilizers not only increases the crop yield but also improves the nutritive value of forages.

2.1 Effect of phosphorus fertilization on growth and yield :

Gururaj et al. (1966) showed that phosphorus influenced the straw yield significantly.

Tomer and Singh (1967) observed that forage yields are much improved with the application of 44.8 kg phosphorus per hectare.

Tomer (1969) showed that yield potential as well as fresh weight per unit area were much improved with the application of 50 kg phosphorus per hectare. The improvement in the yield with the application of phosphorus is possibly due to better utilization of nutrients from the soil owing to greater root development.

However, Tomer and Arora (1971) showed that oats were least responsive to phosphorus application. Singh et al. (1972) also observed that application of phosphorus did not influence forage yields.

2.2 Effect of phosphorus fertilization on nutritive value of oat fodder:

Burriel et al. (1951) reported that crude protein, crude fat and mineral matter were increased with each increase in the level of phosphorus fertilization.

Gururaj et al. (1966) reported that the phosphate had no influence on quality.

Perch et al. (1968) concluded that phosphorus and potassium generally reduced the crude protein content of grain although slight increases were recorded.

Whitney (1968) reported that the application of phosphorus reduced percentage nitrogen content of the forage.

Tomer (1969) reported that application of 50 kg phosphorus per hectare was beneficial as yield, crude protein, crude fat and mineral matter were increased and carbohydrates were decreased. The nutritive ratio was also narrowed down with the application of phosphorus.

3. Effect of nitrogen fertilization on growth, yield and nutritive value of oat fodder:

Most agronomic practices, particularly use of fertilizers aim at improving crop yield. Application of optimum level of nitrogenous fertilizers not only increases the crop yields but also normally hastens maturity and improves the nutritive value of forages.

3.1 Effect of nitrogen fertilization on growth and yield:

Frey and Wiggans (1957) reported that nitrogen applications tended to stimulate tiller growth rather than the development of addition tillers.

Shands and Chapman (1961) reported that nitrogen is the most important element as it increases the vegetative growth and thus the yield of fodder.

Saxena (1962) found that nitrogen fertilization was effective in increasing the number of leaves per plant.

Rai (1965) stated that nitrogen application increased the growth in height and dry matter production.

Gururaj et al. (1966) stated that nitrogen application

favourably influenced growth and developmental characters such as height, number of leaves and tillers.

Kalwate (1967) observed that the number of leaves and dry matter per plant increased significantly by application of nitrogen upto 90 kg per hectare.

Tomer and Singh (1967) reported that forage yields are much improved with the application of 44.8 kg nitrogen per hectare.

Moolani et al. (1968) concluded that increased level of nitrogen at 60 kg per hectare increased the height and dry matter per plant, but they observed no response in case of leaf number per plant.

Sinha (1968) reported that growth and yield of oat increased considerably as the doses of nitrogen increased from 0 to 120 kg. nitrogen per hectare.

Tomer (1969) showed that green forage yield was improved with the application of 90 kg nitrogen per hectare.

Saxena et al. (1971) observed that linear forage response was obtained upto 120 kg nitrogen per hectare. The average response to every 60 kg nitrogen application being about 99 quintals of forage per hectare.

Singh et al. (1972) reported that optimum dose of nitrogen for forage yield was 83 kg per hectare and for maximum profit it was 76 kg per hectare when three-fourth nitrogen dose was applied at sowing and one-fourth after the first cut.

Luostarinen (1973) reported that yield responses to nitrogen application from 20 to 120 kg per hectare were rather variable depending upon years and particularly on the extent of lodging.

3.2 Effect of nitrogen fertilization on nutritive value of oat fodder:

Hart and Burton (1965) reported increase in herbage yield and crude protein content whereas decrease in crude fibre content with increasing levels of nitrogen.

Bhan (1966) observed that application of nitrogen appreciably improved the yield and quality of fodder. Gururaj et al. (1966) reported that the quality in respect of protein in grain and straw was improved by the nitrogen fertilization.

Bokde (1968) reported that nitrogen applications increased the total protein as well as protein content in fodder. He concluded that applied nitrogen was more effective in increasing the total protein yield rather than increasing the dry matter.

Sinha (1968) reported that the quality of oat increased considerably as the dose of nitrogen increased from 0 to 120 kg nitrogen per hectare.

Porch et al. (1968) demonstrated that nitrogen was responsible for increases in crude protein.

Desai (1973) reported that with increased levels of nitrogen fertilization, Crude protein and ash content in forage increased while crude fibre and nitrogen-free extract were decreased.

4. Effect of phosphorus and nitrogen on growth, yield and nutritive value of oat fodder.

Application of optimum levels of phosphatic and nitrogeneous fertilizers is beneficial for forage crops for increasing the yield as well as nutritive value of fodder.

Gururaj et al. (1966) reported that the application of nitrogen favourably influenced the growth and developmental characters. There was an increase in grain yield of 134.9 per cent and 74.3 per cent over control by application of 70 and 35 kg nitrogen per hectare respectively. The respective increases in the yield of straw were 102.7 per cent and 63.6 per cent. Application of phosphorus influenced the straw yield. The quality in respect to protein in grain and straw was improved by nitrogen. Similarly, phosphorus application augmented the phosphate content.

Porch et al. (1968) reported that nitrogen and to a lesser extent phosphorus were necessary for maximum yield of protein.

Tomer (1969) recommended 99 kg nitrogen and 50 kg phosphorus for maximum green fodder production of oat.

Singh et al. (1972) reported that the levels of nitrogen and phosphorus and their timings of application and their interaction influenced the yield of green and dry fodder significantly.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

Experiment to study the comparative performance of oat (Avena sativa L.) varieties under different levels of phosphorus and nitrogen fertilization was conducted during rabi season of 1973 in the "C" block, Central Campus Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra).

1. Experimental location and soil :

The soil under the experimental plot can be classed as medium black. The topography of the experimental site was fairly uniform and levelled. A composite soil sample (0-30 cm depth) was drawn from the experimental plots before sowing for estimating mechanical and chemical properties. The results of mechanical and chemical analyses of initial soil sample are presented in Table 1.

Table 1 : Mechanical and chemical composition of soil (0-30 cm) from the experimental plot.

Sr.No.	Particulars	Percentage
A)	Mechanical composition	
1.	Coarse sand	7.20
2.	Fine sand	29.25
3.	Silt	9.00
4.	Clay	45.00
5.	Textural class	Clay

Table 1 (contd.)

Sr.No.	Particulars	Percentage
B)	Chemical composition	
	1. Total nitrogen	0.046
	2. Available P_2O_5	0.003
	3. Available K_2O	0.016
	4. Organic carbon	0.70
C)	Others	
	1. pH	8.1
	2. C : N ratio	15.22

Total nitrogen was estimated by a modified Kjeldahl's method (A.O.A.C. 1955). The available potassium was estimated by Volk and Troug' method (1934) and available phosphorus by Olsen's method (Olsen, 1954). Organic carbon was determined by Walky and Black tiration method (Piper, 1950). The soil pH was determined by Beckmann's Glass electrode pH meter (Wrlte, 1939).

It can be seen from Table 1 that the soil of the experimental plots can be texurally classed as clayey and it was slightly alkaline in reaction.

2. Climatic conditions :

Mahatma Phule Krishi Vidyapeeth (Campus) lies between 19° 47' North to 19° 57' North latitude and 74° 19' east

longitude at an altitude of about 495 to 569 metres height above the mean sea level.

Climatically, the area falls in the semi-arid sub-tropical zone with annual rainfall varying from 307 to 619 mm, the average being about 475 mm. The distribution of rain is erratic yet low. The number of rainy days vary from 15 to 45 days in different years. Most of the rainfall is received through South West monsoons. The tract falls in the rain shadow zone on the eastern side of the Western Ghats.

Annual average maximum temperature is 38°C, with a range of 33°C to 43°C, and the average minimum temperature is 17°C with a range of 3°C to 17°C. The average relative humidity in the morning is 59 per cent and in the evening is approximately 35 per cent respectively. Agro-climatically, this tract comes under low rainfall and dry region with frequently prevailing famine condition.

In order to get clear idea about the climatic conditions prevailing during the period of experimentation, the weather data obtained from meteorological observatory situated at Mulanagar are presented in Table 2.

3. <u>History of the experimental plot :</u>

The cropping history of the experimental plot in preceeding three years is given in Table 3.

Table 2 : Meteorological data recorded during the cropping period in the year 1973-74.

Meteorological week No.	Dates	Mean Temperature oC		Rainfall in mm	No. of rainy days
		Maximum	Minimum		
		October 1973			
40	1-7	23.3	22.3	8.0	3
41	8-14	26.2	28.2	-	-
42	15-21	23.2	22.1	18.0	1
43	22-28	22.2	21.8	18.0	1
		November 1973			
44	29-4	23.6	17.3	-	-
45	5-11	27.9	16.8	-	-
46	12-18	28.8	17.3	-	-
47	19-25	27.9	16.8	-	-
48	26-2/12	28.8	15.7		
		December 1973			
49	3-9	25.2	17.5	-	-
50	10-16	23.6	16.0	-	-
51	17-23	25.5	16.0	-	-
52	24-30	34.6	22.8	-	-

Table 3 : Cropping history of the experimental plot.

Year	Season	Crops grown	Manuring
1970-71	Kharif	Fallow	Nil
	Rabi	Jowar	Nil
1971-72	Kharif	Fallow	Nil
	Rabi	Jowar fodder	Nil
1972-73	Kharif	Jowar fodder	Nil
	Rabi	Fallow	Nil
1973-74	Kharif	Moth	25 kg N, 40 kg P_2O_5 20 kg K_2O per acre
	Rabi	Present investigation.	As per treatments

It could be seen from Table 3 that sorghum was grown as a general crop during the Rabi season of 1970-71 and 1971-72 without any of manures and fertilizers. Before conducting the present investigation moth was grown in Kharif season of 1973-74 the fertilizer treatment included uniform application of 25 kg N, 40 kg P_2O_5 and 20 kg K_2O per acre.

4. Experimental details :

The experimental design was split plot, with 36 treatment combinations replicated four times. The combinations of three varieties and three phosphorus levels served as main plot treatments, while the subtreatments consisted of four levels of nitrogen fertilization. The details of the factors along with the symbols used are given in Table 4.

Table 4 : The details of the factors along with their symbols.

A. Main Plot : Varieties (3)

	Varieties	Symbol used
1)	Kent	V_1
2)	Parbhani	V_2
3)	Local	V_3
	Phosphorus kg per hectare (3)	
1)	0	P_0
2)	30	P_1
3)	60	P_2

B. Sub-plot - Nitrogen kg per hectare (4)

1)	0	N_0
2)	40	N_1
3)	80	N_2
4)	120	N_3

The gross and net plot sizes were 4.00 x 3.00 m and 3.0 x 2.0 metres respectively. The experiment layout plan is presented in Fig. 1

5. Field operations :

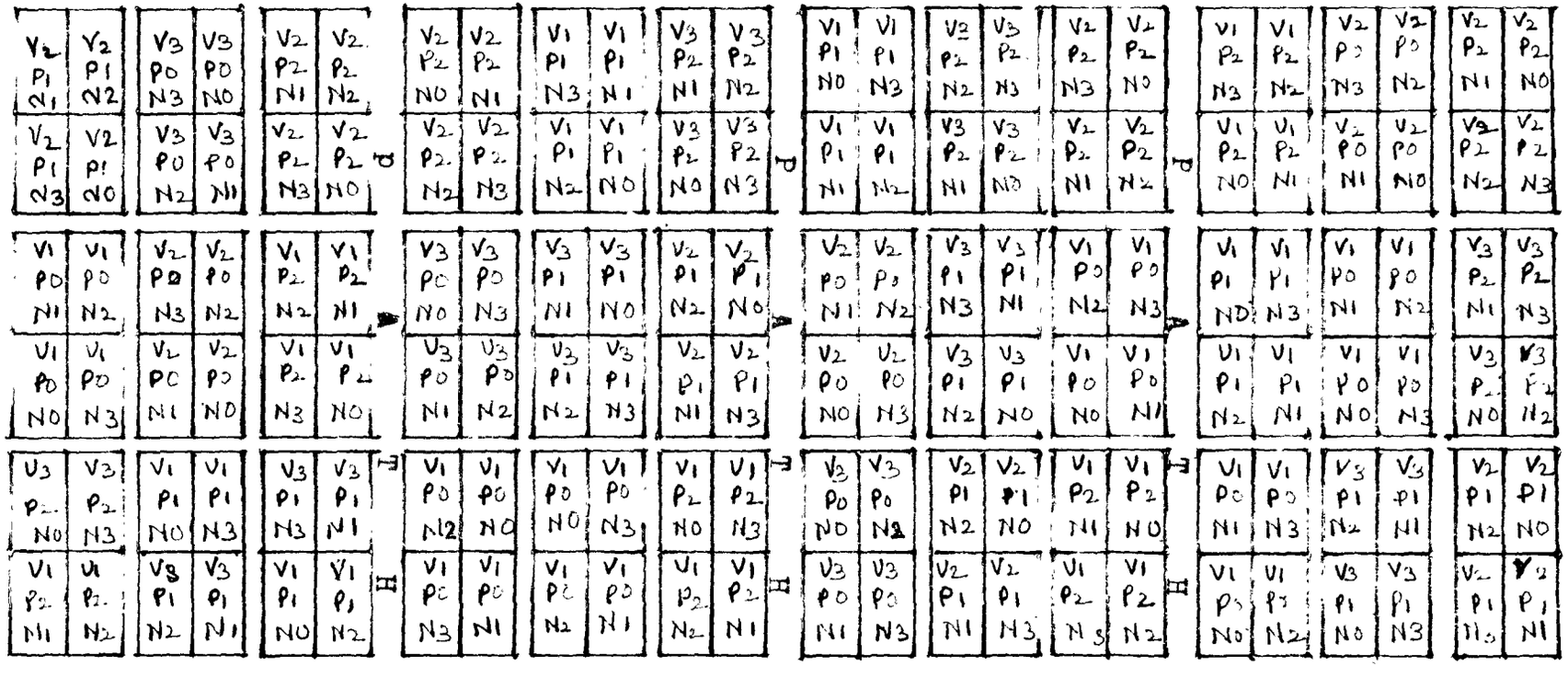
The schedule of various cultural operations carried out in the experimental plot is given in Table 5.

