EFFECT OF DIFFERENT LEVELS OF NITROGEN ON PERFORMANCE OF FODDER OAT (*Avena sativa* L.) VARIETIES UNDER LATERITIC SOIL OF KONKAN REGION

BY

SAWANT SAGAR MANGESH

B. Sc. (Agri.)

DEPARTMENT OF AGRONOMY,
FACULTY OF AGRICULTURE,
DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI - 415 712,
DIST. RATNAGIRI, (M.S.)

May, 2016

EFFECT OF DIFFERENT LEVELS OF NITROGEN ON PERFORMANCE OF FODDER OAT (*Avena sativa* L.) VARIETIES UNDER LATERITIC SOIL OF KONKAN REGION

A thesis submitted to the

DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI
(Agricultural University)
Dist. Ratnagiri (Maharashtra state), India

in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRONOMY

by

SAWANT SAGAR MANGSH
B.Sc. (Agri.)

DEPARTMENT OF AGRONOMY,
FACULTY OF AGRICULTURE,
DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI- 415 712,
DIST. RATNAGIRI (M.S.)
MAY, 2016

EFFECT OF DIFFERENT LEVELS OF NITROGEN ON PERFORMANCE OF FODDER OAT (*Avena sativa* L.) VARIETIES UNDER LATERITIC SOIL OF KONKAN REGION

A thesis submitted to the

DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI

(Agricultural University)
Dist. Ratnagiri (Maharashtra state), India

in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRONOMY

by

SAWANT SAGAR MANGESH
B.Sc. (Agri.)

Approved by the Advisory Committee:
Chairman and Research Guide:

(S. B. Bhagat)
Agronomist (ECF),
Agriculture Research Station, Palghar

: Members:

(S. B. Gangawane)
Associate Professor & P.I.
AICRP on Weed Control,
Department of Agronomy,
College of agriculture, Dapoli.

(M. C. Kasture)
Assistant Professor,
Department of Soil Science and
Agril. Chemistry,

(J. S. Dhekale)
Associate Professor
Department of Agril. Economics,
College of Agriculture,

College of Agriculture, Dapoli. Dapoli.

Dr. S. B. Bhagat
M. Sc. (Agri.)**,** Ph.D. (Agri.)
Agronomist (ECF),
Agriculture Research Station,
Palghar, Dist. Palghar- 401404,
(Maharashtra state)

CERTIFICATE

This is to certify that the thesis entitled **Effect of different levels of nitrogen on performance of fodder oat (*Avena sativa* L.) varieties under lateritic soil of *konkan* region** submitted to the faculty of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra state in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRONOMY**, embodies the results of the piece of *bona-fide* research carried out by **Mr. SAWANT SAGAR MANGESH** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma. All the assistance and help received during the course of investigation and the sources of literature have been duly acknowledged by him.

Place: Dapoli
Date: / /2016

(S. B. Bhagat)
Chairman,
Advisory Committee and
Research Guide

CHAPTER-I
INTRODUCTION

Oat (*Avena sativa* L.) is one of the most important winter cereal fodder crops in the temperate climate of the world. Oat is grown in India mainly for its nutritive grain and fodder values especially suited for horses, dairy cows and buffaloes. It is good balanced concentrate in the rations for poultry, cattle, sheep and other animals. Green fodder contain about 10-12 per cent protein and 30-35 per cent dry matter (Hand book of Agriculture, 2007). Under the situation of limited water supply oat can be a good choice as an alternative fodder crop.

At present in India availability of fodder resources is around 60 per cent of the requirement and area under fodder crops is around 8.6 m ha. Supply and demand scenario of forage and roughages for 1995-2025 also provide the figure of actual deficit as per cent demand for green forage 696 million tons (63.50 per cent) and dry roughages 143 million tons (23.56 per cent) for the year 2015 which is based on Eleventh five year plan document, Government of India (Handbook of Agriculture, 2007). To meet the fodder shortage for the growing animal population, the fodder growing area should ideally be around 20 m ha by 2020 AD, but this appears to be rather difficult to achieve.

Livestock production is the backbone of Indian Agriculture contributing 7 per cent to national GDP and source of employment and ultimate livelihood for 70 per cent population in rural areas. India is having the largest livestock population of 520 million heads, which is about 15 per cent of the world's livestock population (Das *et al.*, 2009).

The livestock population is expected to grow at the rate of 0.55 per cent in the coming years and the population is likely to be around 1.70 billion by 2050. Though India is among the leading producers of milk, meat and eggs, productivity of our animals is 20-60 per cent lower than the global average due to improper nutrition.

Half of the total losses in livestock productivity are contributed to the inadequacy in supply of feed and fodder (DARE/ICAR Annual Report (2012–13).

The crop residues mainly constitute the major feed material for the animals. The productivity of our livestock often remains low due to inadequate and nutritionally unbalanced supply of feed and fodder. The animal products make a larger contribution to dietary energy in the developed countries than developing ones. There is tremendous pressure of livestock on the available total feed and fodder, as land available for fodder production has been decreasing. At present, the country faces a net deficit of 63 per cent green fodder, 24 per cent dry crop residues and 64 per cent feeds (Singh, 2009).

Fodder availability in Maharashtra is 13 kg per cattle and average milk productivity is 32 L per animal (Anonymous, 2007). Total area under forage crops in Maharashtra is 8 Lakh ha and estimated green forage production is 32.4 MT. Maharashtra has about 4.0 crore of livestock population which needs about 12 crore tons dry fodder. However, only 7 crore tons dry fodder is available from all resources. It means there is 45 per cent deficit of green fodder in Maharashtra (Indian livestock census (2007)). Break up of available fodder indicates that 60 per cent fodder supplied by crop residues, 9.30 per cent through field weeds, 6.60 per cent from the crop that failed to produce grains, 3.16 per cent fodder from irrigated fodder crop, 10.30 per cent from forest grasses, 5.37 per cent from permanent pasture and 5.27 per cent from grazing lands, waste lands, current follows etc. These resources are of self-explanatory that around 97 per cent available fodder is of poor quality (Aher *et al.,* 2003).

Forage is the cheapest source of animal feed if it is properly managed, fertilized and harvested at proper stage of growth. In view of these facts, there is an urgent need of increasing good quality forage supply by adopting improved agronomic techniques, among which the improved genotypes and balanced fertilizer use are very crucial. They not only meet the requirements of bulk to be fed to the cattle, but also

supply desired amount of proteins, energy, minerals as well as vitamins to a large extents. Fortunately, Indian livestock are able to utilize the coarse, bulky, fibrous fodders efficiently by converting them into very useful food products. At present, our animals are being fed with low grade roughages such as paddy straw, wheat straw and jowar kadbi without any processing to improve its quality. Looking to the present quantitative and qualitative in sufficiency of feeds, fodders and good quality forage seed in our country, this results in less nutrients availability to the animals.

Oat (*Avena sativa* L.) is annual grass plant belonging to the family Gramineae which is commonly cultivated as an important winter season forage crop and sown in the month of October-November under irrigated conditions in North India as well as in Maharashtra. It requires cool and moist climate for its normal growth. Oat requires cool temperature during germination, tillering, booting and heading stages. It is medium height shrub growing up to 155-165 cm just higher than wheat and its leaves are long and succulent. It has comparatively high palatability and has cooling effect on animal body, thereby it fits in the dairy production program (Handbook of Agriculture, 2007). It became popular among the dairy farmers due to its excellent quick regrowth habit, highest biomass with better nutritive value and ratooning ability which offer it an opportunity for green forage or seed with high yield in short span of time.

Oat is an important cereal forage crop which provides energy rich nutritious and palatable fodder. When the water supply is limited and farmer cannot grow legumes like berseem and lucerne, oat would be better choice as an alternative fodder crop. Amongst various nutrients, oat responds well to nitrogen application, which produces more tonnage per unit area per unit time under favorable environmental conditions (Dubey *et al.*, 2013).

A vast varietal diversity of oat enables its cultivation over wide range which have high yield potential and hence grown for producing green fodder as well as seed. These varieties are highly

responsive to high doses of fertilizers. Hence, substantial increase in yields of these varieties in per unit area per unit time can be achieved by providing balanced fertilizer. According to Malavolta (1980), the factor that most influences the productivity of fodder is fertilization.

Nitrogen is an essential primary nutrient for profuse plant growth that plays an important role in productivity of forage production and is fundamentally important in the production process of pastures. Nitrogen is the most limiting nutrient for plant growth. It is an essential component of organic compounds such as amino acids, proteins, nucleic acids, hormones and chlorophyll (Wilkins *et al.,* 2000). Now a days many new improved genotypes of oat *viz.,* Kent, RO-19, OS-6, UPO 212 etc. are recommended for cultivation of forage varieties. These genotypes are also responsive to split application of nitrogenous fertilizer to produce palatable, nutritious and energy rich green fodder. Yield and forage quality of oat cultivar UPO 212 increased with increasing levels of nitrogen up to 160 kg with improvement concentrations of cell wall (ADF and NDF), Cellulose and Hemicellulose (Bhilare and joshi, 2007). These facts necessitate to determine the adequate supply of nitrogen to the oat based on field experimentation for realizing the genetic yield potential of newly evolved varieties. Keeping these in view, an experiment "Effect of different levels of nitrogen on performance of fodder oat (*Avena sativa* L.) varieties under lateritic soil of *Konkan* region." was conducted at Agronomy Farm, Department of Agronomy, College of Agriculture, Dapoli (M.S.) during the *rabi* season of 2015 with the following objectives

1. To study the performance of different fodder oat varieties
2. To study the effect of levels of nitrogen on growth and yield of oat varieties
3. To study the various quality parameters of different fodder oat varieties
4. To study the economics of different treatment.

CHAPTER-II

REVIEW OF LITERATURE

An attempt has been made in this chapter to review the work done to find out the effect of different levels of nitrogen on performance of fodder oat (*Avena sativa* L.) varieties.