6. Seeds and Sowing :

The sowing was done on 10-10-1973 using 100 kg of seeds per hectare at 25 cm apart.

Fig. 1

PLAN OF LAYOUT



DESIGN: SPLIT PLOT

NUMBER OF REPLICATIONS: IV

GROSS PLOT SIZE : 4.0x3.0 M^2

NET PLOT SIZE : 3.0x 2.0 M^2

(Not to the scale)

Table 5 : Schedule of cultural operations.

Sr.No.	Field operation	Frequency	Time of operation
1	Ploughing	1	29-9-1973
2	Harrowing	1	2-10-1973
3	Collection of stubbles	1	3-10-1973
4	Layout	1	5-10-1973
5	Opening of channels and mending of plots	1	7-10-1973
6	Application of fertilizers	1	A basal dose of potassium at 30 kg per ha. through muriate of potash was given to all plots. Phosphorus and nitrogen fertilizer were given as per treatments just before sowing.
7	Sowing	1	10-10-1973
8	Gap filling	1	20-10-1973
9	Top dressing	1	4-11-1973
10	Weeding	2	1-11-1973 26-11-1973
11	Spraying of 0.02% malathion	2	30-10-1973 15-11-1973
12	Harvesting	1	24-12-1973

7. Fertilizer application :

Potassium was supplied through muriate of potash analysing 60 per cent K_2O as a basal dose at the rate of 30 kg K_2O/ha. Single superphosphate analysing sixteen per cent P_2O_5 was used as a source of phosphorus. The urea analysing 45 per cent nitrogen was used as a source of nitrogen. The full dose of phosphorus and half dose of nitrogen was applied as per the treatments at the time of sowing. The remaining half dose of nitrogen was applied as per the treatments at 25 days after sowing. The fertilizers were evenly distributed over the plot surface with hand and mixed in the soil by rake just before sowing.

8. Plant protection measures :

The attack of jassids was noticed 15 days after sowing. The crop was sprayed with 0.02% malathion to control the pest. No other pest or disease was observed on the crop. In general, the crop was healthy.

9. Observations :

The effects of various treatments on yield and growth contributing characters of the crop were studied. The following observations were recorded at three stages as per the details given below.

Stages : 1) 30 days after sowing.

2) 60 days after sowing.

3) At the time of harvesting i.e. 85 days after sowing.

9.1 Leaf number per plant :

The total number of the functional leaves were recorded at 3 stages. Only green and healthy leaves were counted.

9.2 Plant height :

The height of the plant was measured in cm from the base of stem at the soil surface upto the base of the last fully developed leaf on main stem.

9.3 Number of tillers per plant :

The total number of tillers were recorded at two stages, namely : 60 days after sowing and at the time of harvest.

9.4 Leaf:stem ratio :

For leaf:stem ratio, five plants from each treatment were selected. The leaves were separated from the stem. The leaves and stems were weighed separately. The leaf:stem ratio was calculated by the formula given below :

$$\text{Leaf:Stem ratio} = \frac{\text{wt. of leaves}}{\text{wt. of stems}}$$

9.5 Dry matter yield :

Plant samples weighing 50 g were taken from each treatment, 60 days after sowing and were preserved. The samples were initially sun-dried followed by oven drying at 65° ± 2°C in an hot air oven. The dried samples were weighed. The procedure was repeated till the constant weight was obtained. The samples weighing 500 g were taken from each treatment at the time of harvest and the dry matter was estimated.

10. Harvesting :

The crop was harvested when it reached 50 per cent flowering stage as judged by visual observation. The green forage was weighed immediately after harvest and the yields of net plots were recorded in kg.

Chemical studies :

It is essential to know the nutritive value of fodder by analysing it into various components. The samples taken for dry matter studies were utilized for chemical analyses. The samples were ground to 100 mesh powder in a Willey mill. About 40 g of representative sample was drawn from the powdered material was preserved in suitably labelled plastic bags. The ground samples of respective treatments from different replications were composited. The composited samples for each treatment at 60 days and at harvest stages, were analysed in duplicate for nitrogen, phosphorus, crude fibre and total minerals.

a) Total nitrogen :

It was determined by micro-Kjeldahl's method (A.O.A.C., 1955).

b) Phosphorus :

The phosphorus was determined in an aliquot of the tri-acid extract by measuring in intensity of the vanado-phospho - molybdate. Yellow colour which was estimated as a percentage transmission by spectronic-20, using blue filter adjusted at 420 mμ (Jackson, 1958).

Nutritive value studies :

1. Crude protein :

Nitrogen percentage estimated by micro-Kjeldhal method (A.O.A.C., 1955) was multiplied by 6.25 to obtain per cent crude protein content in the forage.

2. Crude fibre was determined by the method as described in A.O.A.C. (1955).

3. Total ash :

Total ash was determined according to the method described in A.O.A.C. (1955).

4. Ether extract :

The ether extract analysis does not give a good estimation and energy of fats, (Desai, 1975). Therefore, this analysis was made on one composite sample. This value was used for determination of the nitrogen - free extract for each samples from treatment.

5. Nitrogen-free extracts :

This was calculated by difference. It was calculated by substracting the sum of crude protein, ether extract, crude fibre and ash from 100.

Statistical analysis and interpretation of data :

Statistical analysis of data was done by the standard statistical method of " Analysis of variance " in order to ascertain whether the observed treatment effects were real or discernible from the chance effects. The ' Null hypothesis was tested by 'F' test of significance. The appropri-te

standard error (S.E.) for each factor was worked out. Wherever the test revealed significance of treatment effects, to compare two treatment means the critical difference (C.D.) at 5% level of probability was worked out. Suitable graphical illustrations of these data have been presented at appropriate places.

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CHAPTER IV

EXPERIMENTAL FINDINGS

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EXPERIMENTAL FINDINGS

The experimental findings regarding the effect of different varieties of oats, levels of phosphorus and nitrogen on the growth characters, yield contributing characters, green and dry forage yields and chemical composition of forage at harvest are presented in this chapter.

1. Plant population at harvest :

The final plant population per square metre recorded at the time of harvest is presented in Table 6.

It would be seen from the data in Table 6 that the mean plant population at harvest was 400.2 plants per square metre. The plant population was not significantly influenced by any of the factors under study.

2. Growth studies :

The bio-metric observations recorded on various plant growth characters including plant height, number of tillers, number of functional leaves per plant, leaf:stem ratio and dry matter production are presented hereunder:

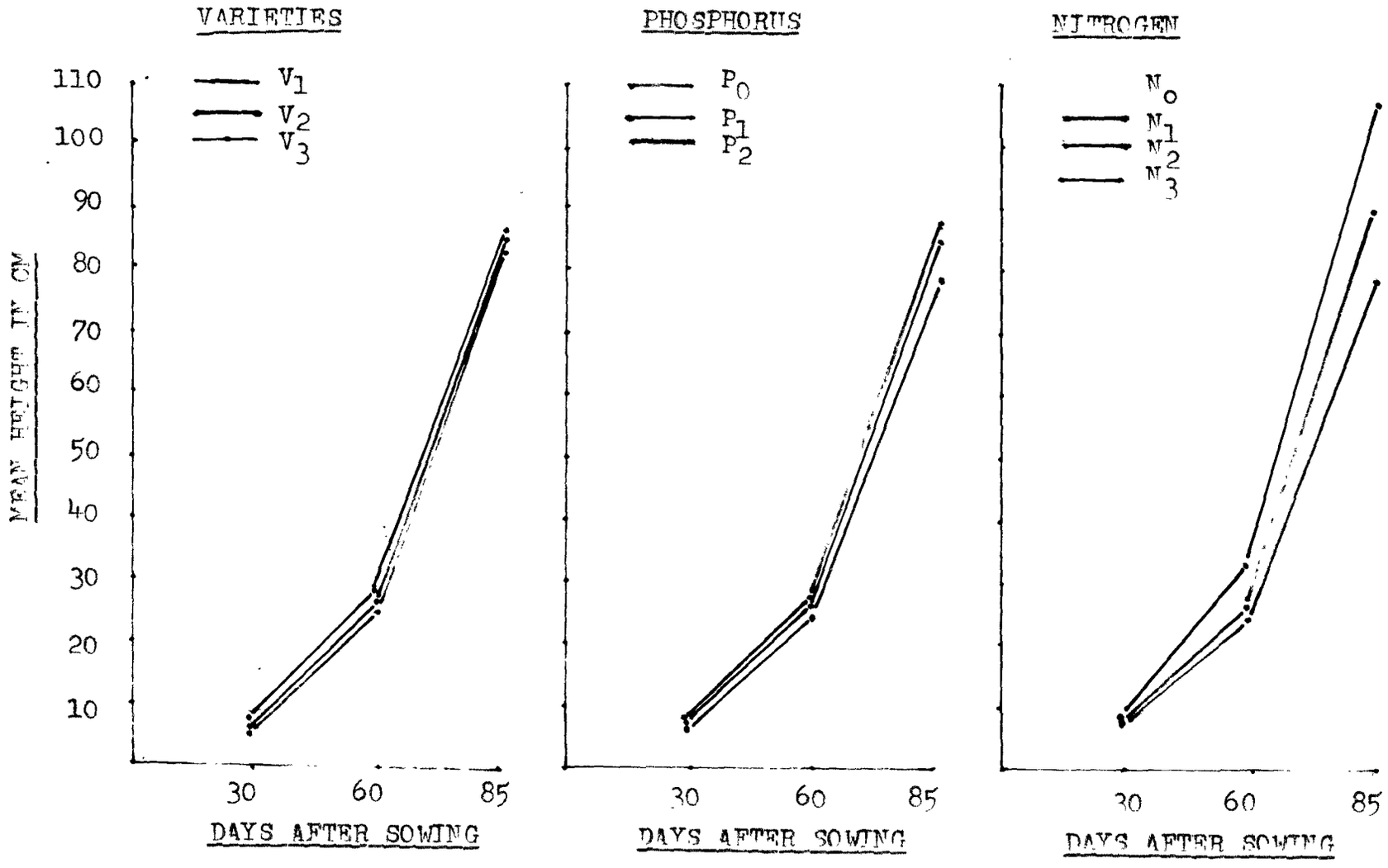
2.1 Plant height :

The data in respect of plant height at various stages of growth as affected by different treatments are presented in Table 7 and graphically depicted in Fig. 2.

It is evident from Table 7 and Fig. 2 that the mean height increased with advancing crop maturity. The mean plant height at 30 days was 7.38 cm which ultimately increased to 84.42 cm at harvest.

Fig. 2

MEAN HEIGHT OF PLANT IN CM AS AFFECTED BY DIFFERENT TREATMENTS.



Effect of varieties:

Data in Table 7 show that differences in the mean height of various oat varieties were statistically non-significant. This was observed at all the crop growth stages.

Effect of phosphorus :

Data in Table 7 show that the different levels of phosphorus fertilization did not affect significantly the mean plant height at 30 and 60 days of crop growth. However, the plant height at harvest was significantly influenced by phosphorus application. In general, the plant height increased with each increase in the level of phosphorus fertilization. The phosphorus fertilization at 60 kg P_2O_5/ha produced a maximum plant height of 88.27 cm followed by 30 and 0 kg P_2O_5/ha. Application of 30 kg P_2O_5/ha increased the plant height over 0 kg P_2O_5/ha, but it was on par with 60 kg P_2O_5/ha level.

Effect of nitrogen :

Nitrogen fertilization increased the mean plant height significantly over no nitrogen at all stages of crop growth (Table 7). Application of 120 kg N/ha resulted in maximum plant height at all the stages of crop growth. Each increment of nitrogen significantly increased the plant height.

2.2 Number of tillers per plant :

The data regarding number of tillers per plant as effected by different treatments are presented in Table 8. The data reveal that the mean numbers of tillers per plant at 60 days and at harvest were [illegible] 51 respectively.

Table 6 : Mean plant population per square metre at harvest as influenced by varieties, levels of phosphorus and nitrogen.

Treatments	Plant population at harvest
1) Varieties	
1) Kent	400.0
11) Parbhani	400.3
111) Local	400.3
'F' test	N.S.
S. E. ±	0.247
C.D. at 5%	-
2) Phosphorus kg/ha	
1) 0	400.3
11) 30	400.2
111) 60	400.2
'F' test	N.S.
S. E. ±	0.247
C. D. at 5%	-
3) Nitrogen kg/ha.	
1) 0	400.3
11) 40	400.1
111) 80	400.2
iv)120	400.3
'F' test	N.S.
S. E. ±	7.414
C. D. at 5%	-
General mean	400.2

N.S. = Not significant.

Table 7 : Mean height of plant in cm at various stages of crop growth, as affected by different treatments.

Treatments	Days after sowing 30	60	85 (At harvest)
1) Varieties			
i) Kent	7.28	25.44	82.65
ii) Parbhani	7.46	26.42	84.60
iii) Local	7.39	25.75	86.02
'F' test	N.S.	N.S.	N.S.
S.E. ±	0.062	0.390	1.824
C.D. at 5%	-	-	-
2) Phosphorus kg/ha			
i) 0	7.27	25.52	79.29
ii) 30	7.24	25.38	85.69
iii) 60	7.62	26.71	88.27
'F' test	N.S.	N.S.	Sigt.
S.E. ±	0.062	0.390	1.824
C.D. at 5%	-	-	5.325
3) Nitrogen kg/ha			
i) 0	6.23	19.33	61.94
ii) 40	7.17	24.11	78.83
iii) 80	7.55	27.36	90.19
iv) 120	8.56	32.66	106.7
'F' test	Sigt.	Sigt.	Sigt.
S.E. ±	0.109	0.481	0.900
C.D. at 5%	0.308	1.352	2.785
General mean	7.38	25.87	84.42

Sigt. = Significant N.S. = Not significant

Effect of varieties :

Table 8 shows that there were no significant differences among the varieties in respect of number of tillers per plant. This indicates that the number of tillers per plant in all the varieties were the same and that these varieties did not differ from each other in tillering ability.

Effect of phosphorus :

Table 8 shows that mean number of tillers per plant was not affected significantly by phosphorus fertilization at both the crop growth stages.

Effect of nitrogen :

Table 8 indicates that there were no significant differences among the nitrogen fertilization levels in influencing the number of tillers at 30 days, although the number of tillers tended to increase with each increase in the level of nitrogen fertilization. At harvest, application of 120 kg N/ha increased the number of tillers significantly over the other nitrogen fertilization levels. The number of tillers per plant increased from 4.64 with no nitrogen to 6.31 with 120 kg of N/ha.

2.3 Number of functional leaves :

The data relating to functional leaves per plant at various stages of crop growth as affected by various treatments are given in Table 9.

Table 8 : Mean number of tillers per plant at 60 days and at harvest as affected by different treatments.

Treatments	Days after sowing 60	85 (At harvest)
1) Varieties		
i) Kent	3.71	5.54
ii) Parbhani	3.63	5.42
iii) Local	3.88	5.56
'F' test	N.S.	N.S.
S.E. ±	0.093	0.151
C.D. at 5%	-	-
2) Phosphorus kg/ha		
i) 0	3.63	5.39
ii) 30	3.75	5.48
iii) 60	3.83	5.65
'F' test	N.S.	N.S.
S.E. ±	0.093	0.151
C.D. at 5%	-	-
3) Nitrogen kg/ha		
i) 0	3.36	4.64
ii) 40	3.64	5.33
iii) 80	3.92	5.76
iv) 120	4.027	6.31
'F' test	Sigt.	Sigt.
S.E. ±	0.121	0.147
C.D. at 5%	0.340	0.414
General mean	3.74	5.51

Sigt. = Significant N.S. = Not significant

It is evident from Table 9 that the number of functional leaves per plant increased with advancing crop growth upto 60 days when the number of mean maximum functional leaves per plant was 15.6. Thereafter, there was decrease in the number of functional leaves per plant presumably due to drying of lower leaves with the cessation of vegetative growth and begining of reproductive growth phase.

Effect of varieties :

It is observed from Table 9 that there were no significant differences in the number of functional leaves per plant due to various varieties at all the stages of the crop growth.

Effect of phosphorus :

It is clear from Table 9 that effects of the levels of phosphorus fertilization on leaf number per plant were not significant, though an increasing trend with each increase in the level of phosphorus application is discernible.

Effect of nitrogen :

Data in Table 9 indicate that the number of functional leaves per plant was significantly affected by nitrogenous fertilization. The differences in this character were significant at all the three stages of growth viz. at 30 days, at 60 days and at harvest.

The number of functional leaves was not affected by 40 kg N/ha but it was increased significantly by 80 and 120

Table 9 : Mean functional leaves per plant at various stages of crop growth as affected by different treatments.

Treatments	Days after sowing 30	60	85 (At harvest)
1) Varieties			
i) Kent	1.95	15.34	13.15
ii) Parbhani	1.95	14.93	12.72
iii) Local	2.31	16.38	14.10
'F' test	N.S.	N.S.	N.S.
S.E. ±	0.136	0.544	0.604
C.D. at 5%	-	-	-
2) Phosphorus kg/ha			
i) 0	2.00	15.17	12.99
ii) 30	2.10	15.46	13.10
iii) 60	2.12	16.02	13.90
'F' test	N.S.	N.S.	N.S.
S.E. ±	0.136	0.544	0.604
C.D. at 5%	-	-	-
3) Nitrogen kg/ha			
i) 0	1.81	11.69	9.72
ii) 40	1.97	14.71	12.42
iii) 80	2.22	16.61	14.22
iv) 120	2.31	19.21	16.06
'F' test	Sigt.	Sigt.	Sigt.
S.E. ±	0.068	0.628	0.876
C.D. at 5%	0.192	1.795	2.468
General mean	2.07	15.56	13.33

N.S. = Not significant Sigt. = Significant

kg N/ha, and the differences in the latter two levels of nitrogen were not significant.

The number of functional leaves at 60 days were significantly increased with each increase in the level of nitrogen. The differences in the number of functional leaves at harvest were not significant for 40 and 80 kg N/ha and for 80 and 120 kg N/ha though application of nitrogen, in general increased the number of functional leaves over no nitrogen treatment.

2.4 Leaf : Stem ratio :

The data in respect of leaf:stem ratio at various stages of crop growth as affected by different treatments are presented in Table 10.

It would be seen from the data in Table 10 that the leaf:stem ratio was maximum during early crop growth stages and it decreased with the advancing maturity. The leaf:stem ratio decreased from 1.63 at 30 days to 0.92 at harvest.

Effect of varieties :

Data in Table 10 show that the leaf:stem ratios were affected by various treatments significantly at all crop growth stages except at harvest. Oats variety V_3(local) and V_2 (Parbhani) were significantly better than the variety V_1(Kent) at 30 days. However, at 60 days oats varieties V_2(Parbhani) and V_1 (Kent) were better than the variety V_3 (local). At maturity, leaf:stem ratios were not significantly different. However, the oats variety V_1 (Kent) produced higher leaf:stem ratio than the other varieties.

Table 10 : Mean leaf : stem ratio at various stages of crop growth, as affected by different treatments.

Treatments	Days after sowing 30	60	85 (At harvest)
1) Varieties			
i) Kent	1.58	1.31	1.12
ii) Parbhani	1.68	1.66	0.78
iii) Local	1.67	1.27	0.85
'F' test	Sigt	Sigt	N.S.
S.E. ±	0.009	0.017	0.108
C.D. at 5%	0.026	0.050	-
2) Phosphorus kg/ha			
i) 0	1.52	1.39	0.73
ii) 30	1.65	1.42	0.93
iii) 60	1.72	1.44	1.09
'F' test	Sigt.	Sigt.	N.S.
S.E. ±	0.009	0.017	0.057
C.D. at 5%	0.026	-	-
3) Nitrogen kg/ha			
i) 0	1.53	1.27	0.87
ii) 40	1.57	1.40	0.90
iii) 80	1.61	1.46	0.92
iv) 120	1.80	1.54	0.97
'F' test	Sigt.	Sigt.	N.S.
S.E. ±	0.014	0.024	0.057
C.D. at 5%	0.039	0.069	-
General mean	1.63	1.42	0.92

Sigt. = Significant N.S. = Not significant

Effect of phosphorus :

It is evident from Table 10 that the phosphorus application at 60 kg P_2O_5/ha increased the leaf:stem ratio, at 30 days, significantly over 0 to 30 kg P_2O_5/ha. The effect of phosphorus on leaf:stem ratio with advancing maturity did not produce significant differences.

Effect of nitrogen :

Table 10 shows that the effect of different levels of nitrogen on the leaf:stem ratio of plant was found to be significant only at 30 days and 60 days after sowing while there was no significant difference at harvest. Leaf:stem ratio at 30 days and 60 days was significantly increased with each increment of nitrogen. Nitrogen fertilization at 120 kg N/ha significantly increased the leaf:stem ratio over other levels at both the crop growth stages.

3. Dry matter production :

3.1 Dry matter percentage :

The data regarding dry matter per cent as affected by different treatments are presented in Table 11.

Data in Table 11 reveal that the percentage of dry matter increased with the increase in the maturity of crop. It increased from 16.01 per cent at 60 days to 21.09 per cent at harvest.

Effect of varieties:

Table 11 shows that oat variety V_1 (Kent) was significantly superior over variety V_3 (local) as far as dry

Table 11 : Mean percentage of dry matter at 60 days and at harvest as affected by different treatments.

Treatments	Days after sowing 60	85 (at harvest)
1) Varieties		
i) Kent	16.32	19.91
ii) Parbhani	16.04	20.95
iii) Local	15.66	22.40
'F' test	Sigt.	Sigt.
S.E. ±	0.144	0.532
C.D. at 5%	0.422	1.555
2) Phosphorus kg/ha		
i) 0	15.92	20.69
ii) 30	15.98	21.11
iii) 60	16.11	21.46
'F' test	N.S.	N.S.
S.E. ±	0.144	0.532
C.D. at 5%	-	-
3) Nitrogen kg/ha		
i) 0	15.28	20.33
ii) 40	15.45	21.01
iii) 80	16.43	21.46
iv) 120	16.86	21.56
'F' test	Sigt.	N.S.
S.E. ±	0.150	0.412
C.D. at 5%	0.424	-
General mean	16.01	21.09

Sigt. = Significant. N.S. = Not significant.

matter percentage at 60 days was concerned, but it was on par with variety V_2 (Parbhani). The oat variety V_3 (local) contained significantly higher dry matter at harvest than the other varieties.

Effect of phosphorus :

It is clear from Table 11 that there were no significant differences due to phosphorus fertilization in respect of dry matter per cent at both the stages of crop growth, though increase in dry matter content with increase in levels of phosphorus fertilization was discernible.

Effect of nitrogen :

Table 11 shows that the increase in the levels of nitrogen fertilization significantly increased the dry matter per cent at 60 days of crop growth, but the levels of nitrogen did not produce significant differences at harvest. The dry matter percentage in plants was highest at both stages of growth with 120 kg N/ha.

3.2 Dry matter yield:

Data regarding dry matter yield per hectare as affected by different treatments are presented in Table 12 and graphically depicted in Fig. 3.

Table 12 shows that the mean dry matter yield of oats was 32.11 q per hectare.

Effect of varieties :

Table 12 shows that the dry matter yield was not significantly influenced by various varieties. The local

Fig. 3

MEAN YIELD OF DRY MATTER AT HARVEST IN QUINTALS, AS AFFECTED BY DIFFERENT TREATMENTS.