2.1. Effect of varieties

2.1.1 Effect on growth attributes

2.1.2 Effect on yield and yield attributes

2.1.3 Effect on quality and nutrient uptake

2.1.4 Effect on Economics

2.2. Effect of nitrogen levels

2.2.1 Effect on growth attributes

2.2.2 Effect on yield and yield attributes

2.2.3 Effect on quality and nutrient uptake

2.2.4 Effect on Economics

2.3. Interaction effect of varieties and nitrogen levels

2.3.1 Effect on growth attributes

2.3.2 Effect on yield and yield attributes

2.1. Effect of varieties

2.1.1 Effect on growth attributes

Desai *et al.,* (1984) from MPKV, Rahuri reported that variety Kent recorded highest plant height (32.2 cm) and leaf: stem ratio (1.53) than variety Weston-11 (32.1 cm, 1.52) and HFO-212-B (32.1 cm, 1.51). However, highest tillers per plant recorded by variety Weston-11 and HFO-212-B (1.8) than variety Kent (1.6).

Het Ram *et al.,* (2001) from Chaudhari Charan Sing Haryana Agriculture University, Hisar conducted an experiment on seed vigor studies in cultivator and wild species of oats at Department of Plant Breeding, and they found that OS 240 shows highest plant height (122 cm) and panicle length (29.70 cm) but tiller count per plant was highest (13.50) with HFO 516 as compared to other varieties.

Singh *et al.,* (2002) carried out an experiment at G.B. Pant University of Agriculture and Technology, Pantnagar (Uttaranchal) to study the forage production potential and quality of different varieties of oat and observed that in variety UPO 2005-1, the average plant height, tillers per plant and leaf: stem ratio increased from 50.92 to 56.84, 17.47 to 26.85, and 0.36 to 0.43 cm, respectively and which was superior to variety JHO-851.

Nawaz *et al.,* (2004) conducted an experiment on performance of five oat varieties *viz.* Tibor, Scott, PD2LV65, Sargotha 81 and Swan under the agro-climatic condition of Bahawalpur, Pakistan and they observed that variety Scott recorded significantly better performance in respect of days to anthesis (149.33 days), days to maturity (210 days), plant height (162 cm), number of seeds per tiller (75) and number of tillers per plant (13) as compared to other varieties.

Mahale *et al.*, (2004) from college of Agriculture, Dapoli carried out experiment on effect of cutting management and nitrogen levels on forage yield of oat during 1992-93 and 1993-94. It was concluded that cultivar Kent produce significantly higher green forage yield (327.59 q ha^{-1}) over cultivar JHO-851 (316.36 q ha^{-1}).

Pathan and Bhilare, (2009a) studied response of nitrogen levels to single cut oat genotypes at AICRP, M.P.K.V, Rahuri (M.S) and reported that genotype Kent showed the highest plant population (93.75 m^{-1}) and leaf: stem ratio (0.895) while genotype RO-19 showed the highest plant height (129.70 cm) as compared to OS-6 (124.93 cm).

Roshan *et al.,* (2012) studied the response of promising varieties of single cut forage oat to different nitrogen levels under agro climatic conditions of Kymore plateau zone, Madhya Pradesh and reported that among the different oat varieties *viz.,* SKO-105, SKO-109, NDO-7, Kent, SKO-90, OS-6, JO-03-93; Kent and OS-6 were at par with each other in relation with height and exhibited their

superiority by producing taller plants and more tillers per meter square as compared to rest of the varieties.

Siloriya *et al.,* (2013) from Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India conducted an experiment on relative performance of oat (*Avena sativa* L.) varieties for their growth and seed yield and reported that, the variety UPO 2005-1 recorded significantly highest plant height (135.2 cm) than others, followed by JO 2003-78 (126.4 cm), OS-6 (125.45 cm), Kent (124.35 cm) and JHO-822 (122.45 cm) which had almost similar plant height.

Dube *et al.,* (2013) from Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (M.P) reported that the cultivar Kent attained highest plant height (113.20 cm) among tested cultivars viz., JHO 851, JHO 822, Kent and OS-6, whereas, variety OS-6 produced maximum number of tillers m^{-2} (416.3)with highest LAI (6.16)at all growth stages.

Midha *et al.,* (2015) from Chaudhary Charan Singh Haryana Agriculture University, Hissar reported that highest plant height (129.4 cm) was recorded by variety SKO-188 over all varieties of oat followed by UPO-10-2 (118.0 cm) then closely followed by SKO-170 (117.6 cm) and JHO-10-1 (115.5 cm). However, lowest plant height (90.8 cm) of oat was recorded by variety OS-377. Maximum tillers per running meter of oat (83.5) were recorded by two varieties *viz.,* JO-03-97 and SKO-188 over all other varieties.

2.1.2 Effect on yield and yield attributes of crop

Kumar *et al.,* (2001) from Rajasthan Agriculture University, Rajasthan carried out a research on oat varieties during the *rabi* season of 1996-97 and they found that variety UPO-240 recorded significantly higher green forage yield (462.23 q ha^{-1}) and dry matter yield (24.45 q ha^{-1}) than variety Kent (455.30 and 21.45 q ha^{-1}).

Pathan *et al.,* (2007) conducted an experiment at AICRP on Forage Crops, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S) to assess the response of multi-cut oat varieties to nitrogen levels and they was observed that the variety RO-19 recorded significantly higher

green forage yield (525.56 q ha^{-1}), than rest of the varieties *viz.* JO-2000-61 (446.37 q ha^{-1}), JHO-851 (313.27 q ha^{-1}), UPO-212 (513.02 q ha^{-1}) and JHO-2003-3 (520.99 q ha^{-1}).

Bagul *et al.,* (2008) from Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S) studied the performance of Phule Harita (Ro-19) and observed that RO-19 was superior in introduction of green forage yield (532.03 q ha^{-1}) as compared to Kent (485.99 q ha^{-1}) and JHO-851 (448.20 q ha^{-1}).

Shekara *et al.,* (2008) conducted a field investigation on response of single cut oat genotypes to nitrogen levels at Zonal Agril. Research Station, V.C. Farm, Mandya, (Karnataka) and they revealed that the genotype OS-6 recorded the highest green forage yield (199 q ha^{-1}) as compared to other genotypes *viz.,* JO-2003-78 (172.17 q ha^{-1}), NDO-1 (137.06 q ha^{-1}) and Kent (141.67 q ha^{-1}) under study.

Pathan and Bhilare, (2009a) from Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S) carried out field experiment to find out the response of nitrogen levels to single cut oat genotypes and they reported that the genotype UPO-04-1 recorded significantly the highest green forage yield (292.04 q ha^{-1}) as compared to other genotypes *viz.,* JHO-2004-04 (271.3 q ha^{-1}), Kent (260.55 q ha^{-1}), OS-6 (250.37 q ha^{-1}) and RO-19 (289.21 q ha^{-1}).

Pathan *et al.,* (2009b) assessed the effect of nitrogen levels on forage yield of promising varieties of multi-cut oat at AICRP on Forage Crops, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S) and found that, RO-19 produced the highest green forage yield (505.4 q ha^{-1}) from two fodder cuts as compared to other varieties *viz.,* JHO-2002-1 (414.6 q ha^{-1}), JHO-2002-3 (458.2 q ha^{-1}), OS-317 (416.4 q ha^{-1}) and UPO-212 (454.8 q ha^{-1}).

Jha *et al.,* (2012) carried out a field experiment at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *rabi* season of 2007-08 with the objective to determine the relative performance of new single cut oat genotypes in combination of nitrogen levels 0, 40, 80 and 120 kg N ha^{-1}. It was observed that, the variety JO 03-91 with

120 kg N ha^{-1} proved significantly superior in producing maximum green fodder yield (503.9 q ha^{-1}) and dry matter yield (121.1 q ha^{-1}).

2.1.3 Effect on quality and nutrient uptake of crop.

Raghubanshi *et al.,* (2002) carried out a field study on nutritional evaluation of oat varieties at G. B. Pant University of Agriculture and Technology, Pantnagar. They observed chemical composition (CP and CF per cent) of oat varieties at 50 per cent flowering stage. The variety UPO-212 recorded the highest crude protein content (12.8 %) as compared to UPO-240 (11.0 %) and Kent (10.8 %). However, variety UPO-240 recorded significantly higher crude fiber content (29.8 %) than UPO-212 (28.0 %) and Kent (28.5 %).

Pathan *et al.,* (2005) conducted a field experiment at Mahatma Phule Krishi Vidyapeeth, Rahuri and revealed that, the RO-19 registered significantly higher crude protein yield (12.64 q ha^{-1}) than Kent (6.77 q ha^{-1}) from two fodder cuts.

Shekara *et al.,* (2008) conducted experiment to study the response of single cut oat genotypes to nitrogen levels at Zonal Agril. Research Station, V.C. Farm, Mandya (Karnataka) and they found that genotype OS-6 registered the highest crude protein yield (2.70 q ha^{-1}) as compared to other genotypes *viz.,* JO-2003-78 (2.42 q ha^{-1}), NDO-1 (1.80 q ha^{-1}) and Kent (1.89 q ha^{-1}).

Pathan *et al.,* (2009b) from Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S) carried out a field experiment on effect of nitrogen levels on forage yield of promising oat varieties during *rabi* 2007-08 and they observed that RO-19 recorded the highest crude protein yield (9.8 q ha^{-1}) than other varieties *viz*. JHO-2002-1 (9.3 q ha^{-1}), JHO-2002-3 (8.6 q ha^{-1}), OS-317 (8.3 q ha^{-1}) and UPO-212 (9.1 q ha^{-1}).

Luikham *et al.,* (2012) conducted a field experiment at College of Agriculture, Central Agricultural University, Imphal and reported that variety JHO-822 recorded significantly highest crude

protein yield (3.22 Kg ha^{-1}) than other varieties *viz.* JHO-851 (2.26 kg ha^{-1}), OF-6 (2.63 kg ha^{-1}), and Kent (2.66 kg ha^{-1}).

2.1.4 Effect on Economics

Jha *et al.,* (2012) conducted a field investigation at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) and they reported that variety JO 03-91 having B: C ratio (5.03) being close to UPO 06-2 (4.68), UPO 06-1 (4.67) and Kent (3.96).

Luikham *et al.,* (2012) from college of Agriculture, Central Agricultural University, Imphal revealed that variety JHO-822 having the highest gross return (Rs 56232.00 ha^{-1}) net return (Rs 42853.74 ha^{-1}) and benefit cost ratio (1:3.20) than other three varieties *viz.,* JHO-851, OF-6 and Kent.

Dubey *et al.,* (2013) conducted a field experiment at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (M.P) on effect of nitrogen levels on green fodder yield of oat (*Avena sativa* L.) varieties during *rabi* season of 2006-07 and reported that variety OS-6 stood topped with respect of B: C ratio (2.27) and being close to Kent (2.23), JHO-822 (2.06) and JHO-851 (1.97)

2.2. Effect of nitrogen levels

2.2.1 Effect on growth attributes of crop

Bhilare and joshi, (2008) from G.B. Pant University of Agriculture and Technology, Pantnagar carried out a field experiment to study the response of oat (*Avena sativa* L.) to nitrogen levels under different cutting management and reported that with increase in levels of nitrogen from 0 to 160 kg ha^{-1}, significantly increased the plant height (158.6 cm), number of shoots (46.8 per 0.5 m row length) and leaves (222.8 per 0.5 meter row length) in variety UPO-212.

Pathan and Bhilare, (2009a) conducted a field experiment at Mahatma Phule Krishi Vidyapeeth, Rahuri to study the response of nitrogen levels in single cut oat genotypes during *rabi* 2006-07 and they observed that increasing nitrogen levels up to 120 N kg ha^{-1} significantly increased the plant height (129.70 cm) in variety RO-19 and the higher plant population (94.17 $m^{-2)}$ in variety UPO-04-01. The

leaf: stem ratio recorded was significantly higher (0.885) due to nitrogen level 120 N kg ha^{-1}.

Roshan *et al.*, (2012) studied the response of promising varieties of single cut forage oat to different nitrogen levels under agro climatic conditions of Kymore plateau zone, Madhya Pradesh and reported that increasing nitrogen levels up to 120 N kg ha^{-1} significantly increased the plant height (145.3 cm), number of tillers (440.3 m^{-2}), LAI (5.89) and leaf: stem ratio (0.91) at 50 % flowering.

Dubey *et al.*, (2013) conducted an experiment at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (M.P) to evaluate the effect of nitrogen levels on green fodder yield of oat (*Avena sativa* L.) during *rabi* season of 2006-07 and they revealed that increasing level of nitrogen dose up to 120 kg ha^{-1} also recorded highest Leaf Area Index (416.30), number of tillers (6.16 m^{-2}) and higher leaf: stem ratio (0.88).

2.2.2 Effect on yield and yield attributes of crop.

Joon *et al.,* (1995) from Chaudhari Charan Singh Haryana Agriculture University, Hissar conducted a field experiment on effect of levels and time of nitrogen application on grain yield of multi cut oat. It was revealed that, application of 80 Kg N ha^{-1} recorded higher grain yield (22.5 and 19.5 q ha^{-1}) during both the year 1991-92 and 1992-93 than other nitrogen levels *viz.,* 60, 40, 20 Kg N ha^{-1} and over control. However, application of nitrogen level 80 Kg ha^{-1} recorded higher straw yield (75.7 q ha^{-1}) during 1991-92 which were at par with 60 Kg N ha^{-1} during 1992-93.

Patel and Rajgopal, (1998) from College of Veterinary Science and Animal Husbandry, Anjora (MP) conducted an experiment during winter season 1996-97 and 1997-98 on effects of nitrogen and phosphorus on growth and forage yield of oat and reported that the application of nitrogen at 75 kg ha^{-1} recorded highest green forage yield (442.6, 633.4 q ha^{-1}) and dry matter yield (81.3, 116.0 q ha^{-1}) than 50, 25 kg N ha^{-1} and over control during 1996-97 and 1997-98.

Kumar *et al.,* (2001) conducted a field experiment at Rajasthan Agriculture University, Rajasthan to find out the effect of

nitrogen levels and cutting management on yield and quality of different varieties of oat and they reported that, the yield of green forage (411.6 q ha^{-1}) and dry matter yield (79.1 q ha^{-1}) of oat were higher in single cut than two cut system (338 q ha^{-1} and 62.7 q ha^{-1} respectively) with increased level of nitrogen up to 120 kg N ha^{-1}.

Sharma and Bhunia, (2001) from Rajasthan carried out a field experiment on response of oat to cutting management, method of sowing and nitrogen and reported that increasing level of nitrogen from 40 to 80 Kg ha^{-1} recorded higher yield and yield attributes in variety Kent. The significantly highest yield of forage (158.97, 169.90 q ha^{-1}) and grain yield (23.55, 23.73 q ha^{-1}) were recorded with 80 kg N ha^{-1}.

Mahale *et al.,* (2003) carried out a field investigation on effect of non-symbiotic nitrogen fixer on the forage yield of oat at Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli and reported that nitrogen application at the rate of 80 kg ha^{-1} produced higher green forage yield (303.88 kg ha^{-1}) and dry fodder yield (74.20 kg ha^{-1}) over 60, 40 N kg ha^{-1} and control.

Bhilare and Joshi, (2008) was conducted a field experiment at G.B. Pant University of Agriculture and Technology, Pantnagar to evaluate response of oat (*Avena sativa* L.) to nitrogen levels and they revealed that the application of 160 kg N ha^{-1} significantly produced higher green forage yield (445.3 q ha^{-1}) and dry matter yield (83.7 q ha^{-1}) which is at par with 120 kg N ha^{-1} which produced green forage yield (428.9 q ha^{-1}) and dry matter yield (81.1 q ha^{-1}).

Pathan and Bhilare, (2009a) studied response of nitrogen levels to single cut oat genotypes during *rabi* 2006-07 at Mahatma Phule Krishi Vidyapeeth, Rahuri and they observed that, the application of 120 kg N ha^{-1} produced significantly higher green forage yield (316.97 q ha^{-1}) and dry matter yield (56.20 q ha^{-1}) than all other levels *viz.,* 0 and 40 kg N ha^{-1} and was at par with 80 kg N ha^{-1} in respect of green forage yield (310.82 q ha^{-1}) and dry matter yield (55.32 q ha^{-1}).

Jha *et al.,* (2012) carried out a field experiment at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *rabi* season of 2007-08 with the objective to determine the relative performance of new single cut oat genotypes in combination of nitrogen levels 0, 40, 80 and 120 kg N ha^{-1}. It was observed that, application of 120 kg N ha^{-1} proved significantly superior in producing maximum green fodder yield (503.9 q ha^{-1}) and dry matter yield (121.1 q ha^{-1})

Dubey *et al.*, (2013) conducted a field experiment during *rabi* season of 2006-07 at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (M.P) and reported that, the application of 120 kg N ha^{-1} produced significantly higher green forage yield (21.06 q ha^{-1}) and dry matter yield (549.90 q ha^{-1}) than all other levels of nitrogen *viz.,* 0, 40 and 80 kg N ha^{-1}.

2.2.3 Effect on quality and nutrient uptake of crop.

Bhat *et al.,* (2000) conducted a field experiment at Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir to evaluate the grain yield of oat as influenced by sowing time and nitrogen levels under temperate conditions of Kashmir and reported that total nitrogen (110.3 kg ha^{-1}), phosphorus (10.6 kg ha^{-1}) and potassium (213.2 kg ha^{-1}) uptake by oat was higher at application of 150 kg ha^{-1} followed 120 and 90 kg N ha^{-1}.

Kumar *et al.,* (2001) studied the effect of nitrogen levels and cutting management on yield and quality of different varieties of oat at Rajasthan Agriculture University, Rajasthan and they found that, under two cutting management system, crude protein yield was higher in single cut (7.0 q ha^{-1}) than in two cut system (6.5 q ha^{-1}) with application of increased level of nitrogen up to 120 kg N ha^{-1}.

Bhilare and Joshi, (2007) carried out an experiment at G.B. Pant University of Agriculture and Technology, Pantnagar to study the productivity and quality of oat in relation to cutting management and nitrogen levels and they revealed that the crude protein content (19.51 %), Acid Detergent Fibre (49.21 %), Neutral Detergent Fibre

(60.32 %) and hemicellulose contents (22.64 %) were significantly higher with increased level of nitrogen up to 160 kg N ha^{-1}.

Dubey *et al.,* (2013) conducted a field experiment at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (M.P) and reported that, the application of 120 kg N ha^{-1} produced significantly higher crude protein yield (9.38 kg $ha^{-1)}$ which is being close to the application of 80 kg N ha^{-1} (8.20 kg $ha^{-1)}$.

Jehangir *et al.*, (2013) conducted a field experiment at Research Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir to find out the influence of sowing dates, fertility levels and cutting management on growth, yield and quality of oat (*Avena sativa* L.) and they revealed that, the green and dry fodder yields (362.06 and 101.96 q ha^{-1}), crude protein content (19.50 %) and crude fiber content (22.31 %) increased with increase in fertility level up to 150 kg N ha^{-1}.

2.2.4 Effect on Economics

Singh *et al.,* (2005) conducted a field experiment at G.B. Pant University of Agriculture and Technology, Pantnagar to evaluate the effect of organic and inorganic sources of nitrogen and cutting management on growth and yield of fodder oat and they reported that, the application of nitrogen up to 80 kg ha^{-1} along with seed inoculation with azatobactor as well as addition of FYM @ 5 t ha^{-1} and taking of two cuts at 55 and 75 DAS proved beneficial to obtain the highest net returns of Rs. 13,360 ha^{-1} and B: C ratio of 2.07.