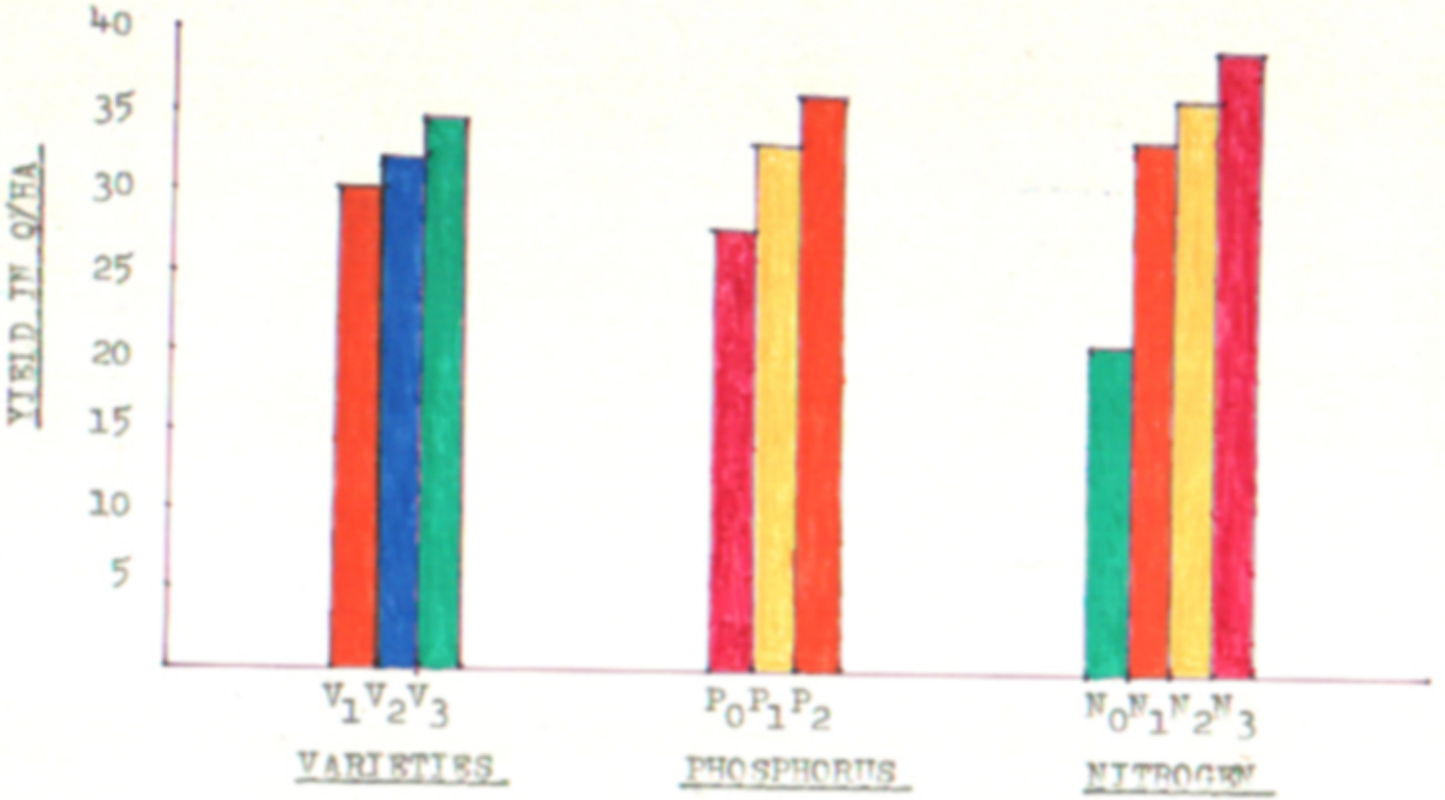


Table 12 : Mean yield of dry matter at harvest in quintals per hectare as affected by different treatments.

Treatments	Mean yield of dry matter q/ha
1) Varieties	
i) Kent	29.91
ii) Parbhani	32.15
iii) Local	34.28
'F' test	N.S.
S.E. ±	1.241
C.D. at 5%	-
2) Phosphorus kg/ha	
i) 0	27.63
ii) 30	32.90
iii) 60	35.81
'F' test	Sigt.
S.E. ±	1.241
C.D. at 5%	3.621
3) Nitrogen kg/ha	
i) 0	20.36
ii) 40	33.44
iii) 80	35.74
iv) 120	38.91
'F' test	Sigt.
S.E. ±	1.051
C.D. at 5%	2.955
General mean	32.11

Sigt. = Significant N.S. = Not significant

variety V_3, produced the maximum dry matter of 34.28 q/ha as compared to other two varieties.

Effect of phosphorus :

A reference to Table 12 reveals that the dry matter yield increased significantly due to phosphorus fertilization. The phosphorus fertilization at 30 kg P_2O_5/ha level produced significantly higher dry matter yield over no phosphorus treatment. The difference in dry matter yield due to 30 kg and 60 kg P_2O_5/ha was however, not significant.

Effect of nitrogen :

The data in Table 12 indicate that the nitrogen application significantly increased the dry matter yield of oats with increase in the level of nitrogen fertilization, except with increase from 40 kg to 80 kg N/ha. The increase in dry matter yield with 120 kg N/ha over 0 kg N/ha was of the order of 90 per cent, being 38.91 and 20.36 q/ha respectively.

Interaction effects :

The data in Table 13 reveal that the effect of interaction between varieties X phosphorus was found to be significant. The highest dry matter yield of 39.12 q/ha was observed in oat variety V_1 (Kent) at 60 kg P_2O_5/ha, while lowest dry matter yield of 25.25 q/ha was produced by the same variety with no phosphorus fertilization. The oat varieties responded to phosphorus fertilization differently. At 0 kg P_2O_5/ha variety V_3 (local) produced

Table 13 : Mean dry matter yield at harvest in quintals, as affected by varieties x phosphorus fertilization interaction.

Varieties	Phosphorus kg/ha 0	30	60	Mean
i) Kent	25.25	25.37	39.12	29.91
ii) Parbhani	26.89	36.55	33.03	32.15
iii) Local	30.77	36.79	35.30	34.28
General mean	27.63	32.90	35.81	32.11

S.E. ± for VP : 2.150
C.D. at 5% for VP : 4.323

Table 14 : Mean dry matter yield at harvest in quintals, per hecta as affected by phosphorus x nitrogen fertilization.

Phosphorus kg/ha	Nitrogen kg/ha 0	40	80	120	Mean
i) 0	16.65	29.81	34.92	31.12	27.63
ii) 30	19.95	35.66	35.88	40.17	32.90
iii) 60	24.48	36.84	36.43	45.51	35.81
General mean	20.36	33.44	35.74	38.91	32.11

S.E. ± for PN : 1.821
C.D. at 5% for PN : 3.862

significantly higher dry matter yield than the other two varieties. At 30 kg P_2O_5/ha, varieties V_2 (Parbhani) and V_3 (Local) were on par and produced significantly higher dry matter yield than V_1 (Kent). However, at 60 kg P_2O_5/ha, V_1 (Kent) was superior to V_2 (Parbhani) but on par with V_3 (Local) in dry matter yield.

Data in Table 14 show that the effect of phosphorus x nitrogen interaction was significant. The highest dry matter yield of 45.51 q/ha was obtained with the combination of P_2 (60 kg P_2O_5/ha) level of phosphorus and N_3 (120 kg N/ha) level of nitrogen, while lowest dry matter yield of 16.65 q/ha produced by the combination of P_0 (0 kg P_2O_5/ha) level of phosphorus and N_0 (0 kg N/ha) level of nitrogen fertilization.

The data in Table 14 further reveal that the requirement of phosphorus to bring about the similar amount of dry matter yield was higher in the absence of nitrogen, but it was lower with increase in the level of nitrogen. Thus, phosphorus and nitrogen have complementary effect in producing the dry matter yield of oats. The effect of nitrogen on dry matter yield was enhanced by phosphorus.

4. <u>Green forage yield :</u>

Data pertaining to green forage yield in quintals/ha as affected by different treatments are presented in Table 15 and graphically shown in Fig. 4.

The data reveal that the mean green forage yield was 152.0 q/ha under the conditions of this experiment.

Fig. 4

MEAN YIELD OF GREEN FORAGE AT HARVEST IN QUINTALS, AS AFFECTED BY DIFFERENT TREATMENTS.

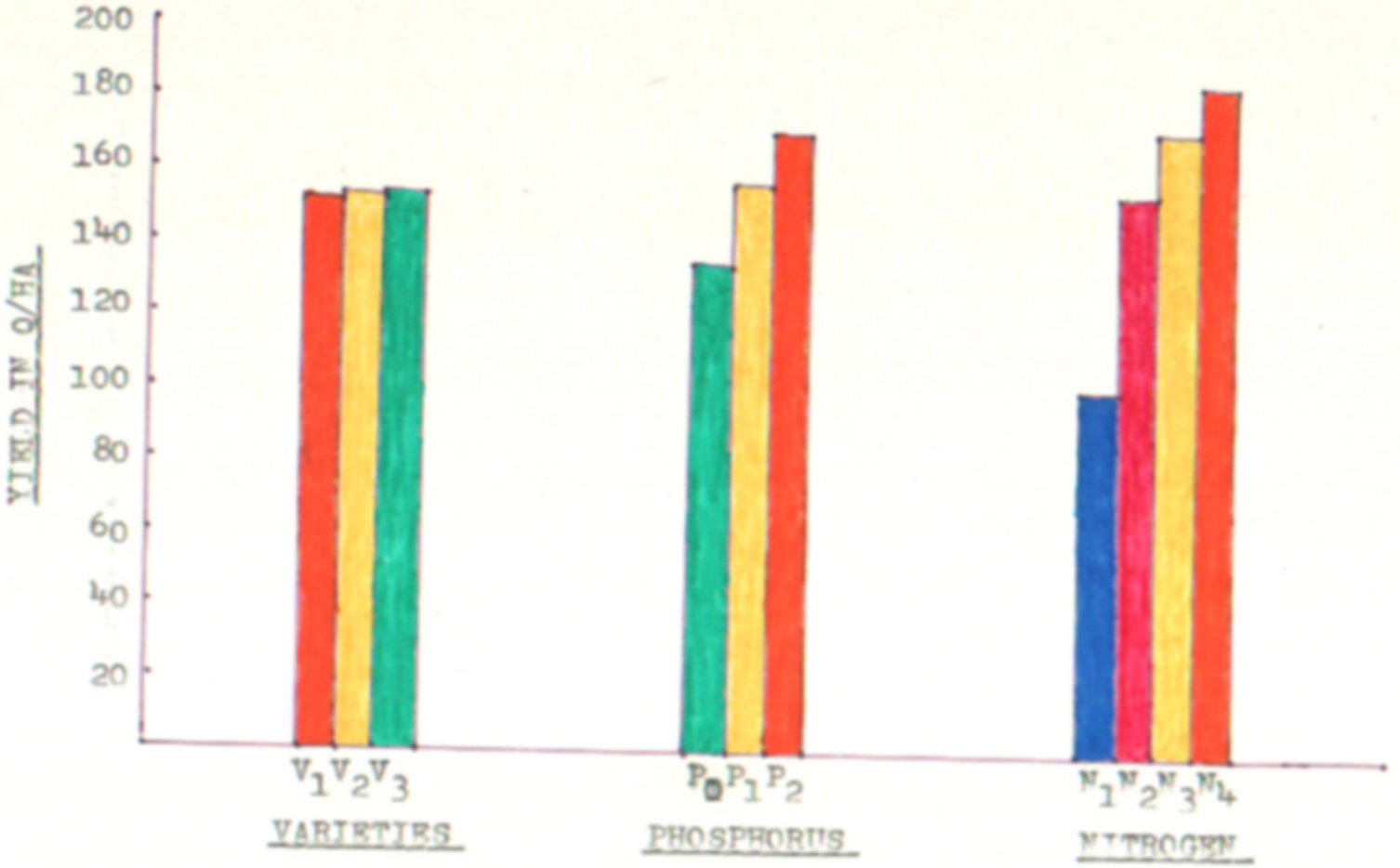


Table 15 : Mean yield of green forage at harvest in quintals per hectare as affected by different treatments.

Treatments	Mean yield of green forage q/h
1) Varieties	
i) Kent	151.2
ii) Parbhani	151.9
iii) Local	152.9
'F' test	N.S.
S.E. ±	2.500
C.D. at 5%	-
2) Phosphorus kg/ha	
i) 0	134.6
ii) 30	155.5
iii) 60	165.9
'F' test	Sigt.
S.E. ±	2.500
C.D. at 5%	7.296
3) Nitrogen kg/ha	
i) 0	100.2
ii) 40	156.9
iii) 80	167.5
iv) 120	183.4
'F' test	Sigt.
S.E. ±	1.950
C.D. at 5%	5.484
General mean	152.0

Sigt. = Significant. N.S. = Not significant.