Jha *et al.,* (2012) conducted a field investigation at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) with the objective to determine the relative performance of new single cut oat genotypes in combination of nitrogen levels *viz.,* 0, 40, 80 and 120 kg N ha^{-1}. Application of nitrogen 120 kg N ha^{-1} resulted into higher B: C ratio of 5.18 than other levels.

Luikham *et al.,* (2012) conducted a field experiment during the *rabi* season of 2008-09 at the experimental field of college of Agriculture, Central Agricultural University, Imphal to evaluate the

effect of nitrogen levels on the yield and quality of promising varieties of oat and reported that, the highest gross return (Rs. 56232.00 ha^{-1}), net return (Rs. 42853.74 ha^{-1}) and benefit cost ratio (1:3.20) were associated with the treatment.

Dubey *et al.,* (2013) conducted a field experiment at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (M.P) to find out effect of nitrogen levels on green fodder yield of oat (*Avena sativa* L.) varieties during *rabi* season of 2006-07 and reported that increased rate of nitrogen 120 kg N ha^{-1} markedly increased the profitability in terms of B: C ratio (2.50).

Devi *et al.,* (2014) conducted a field experiment at Research Farm of Chaudhari Charan Singh Haryana Agricultural University, Hissar during 2003-04 and 2004-05 and they reported that the application of 80 and 120 kg N ha^{-1} gave the highest net returns of Rs.9190 and 9215 ha^{-1} during first year and Rs. 8125 and 8120 ha^{-1} during second year, respectively as compared to 40 kg N ha^{-1}.

2.3. Effect of interaction.

2.3.1 Effect on growth attributes of crop

Pathan and Bhilare, (2009a) conducted a field experiment at Mahatma Phule Krishi Vidyapeeth, Rahuri to study the response of nitrogen levels to single cut oat genotypes during *rabi* 2006-07 and they observed that increasing nitrogen levels up to 120 N kg ha^{-1} significantly increased the higher plant height (129.70 cm) in variety RO-19 and the higher plant population (94.17 m^2) in variety UPO-04-01.

Roshan *et al.*, (2012) studied the interaction effect between verities and nitrogen levels under agro climatic conditions of Kymore plateau zone, Madhya Pradesh and reported that increasing nitrogen levels up to 120 N kg ha^{-1} significantly increased the plant height (144.3 cm), number of tillers (410.3 m^{-2}) and LAI (6.38 at 50 per cent flowering) in Kent as compared to OS-6 in case of plant height (144.2 cm), number of tillers (404.4 m^{-2}) and LAI (5.54 at 50 % flowering).

2.3.2 Effect on yield and yield attributes of crop.

Kumar *et al.,* (2001) conducted a field investigation at Rajasthan Agriculture University, Rajasthan to study the interaction effect between nitrogen levels and cutting management on yield and quality of different varieties of oat and they revealed that the yield of green forage (411.6 q ha^{-1}) and dry matter (79.1 q ha^{-1}) of oat variety Kent were higher in single cut than two cut system (338 q ha^{-1} and 62.7 q ha^{-1} respectively) with increased level of nitrogen up to 120 kg N ha^{-1}.

Bhilare and Joshi, (2008) conducted a field experiment on response of oat (*Avena sativa* L.) varieties UPO-212 to nitrogen levels at Instructional dairy farm, G. B. Pant University of Agriculture and Technology, Pantnagar and revealed that the application of 120 kg N ha^{-1} significantly produced green forage yield (428.9 q ha^{-1}) and dry matter yield (81.1 q ha^{-1}) while 160 kg N ha^{-1} produced green forage yield (445.3 q ha^{-1}) and dry matter yield (83.7 q ha^{-1}) which was at par to each other in case of variety UPO-212.

Pathan and Bhilare, (2009a) from Mahatma Phule Krishi Vidyapeeth, Rahuri studied response of nitrogen levels to single cut oat genotypes during *rabi* 2006-07 and they observed that, the application of 120 kg N ha^{-1} produced significantly higher green forage yield (316.97 q ha^{-1}) and dry matter yield (56.20 q ha^{-1}) of varieties RO-19 and Kent.

Jha *et al.,* (2012) from Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) conducted a field experiment during *rabi* season of 2007-08 with the objective to determine the relative performance of new single cut oat genotypes in combination of nitrogen levels *viz.,* 0, 40, 80 and 120 kg N ha^{-1} and reported that, the variety JO 03-91 with 120 kg N ha^{-1} proved significantly superior in producing maximum green fodder (503.9 q ha^{-1}) and dry matter yield (121.1 q ha^{-1}).

Dubey *et al.,* (2013) conducted a field experiment at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *rabi* season of 2006-07 and they reported that, the application of 120 kg N ha^{-1} produced significantly higher dry matter yield (21.06 q ha^{-1}) and green forage yield (549.90 q ha^{-1}) of variety OS-6 .

Jat *et al.,* (2015) conducted a field experiment at Instructional Farm, Rajasthan College of Agriculture, Udaipur and studied the interaction effect between nitrogen and growth of fodder oat and reported that application of 110 kg N ha^{-1} was recorded significantly superior crop growth rate (70.1, 34.1) of variety UPO 06-2.

CHAPTER-III
MATERIALS AND METHODS

The present investigation "Effect of different levels of nitrogen on performance of fodder oat (*Avena sativa* L.) varieties under lateritic soil of *Konkan* region." was conducted at Agronomy farm, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) during *rabi* season of 2015. The materials used and methodology adopted during the investigation are explained in this chapter.

1. Experimental site

The experiment was conducted at the Agronomy farm, College of Agriculture, Dapoli, Dist. Ratnagiri during *rabi* season of 2015. The experiment was laid out in plot no. 20 of "B" block. The topography of the experimental plot was uniform. The selection of site was considered on the basis of suitability of the land for cultivation of fodder oat.

2. Soil of the experimental field

The composite soil samples from 0 to 30 cm soil depth was taken with the help of screw auger before starting of field experiment. Soil thus collected was air dried and preserved properly in aluminium boxes. It was then analysed for various physico-chemical properties of soil by various methods the details of which are presented in Table 1.

The data represented in Table 1 indicated that the soil of the experimental plot was sandy clay loam in texture, slightly acidic in pH and medium in organic carbon content. It was medium in available nitrogen and potassium and low in available phosphorus.

3. Climate and weather

Agronomy Farm, College of Agriculture, Dapoli, Dist. Ratnagiri is situated in tropical region at $17^0 14'$ North latitude, $73^0 26'$ East longitude having elevation of 250 meters above mean sea level. The climate is sub-tropical characterized by warm and humid day.

During the period of experiment the data regarding different weather parameters recorded at the meteorological observatory of

Agronomy Farm, College of Agriculture, Dapoli from 45th metrological week to 6th metrological week are presented in Table 2 and graphically depicted in Fig.1.

Table 1. Physical and chemical properties of soil from the experimental field

Particulars	Composition	Method used
Physical properties:		
Particle size distribution		
Sand (%)	44.8	Bouyoucos hydrometer (Jackson, 1973)
Silt (%)	21.8	
Clay (%)	33.4	
Textural class	Sandy clay loam	Using textural triangle given by ISSS
Chemical properties:		
Soil pH (1:2.5)	5.68	Potentiometric method (Jackson, 1973)
EC (dSm^{-1})	0.22	
Organic carbon (%)	0.97	Walkey and Black wet oxidation method (Black, 1965)
Available N ($kg\ ha^{-1}$)	284.2	Alkaline permanganate method (Subbaih and Asija, 1956)
Available P_2O_5 ($kg\ ha^{-1}$)	10.80	Bray's method (Bray's and Kurtz, 1945)
Available K_2O ($kg\ ha^{-1}$)	264.22	Flame photometer (Jackson, 1973)

The maximum and minimum temperature was ranged from 28.9 to 34.7^0 C and from 11.4 to 20.6^0 C during crop period, respectively. The maximum evaporation recorded was 4.2 during 45th MW of 2015 and 5th MW of 2016 and minimum recorded was 2.9 during 2nd MW of 2016.

The relative humidity during morning and evening was ranged from 82 to 95 per cent and from 29 to 56 per cent, respectively during the period of experimentation. The maximum sunshine hours recorded was 8.5 hours during 3rd and 5th MW of 2016. The minimum

sunshine hours recorded was 6.0 hours during 47th MW of 2015. The highest wind velocity was recorded 3.8 km hr^{-1} during 4th and 6th MW of 2016 and lowest wind velocity was recorded 2.5 km hr^{-1} during 46th MW of 2015.

Table 2. Meteorological observations during the crop growth period

MW	Period (5.11.2015 to 11.02.2016)	Temperature (^{0}C)		Mean relative humidity (%)		Wind Speed (Km /hr)	Evap. (mm/ day)	Sun-shine (hrs^{-1})
		Max.	Min.	Morn.	Even.			
45	05.11-11.11	33.8	20.3	91	52	2.6	4.2	6.9
46	12.11-18.11	34.2	17.3	93	42	2.5	3.9	8.2
47	19.11-25.11	32.9	20.6	90	52	3.2	3.5	6.0
48	26.11-02.12	33.4	19.2	93.7	47.1	2.6	3.2	6.9
49	03.12-03.12	34.0	16.9	94	41	3.0	3.8	7.6
50	10.12-16.12	32.7	17.1	95	50	2.7	3.4	8.1
51	17.12-23.12	31.8	15.6	94	49	3.0	3.5	7.9
52	24.12-31.12	32.1	11.4	84	29	3.0	3.8	8.4
1	01.01-07.01	34.1	12.7	93	30	2.6	3.5	8.3
2	08.01-14.01	32.4	12.9	95	41	2.8	2.9	7.6
3	15.01-21.01	28.9	11.9	94	39	3.6	3.3	8.5
4	22.01-28.01	32.0	12.4	82	36	3.8	4.0	8.4
5	29.01-04.02	34.7	12.5	92	38	3.1	4.2	8.5
6	05.02-11.02	29.2	13.0	93	56	3.8	3.7	8.1
Mean/Total		32.6	15.3	91.7	43	2.61	3.64	7.8

4. Cropping history of the experimental plot

The cropping sequences followed for the previous years on the experimental plot before the investigation are presented in Table 3.

Table 3. Cropping history of the experimental plot

Year	Season	
	Kharif	***Rabi***
2012-13	Banana	Banana
2013-14	Banana	Banana
2014-15	Banana	Banana
2015-16	Rice	Oat (Experiment)

5. Treatment details

The field experiment was laid out in Split plot design comprising of twelve treatments replicated three times. The main treatments constituted three varieties and four levels of nitrogen were assigned to sub-plot. The details of these treatments with symbols are given in Table 4 and plan of layout is depicted in Fig.2.

Table 4. Symbol used for different treatments

A) Main plot treatments (Varieties)
V_1: RO-19
V_2: Kent
V_3: OS-6
B) Sub-Plot treatments (Nitrogen levels)
N_1: 40 Kg N ha^{-1}
N_2: 60 Kg N ha^{-1}
N_3: 80 Kg N ha^{-1}
N_4: 100 Kg N ha^{-1}

a) Crop : Oat

b) Variety : RO-19, Kent and OS-6

c) Spacing : 30 cm between rows

d) Experimental design : Split plot design

e) No. of replications : Three

f) No. of treatments : Twelve

g) Gross plot size 4.5 m X 3.00 m

h) Net plot size 3.9 m X 2.4 m

i) Manures and fertilizers : a) F.Y.M- 10 t ha^{-1}

b) i. 40:40:40 N:P:K kg ha^{-1}
ii. 60:40:40 N:P:K kg ha^{-1}
iii. 80:40:40 N:P:K kg ha^{-1}
iv. 100:40:40 N:P:K kg ha^{-1}

6. Experimental details

7. Details of field operations

7.1 Preparatory tillage

The experimental site was ploughed with the help of tractor and clod crushing was done by tractor drawn cultivator and rotavator. The field was levelled with the help of leveller and made ready for the layout.

Table 5. Schedule of cultural operations carried out in the experimental plot during *Rabi* 2015-16

Sr.No.	Field operations followed	Frequency	Date of operation
A)	**Preparatory tillage**		
	a. Ploughing by tractor	1	26/10/2015
	b. Clod crushing by rotavator	1	29/10/2015
	c. Layout and ploting of experimental field	1	02/11/2015 03/11/2015
B)	**Sowing**		
	Sowing of oat	1	06/11/2015
C)	**Spraying of herbicides**		
	Pre-emergence herbicide	1	08/11/2015
D)	**Manure and fertilizer application**		
	a. At the time of sowing		

	i) Full dose of phosphorus	1	06/11/2015
	ii) Full dose of potash	1	06/11/2015
	iii) a. Basal dose of nitrogen (50%)	1	06/11/2015
	b. Second dose of nitrogen (50%) at 30 DAS	1	05/12/2015
E)	**Irrigation**		
	Common to all treatments	7	06/11/2015 13/11/2015 21/11/2015 05/12/2015 23/12/2015 07/01/2016 23/01/2016
F)	**Inter culture and weeding operations**		
	a. Hand weeding	2	11/12/2015 13/1/2016
	b. Mechanical weeding	1	20/11/2015
G)	**Harvesting at 50% flowering for fodder (Oat)**		
	Harvesting with Vaibhav Sickle a. OS-6 b. Kent c. RO-19	3	 01/02/2016 06/02/2016 10/02/2016

7.2 Layout of Fields

Layout of field was done as per the split plot design. Small bunds of 15-20 cm height were raised around each plot along with keeping a distance of 1 m between two replications. There were twelve plots in each replication and in all there were three replications. Hence, there were 36 plots of 4.5 m X 3.00 m each.

7.3 Seed and Sowing

The seed of oat varieties *viz.,* RO-19, Kent and OS-6 was treated with thirum at the rate of 3 g kg^{-1} of seed and used for sowing.

Sowing was done by opening small furrows of about 3 cm depth with the help of marker at a distance of 30 cm between the lines. The oat seed was sown about 3 cm deep manually at the rate of 100 kg ha^{-1} and covered with the soil. The sowing was done on 6th November 2015.

7.4 Irrigation

The details of irrigations applied to oat crop are presented in Table 5. The first three irrigations which were applied on 6th, 13th and 21th November 2015 were common to all the treatments for better germination and crop establishment at initial stage of crop growth. The remaining common irrigations were given to treatment as per the need of crop.

7.5 Fertilizer application

The crop was fertilized as per the treatments. Nitrogen was supplied through urea having (46 per cent N) while phosphorous and potash was supplied through single super phosphate (16 per cent P_2O_5) and murate of potash (60 per cent K_2O), respectively.

At the time of sowing half dose of N with full dose of P_2O_5 and K_2O was applied as a basal dose. The remaining half dose of nitrogen was applied after one month of sowing.

7.6 Application of herbicides

Pendimethalin was applied as a pre-emergence herbicide two days after sowing @ 1 Kg a.i ha^{-1}.

7.7 Intercultural and other cultural practices

One common intercultural operations namely mechanical weeding was given to all the treatments at 15 days after sowing with the help of dryland weeder and two common hand weeding's were given to experimental plots at 35 and 70 days after sowing in order to keep the plots weed free.

7.8 Harvesting

The oat crop was harvested when 50 per cent flowering stage occurred. Single line from border of the plots was removed first to eliminate the border effect. Harvesting was done with 'Vaibhav' sickle using manual labours. The plants were cut close to the ground and kept in respective plots for sun drying. Green forage and dry forage yield was recorded from net plot by weighing as per the treatments and converted into hectare basis.

8. Biometric observations

8.1 Growth studies in oat

For studying the effect of various treatments on the plant characters, biometric observations *i.e.* plant height, number of tillers, leaf: stem ratio and dry matter accumulation of plants were recorded at a regular interval of 15 days up to 50 per cent flowering of oat crop. These are presented in Table 6.

8.2 Sampling techniques

For recording biometric observations, five plants from each net plot were randomly selected. The selected plants were labelled and marked by fixing pegs. The one meter length was marked in each of these plots by bamboo pegs. The initial and final plant counts were recorded from the row length.

8.3 Pre harvest studies

a. Plant count

The number of plant per running meter was counted 15 days after sowing.

b. Height of plant

Plant height was measured from base of the plant, *i.e.* from ground level up to the collar of the last fully opened leaf and thereafter up to the tip of the panicle.

c. Number of tillers running meter^{-1}

The total number of tillers produced running meter^{-1} was recorded periodically from one meter row length from each net plot.

Table 6. Details of the biometric and other observations recorded from the treatments

Sr. No.	Particulars	Freq.	Days After Sowing	Plant observed net-1 plot or treatment
A)	**Pre harvest studies**			
	a. Initial plant count	1	10	1 m length
	b. Height of plant (cm)	7	15, 30,45, 60,75, 90 days after sowing and at harvest	5 plants
	c. Total Number of tillers running meter^{-1}	7		1 m length
	d. Dry matter accumulation running meter^{-1}	7		1 m length
B)	**Post-harvest studies**			
	a. Leaf : Stem ratio	1	At harvest	100 gm green plant from net plot
	b. Green fodder yield (q ha^{-1})	1		Net plot area
	c. Dry fodder yield (q ha^{-1})	1		Net plot area
C)	**Chemical studies**			
	I) Initial and at harvest soil analysis For Available Nitrogen, Phosphorous and Potassium (kg ha^{-1})	2	Before sowing and after harvest	From all experimental field
	II) Uptake studies of crop			
	i) Nitrogen uptake (kg ha^{-1})	1	At harvest	One sample from each net plot
	ii) Phosphorous uptake (kg ha^{-1})	1		
	iii) Potassium uptake (kg ha^{-1})	1		

	III) Quality parameters studies of crop			
	i) Crude protein content (per cent)	1	At harvest	One sample from each net plot
	ii) Crude protein yield (q ha^{-1})	1		
	iii) Crude fibre content (per cent)	1		
	iv) Crude fibre yield (q ha^{-1})	1		
	v) Acid detergent fibre content (per cent)	1		
	vi) Neutral detergent fibre content (per cent)	1		

d. Dry matter accumulation running $meter^{-1}$ (g)

A running $meter^{-1}$ plants was sampled from each plot at the time of every observation. The plant was uprooted and its roots were removed. The aerial part were chopped and put in a brown paper bag. Then it was dried in thermostatically controlled oven at a temperature of 50 to 60^0 C till sample was dried and constant weight was recorded.

8.4 Post-harvest studies

a. Leaf : Stem ratio

Leaf : Stem ratio was calculated from the corresponding weights of leaf and stem obtained from each treatment by separating leaves from the stems at harvest of green fodder.

$$L:S = \frac{\text{Leaf weight (g)}}{\text{Stem weight (g)}}$$

b. Green fodder yield (q ha^{-1})

The total green fodder yield produced from each net plot was harvested, weighed and then converted into q ha^{-1}.

c. Dry fodder yield (q ha^{-1})

The total dry fodder yield obtained after harvesting, the green fodder from each net plot was sun dried for about 10 to 15 days and weight was taken and then converted into q ha^{-1}.

9. Chemical studies

9.1 Soil analysis

The treatment wise representative surface soil samples (up to 22.5 cm) were collected both at initial and at harvest with the help of screw auger. These samples were air dried in shade, pounded in wooden mortar and pestle, sieved through 2 and 0.5 mm sieve and stored in plastic bags enclosed in corrugated paper boxes for chemical analysis. The methods used for determination of various soil properties both at initial and at harvest of the crop is given in Table 7.