Effect of varieties :

Data (Table 15) in respect of green forage yield/ha indicate that green forage yield was not significantly affected due to different varieties. The mean yield of green forage varied from 151.2 q/ha in case of variety Kent to 152.9 q/ha for local variety.

Effect of phosphorus :

Table 15 shows that increasing the levels of phosphorus fertilization significantly increased the green forage yield. The phosphorus application at 60 kg P_2O_5/ha was significantly superior over the other levels of phosphorus fertilization, and the phosphorus application at 30 kg P_2O_5/ha was superior to 0 kg P_2O_5/ha in producing green forage yield.

Effect of nitrogen :

Table 15 reveals that the green forage yield/ha was significantly influenced by different levels of nitrogen fertilization. Each increment of nitrogen produced significantly higher yield of green forage over that produced by the next lower level of nitrogen. The maximum green forage yield of 183.4 q/ha was obtained by application of 120 kg N/ha, which was significantly better than all other levels of nitrogen.

Interaction effects :

It is evident from Table 16 that the effect of interaction between varieties X phosphorus was significant.

Table 16 : Mean green forage yield at harvest in quintals/ha as affected by varieties x phosphorus fertilization interaction.

Varieties	Phosphorus kg/ha 0	30	60	Mean
1) Kent	130.8	141.0	181.8	151.2
11) Parbhani	132.9	164.1	158.9	151.9
111) Local	140.1	161.3	157.3	152.9
General mean	134.6	155.5	165.9	152.0

S.E. ± for VP : 4.33
C.D. at 5% for VP: 8.7.

Table 17 : Mean green forage yield at harvest in quintals/ha as affected by phosphorus x nitrogen fertilization interaction.

Phosphorus kg/ha	Nitrogen kg/ha 0	40	80	120	Mean
1) 0	84.31	142.5	154.3	157.4	134.6
11) 30	101.3	162.9	169.7	187.9	155.5
111) 60	115.0	165.4	178.6	204.9	165.9
General mean	100.2	156.9	167.5	183.4	152.0

S.E. ± for PN : 3.88
C.D. at 5% for PN : 7.80

In the case of the varieties x phosphorus interaction, the combination V_1 (Kent) and P_2 (60 kg P_2O_5/ha) level produced the highest green forage yield of 181.8 q/ha, while lowest green forage yield of 130.8 q/ha was produced by the variety V_1 (Kent) at Po (0 kg P_2O_5/ha) level. Variety Kent has responded to phosphorus application upto 60 kg P_2O_5/ha level. However, varieties Parbhani and Local have responded upto 30 kg P_2O_5/ha level only.

Table 17 shows that the phosphorus x nitrogen interaction produced highest green forage yield of 204.9 q/ha at the combination of P_2 (60 kg P_2O_5/ha) level of phosphorus and N_3 (120 kg N/ha) level of nitrogen, while lowest green forage yield of 84.31 q/ha produced by the combination of Po (0 kg P_2O_5/ha) and No (0 kg N/ha) level of nitrogen. Thus the data in Table 17 reveals that the effect of nitrogen fertilization is enhanced in the presence of phosphorus fertilization.

5. Chemical studies :

5.1 Phosphorus concentration in the plant :

Data regarding the phosphorus concentration in the plant as affected by different treatments are presented in Table 18. Data were not statistically analysed. Hence the inferences were drawn from mean values.

The data in respect of phosphorus concentration in the plant indicate that the mean phosphorus concentration of 0.638 was recorded at 60 days after sowing. At harvest

Table 18 : Mean per cent concentration of phosphorus in plant at 60 days and at harvest as affected by different treatments.

Treatments	Days after sowing	
	60	85 (at harvest)
1) Varieties		
i) Kent	0.643	0.744
ii) Parbhani	0.636	0.745
iii) Local	0.636	0.749
2) Phosphorus kg/ha		
i) 0	0.554	0.670
ii) 30	0.632	0.739
iii) 60	0.730	0.829
3) Nitrogen kg/ha		
i) 0	0.614	0.715
ii) 40	0.626	0.735
iii) 80	0.646	0.752
iv) 120	0.666	0.782
General mean	0.638	0.746

(85 days after sowing) the phosphorus content in plant increased to 0.746.

Effect of varieties :

Data in Table 18 shows that the phosphorus concentration in the oat varieties did not vary to a large extent. However, the Local variety was found to be slightly higher in phosphorus content as compared to other two varieties at harvest.

Effect of phosphorus :

Data in Table 18 indicate that with the increase in level of phosphorus application there was increase in the concentration of phosphorus in plants at both the crop growth stages.

Effect of nitrogen :

It can be observed from the data in Table 18 that with the increase in the level of nitrogen from 0 to 120 kg N/ha, there was increase in the concentration of nitrogen from 0.614 to 0.666 per cent and from 0.715 to 0.782 per cent at 60 days after sowing and at harvest respectively.

5.2 Uptake of phosphorus by the crop :

The data pertaining to mean uptake of phosphorus, in kg/ha, as affected by different treatments are presented in Table 19. Data were not statistically analysed. The inferences were based on mean values.

A reference to Table 19 indicates that the uptake of phosphorus increased from 15.51 at 60 days to 23.96 kg/ha at harvest.

Table 19 : Mean uptake of phosphorus in kg per hectare at 60 days and at harvest as affected by different treatments.

Treatments	Days after sowing 60	85 (At harvest)
1) Varieties		
i) Kent	15.75	22.25
ii) Parbhani	15.52	23.95
iii) Local	15.28	25.68
2) Phosphorus kg/ha		
i) 0	12.06	18.51
ii) 30	15.34	24.01
iii) 60	19.13	29.36
3) Nitrogen kg/ha		
i) 0	9.43	14.56
ii) 40	16.11	24.48
iii) 80	18.03	26.70
iv) 120	18.47	30.12
General mean	15.51	23.96

Effect of varieties :

The data in Table 19 clearly indicate that there were very negligible differences among the varieties in respect of uptake of phosphorus at 60 days of crop growth, while the differences were more at harvest. The variety V_2 (local) was found to remove maximum phosphorus than any other variety at harvest.

Effect of phosphorus :

Data in Table 19 show that the increasing levels of phosphorus application helped to increase the uptake of phosphorus by the crop at both the crop growth stages.

Effect of nitrogen :

Data in Table 19 clearly indicate that the increasing dose of nitrogen increased the uptake of phosphorus at both the crop growth stages. At 60 days after sowing, the increase in phosphorus uptake was only upto 80 kg N/ha application while at harvest, there was increase in phosphorus uptake even by increasing dose of nitrogen from 80 to 120 kg N/ha.

5.3 Nitrogen percentage in the plant :

Data regarding the percentage of nitrogen in the plant as affected by different treatments are given in Table 20. Data were not analysed statistically and the inferences were drawn from mean values.

The data reveal that the mean nitrogen per cent at 60 days after sowing was 2.572 and was decreased to 2.177 at 85 days after sowing (i.e. at harvest).

Table 20 : Mean percentage of nitrogen in plant at 60 days and at harvest as affected by different treatments.

Treatments	Days after sowing 60	85 (At harvest)
1) Varieties		
i) Kent	2.572	2.171
ii) Parbhani	2.572	2.179
iii) Local	2.573	2.183
2) Phosphorus kg/ha		
i) 0	2.556	2.008
ii) 30	2.573	2.241
iii) 60	2.588	2.284
3) Nitrogen kg/ha		
i) 0	2.173	1.960
ii) 40	2.272	2.004
iii) 80	2.594	2.050
iv) 120	3.252	2.697
General mean	2.572	2.177

Effect of varieties :

Data in Table 20 show that the variety V_3 (Local) was found to have slightly more nitrogen per cent at both the stages of crop growth while the variety V_1 (Kent) was observed to contain slightly lowest nitrogen per cent at both the stages of crop growth. However, it could be observed from Table 20 that there were very little differences among the varieties in respect of per cent nitrogen contained in the plant.

Effect of phosphorus :

Data in Table 20 show that the phosphorus concentration in plant increased progressively with increased level of nitrogen application at both the crop growth stages.

Effect of nitrogen :

Data in Table 20 indicate that the percentage of nitrogen in plants increased with the increased level of nitrogen application from 0 to 120 kg N/ha at both the crop growth stages.

5.4 Uptake of nitrogen :

Data regarding the uptake of nitrogen by the crop, in kg/ha as affected by different treatments are presented in Table 21. The data were not statistically analysed and the inferences were drawn from mean values.

A glance at the data would reveal that the uptake of nitrogen increased from 62.46 kg at 60 days after sowing to 69.94 kg/ha at harvest.

Table 21 : Mean uptake of nitrogen in kg per hectare at 60 days and at harvest as affected by different treatments.

Treatments	Days after sowing	
	60	85 ('t harvest)
1) Varieties		
i) Kent	62.99	64.94
ii) Parbhani	62.68	70.06
iii) Local	61.73	74.83
2) Phosphorus kg/ha		
i) 0	55.63	55.13
ii) 30	63.21	74.80
iii) 60	68.56	79.90
3) Nitrogen kg/ha		
i) 0	31.97	39.01
ii) 40	57.06	64.33
iii) 80	71.41	71.93
iv) 120	89.41	103.60
General mean	62.46	69.94

Effect of varieties :

Data in Table 21 show that the maximum uptake of 62.99 kg/ha nitrogen was observed in variety V_1 (Kent) at 60 days of crop growth while minimum uptake of 61.73 kg/ha nitrogen was found in variety V_3 (Local) at 60 days after sowing. However, maximum uptake of 74.83 kg/ha nitrogen was observed in variety V_3 (Local) at harvest, while minimum uptake of 64.94 kg/ha nitrogen was observed in variety V_1 (Kent) at harvest.

Effect of phosphorus :

The data in Table 21 show that the increased dose of nitrogen application from 0 to 60 kg P_2O_5/ha increased the uptake of phosphorus progressively at both the crop growth stages.

Effect of nitrogen :

Data in Table 21 indicate that with the increase in nitrogen level from 0 to 120 kg N/ha there was progressive increase in nitrogen uptake at both the crop growth stages. It may be pointed out that there was about threefold increase in nitrogen uptake by increasing the dose of nitrogen from 0 to 120 kg N/ha.

6. Nutritive value :

Nutritive value of fodder generally depends upon crude protein, crude fibre, total ash and nitrogen free extract content of the forage.

6.1 Crude protein :

Crude protein is an important constituent determining the nutritive value of fodder, hence crude protein content in oat fodder as affected by different treatments was estimated. The data pertaining to crude protein content and total uptake of crude protein at harvest are given in Table 22 and 23, respectively, and graphically shown in Fig. 5. The data were not statistically analysed and the inferences were drawn from the mean values.

The data in respect of crude protein (Table 22) reveal that the highest crude protein content of 16.09 per cent was recorded at 60 days crop growth which decreased to 13.61 per cent at harvest.

Effect of varieties :

Table 22 shows that the per cent crude protein contents in oat varieties V_1 (Kent) and V_2 (Parbhani) were lower than the variety V_3 (Local) at both the stages of crop growth, although the differences were smaller in magnitude.

Effect of phosphorus :

Table 22 shows that the crude protein content in oats increased from 15.98 per cent to 16.18 per cent when 60 kg P_2O_5/ha was applied than when no phosphorus was applied. At harvest, these values were 12.55 per cent and 14.28 per cent for 0 and 60 kg P_2O_5/ha, respectively.

Effect of nitrogen :

The data in Table 22 indicates that increasing levels

Fig. 5

MEAN PERCENTAGE OF CRUDE PROTEIN IN PLANT AT 60 DAYS AFTER SOWING AND AT HARVEST AS AFFECTED BY DIFFERENT TREATMENTS.

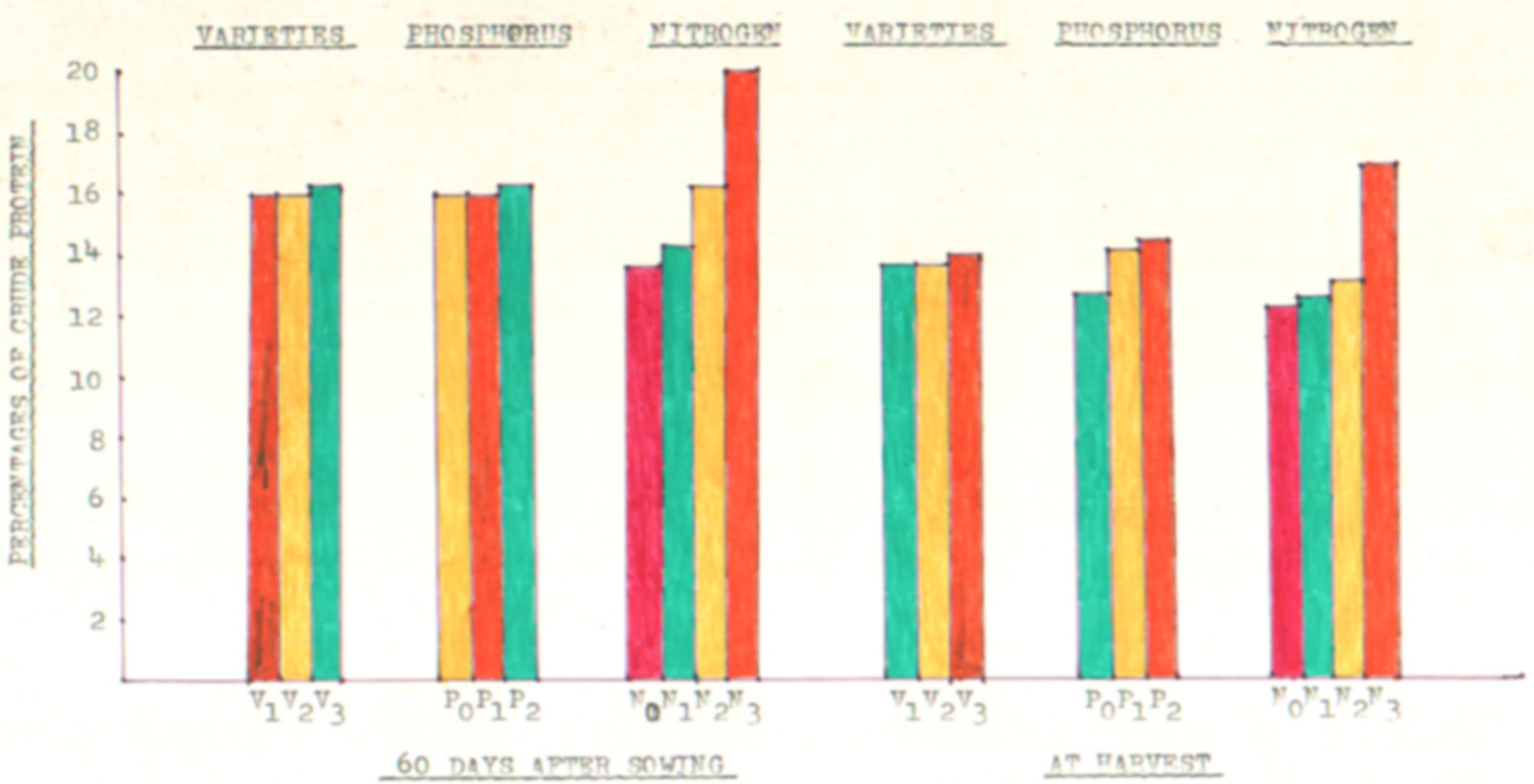


Table 22 : Mean percentage of crude protein in plant at 60 days after sowing and at harvest as affected by different treatments.

Treatments	Days after sowing	
	60	85 (At harvest)
1) Varieties		
i) Kent	16.08	13.57
ii) Parbhani	16.08	13.62
iii) Local	16.09	13.65
2) Phosphorus kg/ha		
i) 0	15.98	12.55
ii) 30	16.08	14.01
iii) 60	16.18	14.28
3) Nitrogen kg/ha		
i) 0	13.59	12.33
ii) 40	14.20	12.35
iii) 80	16.21	12.87
iv) 120	20.33	16.91
General mean	16.08	13.61

of nitrogen fertilization progressively increased the crude protein content in oat plant at 60 days. However, the differences in crude protein content at harvest were smaller in magnitude upto 80 kg N/ha were appreciable at 120 kg N/ha level.

6.2 Crude protein yield :

Data pertaining to crude protein yield in q/ha as affected by different treatments are presented in Table 23.

A glance at the data reveals that the mean crude protein yield was 4.49 q/ha.

Effect of varieties :

Table 23 shows that the highest crude protein yield of 4.75 q/ha was produced in variety V_3 (Local) followed by 4.54 q/ha in V_2 (Parbhani), 4.19 q/ha in V_1 (Kent). The differences in crude protein yield were however, statistically non-significant.

Effect of phosphorus :

Data in Table 23 indicate that increasing the level of phosphorus fertilization increased the crude protein yield. The difference between 0 kg and 30 kg P_2O_5/ha was significant but that between 30 kg and 60 kg P_2O_5/ha was non-significant.

Effect of nitrogen :

Table 23 shows that the application of 120 kg N/ha significantly increased the crude protein yield/ha over other levels under investigation. However, the difference

Table 23 : Mean yield of crude protein in quintals per hectare at harvest as affected by different treatments.

Treatments	Crude protein yield
1) Varieties	
i) Kent	4.19
ii) Parbhani	4.54
iii) Local	4.75
'F' test	N.S.
S.E. ±	0.188
C.D. at 5%	-
2) Phosphorus kg/ha	
i) 0	3.48
ii) 30	4.81
iii) 60	5.19
'F' test	Sigt.
S.E. ±	0.188
C.D. at 5%	0.548
3) Nitrogen kg/ha	
i) 0	2.48
ii) 40	4.20
iii) 80	4.58
iv) 120	6.70
'F' test	Sigt.
S.E. ±	0.295
C.D. at 5%	0.830
General mean	4.49

Sigt. = Significant. N.S. = Not significant.

between 40 kg and 80 kg N/ha levels was non-significant and difference between 0 kg and 40 kg N/ha was significant.

6.3 Crude fibre :

Data in respect of crude fibre content at harvest as influenced by different treatments are presented in Table 24 and graphically shown in Fig. 6. The data were not statistically analysed and the inferences were drawn on the basis of mean values.

A reference to Table 24 indicates that the crude fibre content of oat forage at harvest increased from 28.80 per cent, at 60 days, to 30.70 per cent, at harvest.

Effect of varieties :

Table 24 shows that the crude fibre content was the highest in oat variety V_3 (Local) and was the lowest in variety V_2 (Parbhani), at both the growth stages.

Effect of phosphorus :

Data in Table 24 show that increasing the level of phosphorus fertilization substantially decreased the crude fibre content of oat forage, at both the growth stages.

Effect of nitrogen :

Table 24 shows that the crude fibre content of oat forage decreased with increase in the levels of nitrogen fertilization at both the growth stages.

6.4 Total ash :

Data regarding total ash content of oat forage as affected by different treatments are presented in Table 25.

Fig. 6

MEAN PERCENTAGE OF CRUDE FIBRE AT 60 DAYS AFTER SOWING AND AT HARVEST AS INFLUENCED BY DIFFERENT TREATMENTS.

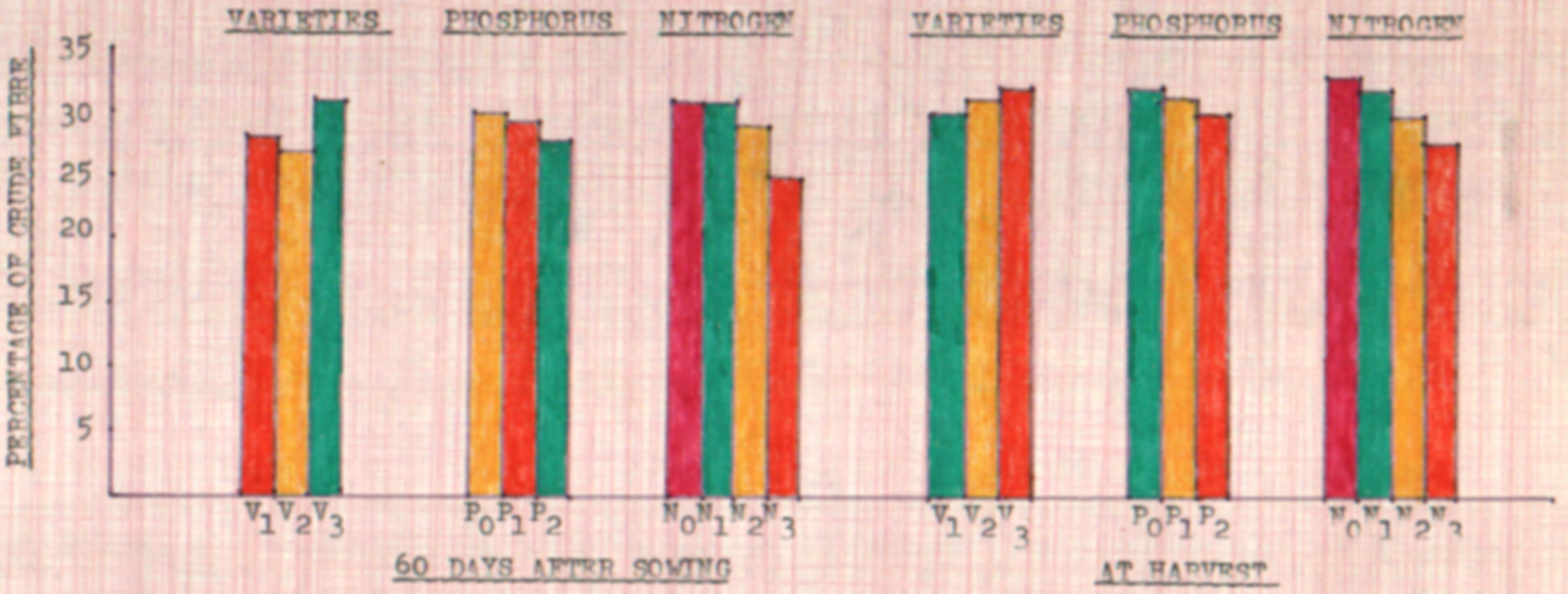


Table 24 : Mean percentage of crude fibre at 60 days after sowing and at harvest as influenced by different treatments.

Treatments	Days after sowing	
	60	85 (At harvest)
1) Varieties		
i) Kent	28.10	29.90
ii) Parbhani	27.10	30.80
iii) Local	30.70	31.60
2) Phosphorus kg/ha		
i) 0	29.80	31.90
ii) 30	28.90	30.60
iii) 60	27.80	29.90
3) Nitrogen kg/ha		
i) 0	31.10	32.60
ii) 40	30.50	31.50
iii) 80	28.50	30.30
iv) 120	25.20	28.40
General mean	28.80	30.70

Table 25 : Mean percentage of total ash in oat fodder at 60 days after sowing and at harvest, as affected by different treatments.

Treatments	Days after sowing	
	60	85 (At harvest)
1) Varieties		
i) Kent	6.50	4.90
ii) Parbhani	6.70	4.70
iii) Local	6.60	4.80
2) Phosphorus kg/ha		
i) 0	6.30	4.20
ii) 30	6.50	4.90
iii) 60	6.80	5.40
3) Nitrogen kg/ha		
i) 0	6.20	4.10
ii) 40	6.50	4.40
iii) 80	6.70	5.10
iv) 120	7.00	5.60
General mean	6.80	4.80

The data were not statistically analysed and the inferences were drawn from mean values.

A reference to Table 25 indicates that the mean total ash content was 6.60 per cent and 4.80 per cent at 60 days and at harvest, respectively.

Effect of varieties :

Total ash content was the highest in variety V_2 (Parbhani) being 6.70 per cent and was the lowest in variety V_1 (Kent) being 6.50 per cent, at 60 days while total ash content was the highest in variety V_1 (Kent) being 4.90 per cent and the lowest in variety V_2 (Parbhani) being 4.70 per cent, at harvest (Table 25).

Effect of phosphorus :

The data in Table 25 indicate that the increasing the levels of phosphorus fertilization increased the total ash content of oat forage at both the growth stages.

Effect of nitrogen :

It is evident from data in Table 25 that the total ash content of oat forage increased with each increase in the level of phosphorus fertilization at both the growth stages.

6.5 Nitrogen-free extract :

Data regarding the content of nitrogen-free extract in oat forage as affected by different treatments are given in Table 26. The data were not statistically analysed and the inferences were drawn from mean values.

Table 26 : Mean percentage of nitrogen free extract in oat fodder at 60 days after sowing and at harvest as affected by different treatments.

Treatments	Days after sowing	
	60	85 (At harvest)
1) Varieties :		
i) Kent	44.52	50.23
ii) Parbhani	45.32	49.48
iii) Local	41.81	48.55
2) Phosphorus kg/ha		
i) 0	42.42	47.02
ii) 30	43.72	49.09
iii) 60	45.12	49.95
3) Nitrogen kg/ha		
i) 0	44.31	50.35
ii) 40	44.00	50.33
iii) 80	43.79	49.57
iv) 120	42.67	47.69
General mean	43.88	49.42

The data in respect of nitrogen-free extract reveal that the highest content of nitrogen-free extract in oat forage was observed at harvest.

Effect of varieties :

The data in Table 26 indicate that the oats variety V_1 (Kent) analysed the highest for nitrogen free extract at harvest while the variety V_2 (Parbhani) analysed the maximum per cent nitrogen-free extract at 60 days.