Table 7. Methods used for soil analysis

Soil analysis			
Sr.No.	**Properties**	**Method**	**Reference**
1.	Texture and textural class of initial soil sample.	Bouycos hydrometer method	Piper (1956)
2.	Soil reaction (pH)	Potentiometric (1:2.5)	Jackson (1973)
3.	Electrical conductivity	Potentiometric (1:2.5)	Jackson (1973)
4.	Organic carbon	Walkley and Black wet oxidation method	Black (1965)
5.	Available Nitrogen	Alkaline permanganate method	Subbaiah and Asija (1956)
6.	Available Phosphorus	Bray's No. 1(0.025 N HCl+ 0.03 N NH_4 F Fextraction)	Black (1965)
7.	Available Potassium	Flame photometry (Neutral normal ammonium acetate)	Jackson (1973)

9.2 Plant analysis

The sampled plants from each net plot were harvested and used for chemical analysis of the nutrient uptake and quality studies. The dried samples were ground to fine powder and kept in the properly labelled polythene bags and used for analysis. The samples were analysed for total N, P, and K content by the methods mentioned in Table 8.

The uptake of nitrogen, phosphorus and potassium (kg ha^{-1}) was worked out by multiplying the percentage of these nutrients in

straw with the corresponding yields or dry weight of the respective constituent.

Table 8. Methods used for plant analysis

Plant analysis			
Sr.No.	**Properties**	**Method**	**Reference**
1.	Total nitrogen	Micro-Khjeldal method	Tandon (1993)
2.	Total phosphorus	Ammonium molybdovanadate method	Tandon (1993)
3.	Total potassium	Flame photometry	Tandon (1993)
4.	Crude protein	Micro-Kjeldhal method	A.O.A.C.,(2005)
5.	Crude fibre	Gravimetric	A.O.A.C.,(2005)
6.	Acid Detergent Fibre content	Van Soest fiber analysis method	(Van soest *et al.*, 1991).
7.	Neutral Detergent Fibre content	Van Soest fiber analysis method	(Van soest *et al.*, 1991).

9.3 Quality studies of crop

9.3.1 Crude protein content

Protein content was considered as the important quality attribute. Quality of fodder was studied by working out the protein percentage in the fodder. The nitrogen percentage in the plant sample was multiplied by a factor 6.25 (A.O.A.C. 2005) to find out the protein content in the fodder oat from the respective treatment.

Per cent protein = 'N' percentage x 6.25

9.3.2 Crude protein yield

The crude protein yield in q ha^{-1} was calculated by the following formula

$$CPY\ (q\ ha^{-1}) = \frac{\text{Dry matter yield } (q\ ha^{-1}) \times \text{Crude protein content (per cent)}}{100}$$

9.3.3 Crude fibre content

Crude fibre is that fraction of total carbohydrate which is not digested. It consist of cellulose, hemicellulose and lignin. The crude fiber content in fodder was determined by the formula given in A.O.A.C. (2005).

$$\text{Crude fibre (per cent)} = \frac{\text{Weight of dried residue (gm) - Weight of ash (g)}}{\text{Weight of dried sample (g)}} \times 100$$

9.3.4 Crude fibre yield

Crude fiber yield was calculated by the formula as given below.

$$\text{CFY (q ha}^{-1}\text{)} = \frac{\text{Dry matter yield (q ha}^{-1}\text{)} \times \text{Crude fiber content (per cent)}}{100}$$

9.3.5 Acid detergent fibre (ADF)

Acid detergent fibre (ADF) content in fodder was calculated by the formula as given below (Van soest *et al.*, 1991).

$$\text{ADF (per cent)} = \frac{\text{(Wt. of crucible + fibre) – Wt. of empty crucible}}{\text{Wt. of dry sample}} \times 100$$

9.3.6 Neutral detergent fibre (NDF)

Neutral detergent fiber (NDF) content in fodder was calculated by the formula as given below (Van soest *et al.*, 1991).

$$\text{NDF (per cent)} = \frac{\text{(Wt. of crucible + Cell wall constituents) – Wt. of empty crucible}}{\text{Wt. of dry sample}} \times 100$$

10. Statistical analysis and interpretation of data

Experimental data were analysed statistically by applying standard method of analysis known as “analysis of variance as applicable to split plot design.” The significance of the treatment differences was tested by variance ratio test (F value), critical difference (C.D.) at 5 per cent level of probability was worked out for

comparison and statistical interpretation of the significance was done on the basis of treatment means (Panse and Sukhatme, 1967).

11. Economics of the treatments

On the basis of the results obtained from the field experiment the economics was worked out. The net return ha^{-1} was calculated on the basis of cost of green fodder and their yield from the respective treatments. The prevailing market price for green fodder were considered. The cost of cultivation of crop under individual treatment was worked out by taking into accounts the cost of all inputs.

CHAPTER-IV

EXPERIMENTAL FINDINGS

The results of the trial entitled "Effect of different levels of nitrogen on performance of fodder oat (*Avena sativa* L.) varieties under lateritic soil of *konkan* region" are presented in this chapter under the following sub headings.

4.1 Plant population studies

4.2 Crop growth and development studies

4.3 Yield contributing character and yield

4.4 Quality studies

4.5 Nutrient studies

4.6 Economics of the treatments

4.1 plant population studies

The initial plant population of oat as influenced due to different nitrogen levels and varieties are presented in Table 9 and graphically depicted in Fig. 3. The mean plant population recorded was 31.56 running meter^{-1}.

Effect of varieties

Perusal of the data showed that, the differences in mean number of plant count per net plot due to different varieties were non significant at 15 days after sowing. Therefore, variation in the yield of oat crop under different treatments was not due to the plant population but it was due to treatments effect only.

Effect of nitrogen levels

Application of nitrogen at different rates did not increase the initial plant population significantly. The application of 100 kg N ha^{-1} recorded numerically higher plant population than other nitrogen levels.

Interaction effect

The interaction effect between varieties and nitrogen levels was non-significant with respect to initial plant population running meter^{-1}.

Table 9. Mean initial plant population (running meter^{-1}) of oat as influenced by different treatments

Treatments	Initial plant population (m^{-1})
Varieties	
V_1 : RO-19	32.15
V_2 : Kent	31.07
V_3 : OS-6	31.48
S.E.m ±	0.34
C.D. at 5 %	N.S
Nitrogen levels	
N_1 : 40 kg ha^{-1}	31.12
N_2 : 60 kg ha^{-1}	31.39
N_3 : 80 kg ha^{-1}	31.43
N_4 : 100 kg ha^{-1}	32.33
S.E.m±	0.58
C.D. at 5 %	N.S
Interaction effect	
S.E.m±	1.01
C.D. at 5 %	N.S.
General mean	31.56

4.2 Crop growth and development studies

The data on growth parameters *viz.* plant height (cm), number of tillers running metere^{-1}, leaf : stem ratio and dry matter accumulation (g) were recorded at 15 days interval up to harvesting are presented here.

4.2.1 Plant height (cm)

Data pertaining to the mean plant height at 15, 30, 45, 50, 60, 75, 90 DAS and at harvest influenced by different treatments are presented in Table 10 and graphically depicted in Fig. 4. Plant height progressively increased with increase in age of the crop and mean plant height was 90.67 cm at harvest.

Table 10. Mean plant height (cm) as influenced by different treatments

Treatments	Plant height (cm) DAS						
	15	30	45	60	75	90	At harvest
Varieties							
V_1 : RO-19	7.04	24.25	42.25	57.18	77.13	92.54	92.69
V_2 : Kent	5.85	22.13	39.36	54.36	74.38	89.42	89.98
V_3 : OS-6	5.68	21.73	38.43	53.75	73.12	89.19	89.37
S.E.m $\pm$	0.23	0.26	0.45	0.58	0.29	0.41	0.41
C.D. at 5 %	0.92	1.04	1.77	2.26	1.13	1.59	1.63
Nitrogen levels							
N_1 : 40 kg ha^{-1}	5.62	20.83	37.44	53.05	72.69	87.41	87.53
N_2 : 60 kg ha^{-1}	5.84	22.39	38.40	53.34	73.71	89.15	89.34
N_3 : 80 kg ha^{-1}	6.51	23.52	41.55	56.42	75.78	91.56	92.09
N_4 : 100 kg ha^{-1}	6.78	24.07	42.66	57.56	77.33	93.42	93.74
S.E.m$\pm$	0.20	0.37	0.75	0.61	0.49	0.54	0.60
C.D. at 5 %	0.60	1.08	2.22	1.82	1.46	1.62	1.77
Interaction effect							
S.E.m$\pm$	0.35	0.63	1.29	1.06	0.85	0.94	1.03
C.D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	2.80	3.07
General mean	6.19	22.73	40.01	55.09	74.87	90.38	90.67

Effect of varieties

The varieties significantly influenced the mean plant height at all the stages of crop growth. Variety RO-19 recorded the significantly the highest plant height followed by varieties Kent and OS-6 at all the growth stages. However, variety Kent was at par with OS-6 during all the growth stages, except at 75 DAS.

Effect of nitrogen levels

The height of plant increased significantly with increase in the level of nitrogen application at all the stages of crop growth under study. Data from the Table 10 implied that, each increment of nitrogen application increased the height of plant over the preceding level. Application of nitrogen at 100 kg ha^{-1} recorded significantly

higher plant height as compared to application of 60 kg N ha^{-1} and 40 kg N ha^{-1} and remained at par with application of 80 kg N ha^{-1} at 15, 30, 45, 60 DAS and at harvest. The plant height was found significantly lower with 40 kg N ha^{-1} at 30, 90 DAS and at harvest and was at par with 60 kg N ha^{-1} at 15, 45, 60 and 75 DAS.

Interaction effect

Interaction between varieties and nitrogen levels was found significant in respect of plant height at 90 DAS and at harvest. Data are presented in Table 11 and 12.

Table 11. Interaction effect between varieties and nitrogen levels on plant height (cm) at 90 DAS.

Varieties X Nitrogen levels (90 DAS)			
Nitrogen levels	**V_1 (RO-19)**	**V_2 (Kent)**	**V_3 (OS-6)**
N_1 (40 kg ha^{-1})	91.08	86.57	84.56
N_2 (60 kg ha^{-1})	91.65	86.45	89.35
N_3 (80 kg ha^{-1})	92.78	90.69	91.20
N_4 (100kg ha^{-1})	94.77	94.32	91.66
S.E.m±		0.96	
C.D. at 5%		2.85	

It was observed from the data presented in Table 11 that treatment combination V_1N_4 *i.e.* variety RO-19 along with application of 100 Kg N ha^{-1} recorded significantly higher plant height at 90 DAS which was found to be at par with treatment combination V_1N_3 *i.e.* (variety RO-19 along with application of 80 kg N ha^{-1}) and V_2N_4 (variety Kent along with application of 100 kg N ha^{-1}) and was significantly superior over rest of the treatment combinations. Treatment combination V_3N_1 *i.e.* variety OS-6 along with application of 40 kg N ha^{-1} recorded the lowest plant height.

Table 12. Interaction effect between varieties and nitrogen levels on plant height (cm) at harvest

Varieties X Nitrogen levels (at harvest)			
Nitrogen levels	**V_1 (RO-19)**	**V_2 (Kent)**	**V_3 (OS-6)**
N_1 (40 kg ha^{-1})	91.08	86.96	84.56

N_2 (60 kg ha^{-1})	91.78	86.74	89.51
N_3 (80 kg ha^{-1})	93.38	91.97	91.53
N_4 (100Kg ha^{-1})	94.85	94.52	91.86
S.E.m±		1.03	
C.D. at 5%		3.07	

Data from the Table 12 revealed that, the treatment combination V_1N_4 *i.e.* variety RO-19 along with application of 100 kg N ha^{-1} recorded significantly higher plant height followed by treatment V_2N_4 *i.e.* variety Kent along with application of 100 kg N ha^{-1} which were at par with each other but significantly superior over rest of the treatment combinations except V_1N_2, V_1N_3, V_2N_4 and V_3N_4. the lowest plant height was observed in treatment combination V_3N_1 *i.e.* variety OS-6 along with application of 40 kg N ha^{-1} as compared to other treatment combination.

4.2.2 Number of tillers running meter^{-1}

Data regarding the mean number of tillers running meter^{-1} of different varieties as influenced periodically by different levels of nitrogen are presented in Table 13 and graphically depicted in Fig. 5.

It is clear from the data that, in all treatments under study the number of tillers running meter^{-1} went on increasing with the advancement in age of the crop up to the harvest. The mean number of tillers at 30 DAS was 82.95 and gradually increased up to 98.31 at harvest.

Effect of varieties

Variety RO-19 recorded significantly higher number of tillers at all the growth stages of crop except 30 DAS where it was found to be at par with variety Kent. At 45, 60, 90 DAS and at harvest variety Kent was found at par with variety OS-6. Oat variety OS-6 recorded minimum number of tillers at all the growth stages.

Effect of nitrogen levels

Scrutiny of data presented in Table 13 denoted that, application of nitrogen significantly enhanced the number of tillers running meter^{-1} at all the growth stages. Application of 100 kg N ha^{-1} recorded the significantly highest number of tillers meter^{-1} at all the

growth stages except 90 DAS and at harvest where it was at par with 80 kg N ha^{-1}. However, 80 kg N ha^{-1} produced number of tillers showing statistical similarity with application of 60 and 40 kg N ha^{-1} at 30 and 45 DAS. The number of tillers with application of nitrogen 60 kg N ha^{-1} found at par with 40 kg N ha^{-1} at all the crop growth stages.

Table 13. Mean number of tillers (running $meter^{-1}$) of oat plant as influenced periodically by different treatments

Treatments	Tillers (running $meter^{-1}$) DAS					
	30	**45**	**60**	**75**	**90**	**At harvest**
Varieties						
V_1 : RO-19	83.74	94.84	97.28	98.72	99.32	99.56
V_2 : Kent	83.47	92.82	95.46	95.68	96.83	97.02
V_3 : OS-6	81.64	91.76	95.13	96.63	96.66	96.94
S.E.m ±	0.43	0.36	0.20	0.20	0.46	0.52
C.D. at 5 %	1.70	1.40	0.78	0.78	1.82	2.04
Nitrogen levels						
N_1 : 40 kg ha^{-1}	81.33	91.49	93.74	94.85	95.31	95.48
N_2 : 60 kg ha^{-1}	81.14	91.41	94.67	95.91	96.21	96.55
N_3 : 80 kg ha^{-1}	83.01	93.17	96.59	97.30	98.67	98.88
N_4 :100 kg ha^{-1}	86.32	96.48	98.84	99.96	100.21	100.44
S.E.m±	0.66	0.67	0.62	0.62	0.61	0.60
C.D. at 5 %	1.96	1.98	1.85	1.85	1.82	1.77
Interaction						
S.E.m±	1.14	1.16	1.08	1.08	1.06	1.03
C.D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General mean	82.95	93.14	96.11	96.61	98.17	98.31

Interaction effect

The interaction effect between varieties and nitrogen levels in respect of number of tillers was found to be non significant at all the stages of crop growth in oat.

4.2.3 Dry matter yield (g)

Data regarding dry matter yield (g) as influenced by different treatments are presented in Table 14 and graphically illustrated in Fig. 6. It was found from the data that, the mean dry matter of oat was 3.30 g at 30 DAS which was gradually increased up to 115.96 g at the harvest.

Table 14. Dry matter (running meter^{-1}) of oat plant as influenced periodically by different treatments

Treatments	Dry matter (g) DAS					
	30	**45**	**60**	**75**	**90**	**At harvest**
Varieties						
V_1 : RO-19	3.37	7.39	13.63	35.65	83.18	118.43
V_2 : Kent	3.33	7.30	13.29	35.17	82.74	116.62
V_3 : OS-6	3.20	7.21	13.22	34.96	82.52	112.85
S.E.m ±	0.08	0.08	0.16	0.33	0.12	0.53
C.D. at 5 %	N.S.	N.S.	N.S.	N.S.	0.47	2.10
Nitrogen levels						
N_1 : 40 kg ha^{-1}	2.14	5.14	9.64	31.80	80.05	112.71
N_2 : 60 kg ha^{-1}	2.68	6.50	10.70	34.49	81.90	114.68
N_3 : 80 kg ha^{-1}	3.24	7.91	15.09	36.23	84.18	116.94
N_4 : 100 kg ha^{-1}	5.14	9.64	18.09	38.51	85.21	119.53
S.E.m±	0.08	0.15	0.14	0.29	0.20	0.48
C.D. at 5 %	0.24	0.14	0.43	0.87	0.58	1.42
Interaction						
S.E.m+	0.14	0.25	0.25	0.51	0.34	0.83
C.D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General mean	3.30	7.29	13.38	35.25	82.83	115.96

Effect of varieties

Data from the Table 14 reveled that, the dry matter was not influenced significantly due to different varieties at 30, 45, 60 and 75 days after sowing. At 90 DAS verity RO-19 recorded significantly higher dry matter then rest of the varieties while variety Kent was found to be statistically similar with variety OS-6. At harvest variety RO-19 produced significantly higher dry matter accumulation

followed by variety Kent which were at par with each other and significantly superior to OS-6.

Effect of nitrogen levels

Data pertaining to periodical mean dry matter production have been presented in Table 14 which indicated that, the application of nitrogen significantly increased the dry matter with increase in the levels of nitrogen application. Application of 100 kg N ha^{-1} recorded significantly higher dry matter accumulation as compared to other nitrogen levels at all the growth stages and at harvest. The lowest dry matter accumulation was found due to the application of 40 kg N ha^{-1}.

Interaction effect

Interaction effect between varieties and nitrogen levels in respect with dry matter accumulation was found to be non significant.

4.3 Yield contributing characters and yield

Data pertaining to leaf: stem ratio, green fodder yield and dry fodder yield as influenced by varieties and nitrogen levels are presented in Table 15 to 19.

4.3.1 Leaf : Stem ratio

Data related to the mean leaf: stem ratio as influenced by different treatments at harvest are presented in Table 15 and graphically illustrated in Fig. 7. The mean leaf: stem ratio of forage oats was 0.77.

Table 15. Mean leaf : stem ratio of oat at harvest as influenced by different treatments.

Treatments	(At harvest)
Varieties	
V_1 : RO-19	0.85
V_2 : Kent	0.82
V_3 : OS-6	0.66
S.E.m ±	0.02
C.D. at 5 %	0.06
Nitrogen levels	
N_1 : 40 kg ha^{-1}	0.67
N_2 : 60 kg ha^{-1}	0.75
N_3 : 80 kg ha^{-1}	0.81
N_4 : 100 kg ha^{-1}	0.87
S.E.m±	0.01
C.D. at 5 %	0.03
Interaction	
S.E.m±	0.02
C.D. at 5 %	N.S.
General mean	0.77

Effect of varieties

It is seen from the data presented in Table 15 that, leaf: stem ratio in respect to the oat varieties was found to be significant at harvest. The oat variety RO-19 recorded the highest leaf: stem ratio followed by Kent which were statistically identical with each other, but significantly superior over variety OS-6. The significantly lowest leaf: stem ratio was recorded by variety OS-6 at the time of harvest.

Effect of nitrogen levels

Data presented in Table 15 reveled that, each increase in the level of nitrogen fertilization significantly increased the leaf: stem ratio over the preceding level. Application of 100 kg N ha^{-1} recorded significantly higher leaf: stem ratio than rest of the treatments *viz.* 80, 60 and 40 kg N ha^{-1} in that descending order of significance.

Interaction effect

The interaction effect between varieties and nitrogen levels in respect to leaf: stem ratio was found to be non significant at harvest.

4.3.2 Green forage yield (q ha^{-1})

The green forage yield (q ha^{-1}) of oat as influenced by different varieties and nitrogen levels are presented in Table 16 and graphically depicted in Fig. 8. The data indicated that mean green forage yield was 265.33 q ha^{-1} and 266.81 kg day^{-1} ha^{-1}.