Effect of phosphorus :

Data in Table 26 show that the percentage of nitrogen-free extract content in oat forage increased with each higher levels of phosphorus fertilization at both the growth stages.

Effect of nitrogen :

The data from Table 26 reveal that increasing levels of nitrogen-fertilization decreased the per cent nitrogen-free extract content in oat forage at both the growth stages.

CHAPTER V

DISCUSSION

CHAPTER V

DISCUSSION

The results of the current investigation reported in the previous chapter are discussed in this chapter.

1. Soil, weather and crop development :

A reference to Table 1 indicates that the soil of the experimental plot was clayey in texture with fairly optimum supply of nitrogen, available phosphorus and available potash.

The oat crop was sown on 10th October, 1973. The mean maximum temperature during the entire growth period ranged from 22.2°C to 34.6°C while the mean minimum temperature ranged from 15.7°C to 28.2°C.

It is evident from Table 6 that the plant population at harvest on an average was 400.2 per square metre. The effect of different treatments on plant population was found to be nonsignificant indicating uniform plant population at harvest.

In order to get an idea about the general performance of the oat crop under soil and environmental conditions of Rahuri, the general means of the important growth, yield contributory characters, green forage yield and nutritive value of forage were studied. The data in Table 7 show that the oat plant attained the mean maximum height of 84.42 cm at harvest. It had, on an average 5.51 tillers at harvest (Table 8). Table 9 shows that the functional leaf number per plant was found to be 15.56 at 60 days which was decreased

to 13.33, at harvest. The leaf:stem ratio and percentage of dry matter at harvest was 0.92 and 21.09, respectively (Table 10 and 11). It would be observed from the Table 12 that the mean yield of dry matter was 32.11 q/ha. Table 15 indicates that the overall mean yield of green forage was 152.0 q/ha.

It is evident from Table 18 that the per cent concentration of phosphorus in plant at harvest on an average was 0.746 per cent. The data in Table 19 show that the uptake of phosphorus increased from 15.51 kg/ha at 60 days to 23.96 kg/ha at harvest. Table 20 shows that the mean percentage of nitrogen in plant 60 days after sowing was 2.572 and was decreased to 2.177 at harvest. It is evident from Table 21 that the uptake of nitrogen increased from 62.46 at 60 days after sowing to 69.94 kg/ha at harvest.

The data in respect of crude protein (Table 22) show that the crude protein per cent at harvest was 13.61. The data in Table 23 indicate that the mean crude protein yield/ha was 4.49. Table 24 in respect of crude fibre shows that the mean per cent of crude fibre at harvest was 30.70. The data presented in Table 25 show that the maximum content of total ash of 6.60 per cent was observed at 60 days. The data in respect of nitrogen-free extract (Table 26) show that the nitrogen-free extract per cent at harvest was 49.69.

2. Effect of varieties :

It was observed from Table 7 that the oats variety Local, attained maximum height of 86.02 cm, though the

varieties showed non-significant differences in respect of height.

The data pertaining to mean number of tillers per plant (Table 8) revealed that the varieties did not differ significantly in respect of tillers per plant but data clearly indicate that the oat variety Local produced maximum number of tillers, such as, 5.56 tillers per plant. Generally, the apical meristem is responsible for linear growth.

The data presented in Table 9 show that the variety Local produced maximum number of functional leaves per plant at 60 days, i.e. 16.38 followed by the variety Kent and Parbhani. The differences in the number of functional leaves per plant due to different varieties were non-significant at all the growth stages. At harvest, the mean number of functional leaves decreased due to drying of lower leaves as a result of senescence.

The data in respect of mean leaf:stem ratio (Table 10) show significant differences among the varieties at 30 days and at 60 days. Variety Parabhani produced significantly higher leaf:stem ratios of 1.68 and 1.66 at 30 days and 60 days, respectively. The leaf:stem ratio of 1.12 was produced by the oat variety Kent, which was not significantly different at harvest from those of other two varieties. It would be observed from Table 10 that the leaf:stem ratio decreased with the advanced stage of crop growth. This is

due to the reduced number of functional leaves per plant. With the advanced growth the mean number of functional leaves decreased due to drying of lower leaves as a result of senescence. The ratio might have also been lowered due to translocation of photosynthate from leaves to stem.

Significant differences among the varieties in respect of dry matter content at 60 days and at harvest were observed. The variety Local produced maximum dry matter of 22.40 per cent, followed by the varieties Parbhani with 20.95 per cent, and Kent, with 19.91 per cent of dry matter. The higher dry matter content resulted in more dry matter yield/ha.

The variety Local produced maximum dry matter yield of 34.28 q/ha. Variety Kent produced 29.91 q/ha and Parbhani 32.15 q/ha of dry matter yield. This is because of the variety Local had maximum dry matter content of 22.40 per cent as compared to variety Kent with 19.9 per cent and Parbhani with 20.95 per cent.

Table 13 shows that the variety Kent produced highest yield of 39.12 q/ha dry matter with the application of 60 kg P_2O_5/ha while it produced lowest yield of 25.25 q/ha with the application of 0 kg P_2O_5/ha. This is probably because variety Kent's requirement of phosphorus is higher and it suffers at low level of phosphorus and responds better at high levels. Whereas the requirement of phosphorus of oat variety Local is small as would be seen from the relatively

better response at no phosphorus level.

In the case of phosphorus x nitrogen interaction (Table 14) the highest dry matter yield of 45.51 q/ha was observed with the combination of 60 kg P_2O_5/ha and 120 kg N/ha while lowest yield of 16.65 q/ha was observed at the combination of 0 kg P_2O_5/ha and 0 kg N/ha. The data (Table 14) shows that the application of 60 kg P_2O_5/ha and 120 kg N/ha was in proper balance.

Nitrogen and phosphorus are complementary to each other. The requirement of one is more with the supply of the other nutrient. The response to nitrogen increased with the increase in the level of phosphorus. It is well established fact that phosphorus stimulates root development. Better root development is essential with the increase in the level of nitrogen fertilization to meet the increased demand for moisture and nutrients with the increased vegetative growth favoured by nitrogen. With lower availability of phosphorus, the root development would hamper and the response to higher level of nitrogen fertilization would be limited. Thus, nitrogen and phosphorus behave complementary to each other by affecting above ground and underground development of plants, respectively.

The data in respect of green forage yield (Table 15) shows non-significant differences among varieties. The data (Table 15) shows that the variety Local produced green forage yield of 152.9 q/ha followed by 151.9 and 151.2 q/ha

in the variety Parbhani and Kent respectively. This indicates that the varieties do not differ much from each other in their genetic make up which is reflected in their performance under the set of conditions of this experiment, at least.

In the case of varieties x phosphorus interaction (Table 16) the variety Kent produced highest green forage yield of 181.8 q/ha with the application of 60 kg P_2O_5/ha while lowest green forage yield of 130.8 q/ha was produced at 0 kg P_2O_5/ha. This might be because of higher requirement as well as better assimilation of phosphorus by the variety Kent.

The data in respect of phosphorus x nitrogen interaction (Table 17) indicate that highest green forage yield of 204.9 q/ha, was produced by the combination of 60 kg P_2O_5/ha and 120 kg N/ha while lowest green forage yield of 84.31 q/ha was produced by the combination of 0 kg P_2O_5/ha and 0 kg N/ha. Table 17 indicate that the application of 60 kg P_2O_5/ha and 120 kg N/ha was proper for highest green forage production. The data regarding green forage yield and dry matter yield are in agreement with each other as far as the responses to nitrogen and phosphorus fertilization to oats are concerned.

In all the growth contributory characters the oat variety local was found to be superior over those of Kent and Parbhani.

The data in Tables 18, 19, 20 and 21 show that at 60 days after sowing, varieties did not differ very much in phosphorus and nitrogen concentration in plant. However, at harvest, Local variety appeared to contain more phosphorus and nitrogen as compared to other varieties.

The data in respect of crude protein (Table 22) show that the variety local contained slightly higher crude protein of 16.09 per cent than the varieties Kent and Parbhani, containing 16.08 per cent of crude protein at 60 days. Table 22 clearly indicate that the per cent crude protein decreased from 16.08 to 13.61 with advancing maturity of crop. In case of variety Local the per cent crude protein decreased from 16.09 to 13.65 while it was decreased from 16.08 to 13.57 in case of Kent and 16.08 to 13.62 in case of Parbhani. This is because of more concentration of nitrogen was observed in the plant at 60 days and the nitrogen concentration was decreased at later stages. This indicates that the uptake of nitrogen by oats was negligible after 60 days growth stage. The reduction in the percentage of crude protein after this stage could be attributed to the attenuation effect due to continued addition of photosynthate by the active leaves even after 60 days. Data in Table 11 supports this statement as could be seen by about 30 per cent increase in the dry matter of oats during period from 60 to 85 days. Table 23 shows that the variety local produced maximum yield of 4.75 q/ha crude protein. The minimum yield

of 4.19 q/ha crude protein was observed in the variety Kent. The higher nitrogen concentration in plant is responsible for higher crude protein content and higher dry matter yield is responsible for higher protein yield/ha.

The data pertaining to mean percentage of crude fibre (Table 24) indicate that mean crude fibre in the plant at 60 days and at harvest was highest in the oats variety local as compared to other varieties.

The data presented in Table 25 revealed that the variety local contained higher total ash, 6.60 per cent, while the variety Kent contained lower amount of total ash i.e. 6.50 per cent, at 60 days. Table 25 shows that the per cent total ash decreased from 6.60 to 4.80 with advancing maturity of crop. This reduction in the total ash content in oats from 60 days to 85 days stage of growth may be attributed to relatively reduced uptake of minerals by the plant after heading stage and continued addition of carbohydrates due to photosynthetic activity. The data regarding the nitrogen-free extract (Table 26) shows that the mean percentage of nitrogen-free extract, in general, showed higher values 50.23 in the variety Kent while lower values 48.55 were observed in the variety local, at harvest. Similarly, at 60 days the variety Parbhani showed higher values 45.32 while the variety local showed lower values 41.81

It was thus observed that in oat variety local, the concentration of crude protein and crude fibre content

showed higher values against lower percentage of nitrogen-free extract than other varieties.

3. Effect of phosphorus :

The data presented in Table 7 indicate that the plant height increased with each increased level of phosphorus fertilization at 30, 60 days and at harvest. Application of 60 kg P_2O_5/ha produced maximum height (88.27 cm) while minimum height (79.29 cm) was produced with no phosphorus fertilization. Phosphorus is an essential element for plants. In the absence of phosphorus the growth of the roots gets usually stunted which, in turn affect the shoot growth. Therefore, the plant height was higher at 60 kg P_2O_5/ha level as compared to the height at no phosphorus fertilization.

The data in respect of tillers per plant (Table 8) clearly shows that there was non-significant difference among the different levels of phosphorus fertilization. Table 8 shows that the number of tillers per plant increased with increased dose of phosphorus fertilization at both the growth stages. The maximum number of 5.65 tillers was observed at 60 kg P_2O_5/ha level while minimum number of 5.39 tillers was recorded at 0 kg P_2O_5/ha level. Application of phosphorus is beneficial for root development. Due to the best root development plant is able to absorb more nutrients. Therefore, there is good growth of plant and ultimately more number of tillers are produced by the plant, as tillering is a function of nutrient status in the plant.

The data in respect of number of functional leaves (Table 9) indicate that there was non-significant difference among the different levels of phosphorus fertilization. Table 9 shows that the number of leave per plant increased with increased level of phosphorus fertilization at 30 and 60 days of crop growth while it was decreased at harvest due to drying of lower leaves as a result of senescence. The higher number of leaves (16.02) was recorded at 60 kg P_2O_5/ha level while lower number of leaves (15.17) was recorded at 0 kg P_2O_5/ha at 60 days. Phosphorus is closely related to cell division and development. In the case of 60 kg P_2O_5/ha level, there is more absorption of phosphorus by the plants which may be responsible for better cell division which presumably resulted in higher number of leaves.

The data in respect of leaf:stem ratio (Table 10) reveal that there was significant difference, at 30 days, due to different levels of phosphorus fertilization, while the differences were non-significant at later stages. It would be observed from the Table 10 that the leaf:stem ratio decreased with the advancing crop growth. This is due to reduction in the number of functional leaves per plant at later stage of growth. The highest 1.09 leaf:stem ratio was observed at 60 kg P_2O_5/ha level while lowest 0.73 leaf:stem ratio was recorded at 0 kg P_2O_5/ha level. This implies that the senescence of leaves was delayed by phosphorus fertilization.

The data pertaining to mean percentage of dry matter (Table 11) show that the per cent dry matter increased with increased dose of phosphorus application as well as advancement in maturity of the crop. The maximum dry matter content of 21.04 per cent was observed at 60 kg P_2O_5/ha level while the minimum dry matter content of 20.69 per cent was observed at 0 kg P_2O_5/ha level. These findings can also be discussed in line with those for leaf:stem ratio. One could visualise this effect of phosphorus as it is responsible for root development and thus for the development of shoots and ultimately for dry matter production.

Table 12 also shows that the dry matter yield/ha increased with increased level of phosphorus fertilization. The dry matter yield increased from 27.63 q/ha to 35.81 q/ha. Similar trend was also observed in respect of green forage yield/ha (Table 15). These results were in confirmity with those obtained by Tomer and Singh (1967) and Tomer (1969). Table 15 shows that green forage yield increased from 134.6 q/ha to 165.9 q/ha, with increased (0 to 30 kg P_2O_5/ha) level of phosphorus fertilization.

The data in Tables 18, 19, 20 and 21 showed that the phosphorus concentration in plant and the uptake of phosphorus increased with the increase in the level of phosphorus from 0 to 60 kg P_2O_5/ha. Similarly with the increase in the dose of nitrogen from 0 to 120 kg N/ha, nitrogen concentration in plant and the uptake of nitrogen also increased

Data pertaining to mean percentage of crude protein and crude protein yield/ha (Table 22 and 23) show that increased level of phosphorus application helped to enhance the crude protein content as well as protein yield/ha. Similar results were also reported by Burriel et al (1951) and Tomer (1969). Table 22 clearly indicates that highest crude protein of 16.18 per cent was observed at 60 kg P_2O_5/ ha level at 60 days of crop growth, while it decreased upto 14.28 per cent at harvest. Similarly, highest 15.98 per cent crude protein was recorded at 60 days at 0 kg P_2O_5/ha, and it decreased to 12.55 per cent at harvest. Table 23 shows that the maximum yield of 5.19 q/ha crude protein was observed at 60 kg P_2O_5/ha level and minimum yield of 3.48 q/ha was observed at 0 kg P_2O_5/ha level. Table 24 shows that the mean crude fibre content decreased with increase in the level of phosphorus fertilization at both the stages of crop growth. Table 24 clearly indicates that the maximum percent of 29.80 crude fibre was observed at 60 days at 0 kg P_2O_5/ha level and it increased upto 31.90 per cent, at the same level, at harvest. Similarly, minimum crude fibre content of 27.80 per cent was observed at 60 days at 60 kg P_2O_5/ha level and it increased upto 29.90 per cent, at the same level, at harvest. The data in respect of mean percentage of total ash (Table 25) clearly indicate that the mean percentage of total ash increased with each increase in the level of phosphorus. Similar results are also reported

by Murriel et al (1951) and Tomer (1969). Table 21 indicates that the higher percentage of 6.80 of total ash was observed at 60 kg P_2O_5/ha level while less percentage of 6.30 total ash was observed at 0 kg P_2O_5/ha level, at 60 days. Similarly, at harvest, highest per cent of 5.40 of total ash was found at 60 kg P_2O_5/ha and lowest per cent of 4.20 of total ash was found at 0 kg P_2O_5/ha level. The data in respect of mean percentage of nitrogen-free extract (Table 26) show that the nitrogen-free extract increased with each increment of phosphorus fertilization. The nitrogen-free extract increased from 42.02 to 49.95 increase in levels of phosphorus fertilization from 0 to 60 kg P_2O_5/ha.

The overall effect of phosphorus application could be judged on the chemical composition of the plant. It was observed that with increase in the phosphorus level there was improvement in the nutritive value of fodder. These studies clearly show that phosphorus fertilization not only improved the growth, yield contributory characters and yield but also improved the nutritive value of green forage as judged by crude protein, crude fibre, ash, nitrogen-free extract content.

4. Effect of nitrogen :

It would be observed from Table 7 that the plant height gave significant response to nitrogen fertilization in all the stages of crop growth. Table 7 indicates that the plant height increased significantly with each

increase in the dose of nitrogen application. Application of 120 kg N/ha produced maximum height of 106.7 cm at harvest, while minimum plant height of 61.14 cm was produced by 0 kg N/ha level. It is an established fact that nitrogen increases plant growth by cell elongation and cell division both in turn enhancing cell multiplication thereby increasing plant height. Nitrogen being an important constituent of protein which constitute a major portion of plant cell components, is also responsible for growth in terms of cell multiplication.

In case of mean number of tillers per plant (Table 8) a significant response to nitrogen fertilization at all the stages of crop growth was observed. Application of 120 kg N/ha produced maximum number of 6.31 tillers per plant while minimum number of 4.64 tillers per plant was observed at 0 kg N/ha level.

The data in respect of number of functional leaves (Table 9) indicate a significant response to nitrogen fertilization at all the stages of crop growth. The maximum number of 19.21 leaves was observed at 120 kg N/ha level while minimum number of 11.69 leaves was observed at 0 kg N/ha level. Nitrogen is a basic constituent of life. It promotes the vegetative growth. Therefore, higher number of leaves was observed in the case of 120 kg N/ha level. The number of leaves at harvest was decreased than what it was at 60 days. It is because of drying of leaves as a result of senescence of older leaves.

The data in respect of leaf:stem ratio (Table 10) indicate that the leaf:stem ratio was significantly increased by different levels of nitrogen fertilization except at harvest. Table 10 revealed that the leaf:stem ratio was increased from 0.87 to 0.97 with increased (0 to 120 kg N/ha) level of nitrogen fertilization. The leaf:stem ratio decreased with advancing crop maturity. This is because of drying of lower leaves due to senescence.

The data pertaining to mean percentage of dry matter (Table 11) show that the dry matter content significantly increased with each increase in the dose of nitrogen application at 60 days. At harvest, the results were however, nonsignificant. Application of 120 kg N/ha produced maximum dry matter of 21.56 per cent, at harvest followed by 80, 40 and 0 kg N/ha with 21.46, 21.01 and 20.33 per cent dry matter respectively.

The data in Table 12 show that dry matter yield/ha increased with each increased level of nitrogen fertilization. The dry matter yield/ha increased from 20.36 q/ha to 38.91 q/ha with increased level of nitrogen fertilization from 0 to 120 kg N/ha. This is because of increased dry matter content as well as green forage yield with the increased level of nitrogen fertilization.

The data in Table 15 show that application of 120 kg N/ha produced maximum yield of 183.4 q/ha green forage. This is because more number of tillers and functional

leaves per plant were produced with increase in level of nitrogen. Since green forage yield is the result of these two yield contributing characters which have been observed to increase with increased levels of nitrogen, the green forage yield would also naturally be expected to increase with increased levels of nitrogen.

It was observed that the phosphorus and nitrogen content in plant and uptake of these two elements increased with the increase in the level of nitrogen from 0 to 120 kg N/ha (Tables 18, 19, 20 and 21).

In respect of nutritive value studies, the increase in the application of nitrogen from 0 to 120 kg N/ha resulted in the increase of the crude protein content at 60 days from 13.59 to 16.21 per cent. Table 22 indicates that the crude protein content decreased from 16.08 to 13.61 per cent with advancement in maturity of the crop. This is because of more concentration of nitrogen was observed at 60 days of crop growth, at later stage the nitrogen concentration in plant decreased substantially due to dilution effect of increased photosyntates, some physiologic activities, therefore the crude protein per cent also decreased ultimately at later stage of crop growth. Similar trend was observed in the case of protein yield/ha (Table 23). Bokde (1968) concluded that the application of higher doses of nitrogen improved the crude protein content of oat fodder over lower doses of nitrogen

application. Table 23 indicates that crude protein yield increased from 2.48 q/ha to 6.70 q/ha with the increased (0 to 120 kg N/ha) level of nitrogen application. It was observed that crude fibre content of oat plant decreased from 32.60 to 28.40 per cent with increased (0 to 120 kg N/ha) level of nitrogen fertilization, at harvest. The total ash content of the oats fodder, however, increased from 4.10 to 5.60 per cent with increased (0 to 120 kg N/ha) level of nitrogen fertilization (Table 25). The data in respect of nitrogen-free extract (Table 26) indicate that the percentage of nitrogen-free extract in oat plants, at harvest, decreased from 50.35 per cent to 47.69 per cent with increased level of (0 to 120 kg N/ha) level of nitrogen fertilization.

The overall effects of nitrogen could be judged from the chemical composition of the plant. It was observed that with increase in the level of nitrogen fertilization, there was improvement in the nutritive value of fodder. These studies clearly demonstrated that nitrogen fertilization not only enhanced the growth, yield contributory characters and final yield of green forage of oats but also improved the nutritive value through increase in the concentration of crude protein and total ash in plant tissues and through decrease in the percentage of crude fibre and nitrogen free extract.

CHAPTER VI

SUMMARY

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SUMMARY

An agronomic experiment to study the comparative performance of oats (*Avena sativa* L.) varieties under different levels of phosphorus and nitrogen fertilisation was conducted during the *rabi* season of 1973 in the "C" block, Central Campus Farm, Mahatma Phule Krishi Vidyapeeth, (Agricultural University), Rahuri, Maharashtra.

The experiment was laid in a split plot design with four replications. The main plot treatments consisted of combinations of three varieties (Kent, Parbhani and local) and three phosphorus levels (0, 30 and 60 kg P_2O_5/ha). The sub-plot treatments comprised of four nitrogen levels (0, 40, 80 and 120 kg N/ha). There were in all 36 treatment combinations. Besides the yield data and nutritive value of the forage, periodical observations were recorded to evaluate the treatment effects on growth and yield contributory characters. The important findings are summerised below :

1) Studies in respect of oat varieties revealed that the oat variety ' local ' showed better performance in growth contributory characters such as height, tillers and leaf number though not significantly over those of varieties ' Kent ' and ' Parbhani '. The per cent dry matter was also more in this variety.

2) Increase in the level of phosphorus fertilisation showed beneficial effect on growth contributory characters

such as height, tillers, leaf number and per cent dry matter content. The plant height increased significantly with increasing levels of phosphorus fertilization. All the yield contributory characters improved with increasing levels of phosphorus fertilization, though not significantly.

3) Nitrogen application produced beneficial effects on the plant height, number of tillers, leaf number, leaf:stem ratio and dry matter percentage. In general, all these characters had higher values due to increasing levels of nitrogen fertilization. Increased levels of nitrogen fertilization significantly increased the plant height, number of tillers, number of functional leaves. However, leaf:stem ratio was not influenced significantly. Similarly, the per cent dry matter was affected significantly, at 60 days, while differences were nonsignificant at harvest.

4) The variety, ' Local ' produced the highest green forage yield and dry matter yield i.e. 152.9 q/ha and 34.28 q/ha, respectively, though not significantly.

5) The green forage yield/ha ~~= dry matter yield/ha~~ increased significantly with increasing levels of phosphorus fertilization. The maximum green forage yield of 165.9 q/ha and dry matter yield of 35.81 q/ha were obtained with the application of 60 kg P_2O_5/ha, while minimum green forage yield of 134.6 q/ha and dry matter yield of 27.63 q/ha were obtained in the control, i.e. 0 kg P_2O_5/ha.

6) Increased levels of nitrogen fertilization significantly increased the green forage yield/ha and dry matter yield/ha. The highest green forage yield of 183.4 q/ha and dry matter yield of 38.91 q/ha were produced with the application of 120 kg N/ha, while the lowest green forage yield of 100.2 q/ha and dry matter yield of 20.36 were produced with no nitrogen fertilization.

7) Varieties did not differ in concentration of P_2O_5 and N in plant at 60 days after sowing. At harvest there was more uptake of P_2O_5 as well as nitrogen by local variety. It was observed that the phosphorus and nitrogen concentration in plant and the uptake of P_2O_5 and N per hectare increased with the increase in dose of phosphorus and nitrogen.

8) The variety local contained higher percentage of crude protein and crude fibre ~~and total ash~~. Similarly, this variety produced maximum crude protein yield/ha through the variety ' Parbhani ' produced more nitrogen-free extract at 60 days, while variety ' Kent ' produced higher percentage of nitrogen-free extract, at harvest.

9) The percentages of crude protein, nitrogen-free extract and total ash increased with increasing levels of phosphorus fertilization, while crude fibre percentage decreased with increasing levels of phosphorus fertilization. The crude protein yield/ha also increased significantly with increased level of phosphorus application.

10) The percentages of crude protein and total ash increased with each increase in the level of nitrogen fertilization, while crude fibre percentage and nitrogen-free extract decreased with the increase in the level of nitrogen fertilization.

From all above summerized points, it could be concluded that all varieties were equally good in their performances of growth and quality of green forage. However, oats variety ' Local ' may be preferred for higher green forage yield and better nutritive value of fodder under 60 kg P_2O_5/ha and 120 kg N/ha fertilization.

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