Effect of varieties

It was revealed from the data presented in Table 16 that, variety RO-19 recorded significantly higher green forage yield than varieties Kent and OS-6. However, variety Kent was found to be statistically identical with variety OS-6 at harvest.

Table 16. Green forage yield of oat as influenced by different

Treatments	Green forage yield	
	(q ha^{-1})	(kg day^{-1} ha^{-1})
Varieties		
V_1 : RO-19	290.60	279.42
V_2 : Kent	253.43	261.27
V_3 : OS-6	251.97	259.76
S.E.m ±	1.58	1.59
C.D. at 5 %	6.21	6.26
Nitrogen levels		
N_1 : 40 kg ha^{-1}	234.98	236.12
N_2 : 60 kg ha^{-1}	250.05	251.34
N_3 : 80 kg ha^{-1}	272.21	273.97
N_4 : 100 kg ha^{-1}	304.08	305.83
S.E.m±	3.45	3.47
C.D. at 5 %	10.26	10.30
Interaction		
S.E.m±	5.98	6.00
C.D. at 5 %	17.77	17.83
General mean	265.33	266.81

treatments

Effect of nitrogen levels

The data pertaining to the green forage yield was significantly influenced by different levels of nitrogen. Application of 100 kg N ha^{-1} recorded the significantly highest green forage yield followed by 80, 60 and 40 kg N ha^{-1} at harvest. The application of nitrogen at 40 kg ha^{-1} recorded the significantly lowest quantity of green forage yield than rest of the nitrogen levels.

Interaction effect

Data presented in Table 16 indicated that interaction of varieties and nitrogen levels with respect to green forage yield was found to be significant.

Table 17. Interaction effect of varieties and nitrogen levels on green forage yield (q ha^{-1})

Varieties X Nitrogen levels			
Nitrogen levels	**V_1 (RO-19)**	**V_2 (Kent)**	**V_3 (OS-6)**
N_1 (40 kg ha^{-1})	264.95	218.52	221.47
N_2 (60 kg ha^{-1})	278.89	222.33	249.18
N_3 (80 kg ha^{-1})	287.99	263.57	265.06
N_4 (100 kg ha^{-1})	330.87	309.22	272.14
S.E.m±		5.98	
C.D. at 5%		17.77	

Glimpses of data presented in Table 17 denoted that, treatment combination V_1N_4 *i.e.* variety RO-19 along with 100 kg N ha^{-1} recorded significantly higher green forage yield over rest of the treatment combinations. Similarly, treatment combination V_2N_4 also produced significantly higher green forage yield than rest of the treatment combination except V_1N_4. Treatment combination V_2N_1 *i.e.* variety Kent along with 40 kg N ha^{-1} recorded the lowest green forage yield than rest of the treatments.

4.3.3 Green forage yield (kg day^{-1} ha^{-1})

Data pertaining to the green forage yield (kg day^{-1} ha^{-1}) was significantly influenced by varieties and nitrogen levels which are presented in Table 16 and graphically depicted in Fig. 9. The mean green forage yield (kg day^{-1} ha^{-1}) was found to be 266.81 at harvest.

Effect of varieties

Data furnished in Table 16 indicated that, different varieties significantly influenced the green forage yield (kg day^{-1} ha^{-1}) of oat. Variety RO-19 recorded significantly higher green forage yield in terms of kg day^{-1} ha^{-1} followed by variety Kent and OS-6 at harvest. However, later two varieties were at par with each other.

Effect of nitrogen levels

Data regarding green forage yield (kg day^{-1} ha^{-1}) was significant due to different levels of nitrogen application. Each increase in the levels of nitrogen application significantly increased the green forage yield over the preceding one. The nitrogen application at 100 kg N ha^{-1} produced significantly higher green forage yield followed by 80, 60 and 40 kg N ha^{-1} in descending order of significance. The significantly lowest green forage yield in terms of kg day^{-1} ha^{-1} was recorded due to application of 40 kg N ha^{-1}.

Interaction effect

Data represented in Table 16 indicated that interaction between varieties and nitrogen levels was significantly influenced the green forage yield (kg day^{-1} ha^{-1}).

Table 18. Interaction effect of varieties and nitrogen levels on green forage yield (kg day^{-1} ha^{-1})

Varieties X Nitrogen levels			
Nitrogen levels	**V_1 (RO-19)**	**V_2 (Kent)**	**V_3 (OS-6)**
N_1 (40 kg ha^{-1})	254.77	225.27	222.32
N_2 (60 kg ha^{-1})	267.84	229.28	256.89
N_3 (80 kg ha^{-1})	276.92	271.72	273.26
N_4 (100 kg ha^{-1})	318.15	318.79	280.56
S.E.m±		6.00	
C.D. at 5%		17.83	

It is reveled from the data presented in Table 18 that, green forage yield (kg day^{-1} ha^{-1}) significantly increased due to interaction between varieties and nitrogen levels. Treatment combination V_1N_4 and

V_2N_4 *i.e.* variety RO-19 and Kent along with application of 100 kg N ha^{-1} recorded significantly higher green forage yield than rest of the treatment combinations. However, earlier both the combinations were statistically at par. Treatment combination V_2N_1 *i.e.* variety Kent along with application of 40 kg N ha^{-1} was found to be statistically similar with V_3N_1 and V_2N_2.

4.3.4 Dry fodder yield (q ha^{-1})

Dry fodder yield of oat in terms of q ha^{-1} as influenced by different varieties and nitrogen levels are presented in Table 19 and graphically depicted in Fig. 10.

Effect of varieties

Data presented in Table 19 reveled that, different oat varieties did not differ significantly with each other in respect of dry fodder yield (q ha^{-1}). However, variety RO-19 recorded numerically higher dry fodder yield (q ha^{-1}) which was followed by variety Kent and OS-6.

Effect of nitrogen levels

The data presented in Table 19 denoted that application of nitrogen at different rates significantly increase the dry fodder yield then preceding level of nitrogen. Application of 100 kg N ha^{-1} significantly increased the dry fodder yield than application of 80, 60 and 40 kg N ha^{-1}. However, yield obtained from 60 kg N ha^{-1} recorded statistically identical with application of 40 kg N ha^{-1} at harvest.

Interaction effect

Interaction effect between varieties and nitrogen levels in respect with dry fodder yield (q ha^{-1}) was found to be not significant.

4.3.5 Dry fodder yield (kg day^{-1} ha^{-1})

Data pertaining to dry fodder yield (kg day^{-1} ha^{-1}) as influenced by different levels of nitrogen and oat varieties are presented in Table 19 and graphically shown in Fig. 11.

Effect of varieties

The different varieties did not differ significantly with each other in respect of dry fodder production (kg day^{-1} ha^{-1}) of oat crop.

Variety RO-19 recorded numerically higher dry fodder production than rest of the varieties *viz.* Kent and OS-6.

Table 19. Dry fodder yield of oat as influenced by different treatments

Effect of nitrogen levels

Data from Table 19 reveled that, the differences in the dry fodder yield (kg day^{-1} ha^{-1}) was found to be graded and significant due to different levels of nitrogen application. The nitrogen application at 100 kg ha^{-1} produced significantly higher dry fodder yield than 80, 60, and 40 kg N ha^{-1}.

Treatments	Dry fodder yield	
	(q ha^{-1})	(kg day^{-1} ha^{-1})
Varieties		
V_1 : RO-19	91.11	77.21
V_2 : Kent	83.18	74.94
V_3 : OS-6	82.96	74.74
S.E.m ±	2.30	2.07
C.D. at 5 %	N.S.	N.S.
Nitrogen levels		
N_1 : 40 kg ha^{-1}	72.20	63.67
N_2 : 60 kg ha^{-1}	77.83	68.64
N_3 : 80 kg ha^{-1}	88.70	78.33
N_4 : 100 kg ha^{-1}	104.28	91.89
S.E.m±	2.00	1.77
C.D. at 5 %	5.93	5.25
Interaction		
S.E.m±	3.46	3.06
C.D. at 5 %	N.S.	N.S.
General mean	85.75	75.63

Interaction effect

Interaction effect between varieties and nitrogen levels in respect with dry fodder yield (kg day^{-1} ha^{-1}) was not significant.

4.4 Quality parameter studies

4.4.1 Crude protein content

Crude protein is the most important constituent determining nutritive value of forage. The information regarding mean

percentage of crude protein in forage oats influenced by different treatments at harvest are presented in Table 20 and graphically depicted in Fig. 12. It was found from the Table 20 that, the mean crude protein content in oat was (11.84 per cent).

Table 20. Crude protein content and yield of oat at harvest as influenced by different treatments

Effect of varieties

Data presented in Table 20 reveled that, the different varieties did not differ significantly in respect of crude protein content in oat. However, variety RO-19 was found numerically superior in crude protein content than variety Kent and OS-6.

Treatments	**Crude protein Content (per cent)**	**Crude protein yield ($q\ ha^{-1}$)**
Varieties		
V_1 : RO-19	12.01	11.09
V_2 : Kent	11.74	9.89
V_3 : OS-6	11.78	9.90
S.E.m ±	0.10	0.34
C.D. at 5 %	N.S.	N.S.
Nitrogen levels		
N_1 : 40 kg ha^{-1}	10.49	7.57
N_2 : 60 kg ha^{-1}	11.09	8.64
N_3 : 80 kg ha^{-1}	12.40	10.99
N_4 : 100 kg ha^{-1}	13.40	13.97
S.E.m±	0.10	0.22
C.D. at 5 %	0.29	0.66
Interaction		
S.E.m±	0.17	0.38
C.D. at 5 %	N.S.	N.S.
General mean	11.84	10.29

Effect of nitrogen levels

It was seen from the data presented in Table 20 that, the application of nitrogen produced beneficial effects on crude protein content. The crude protein content was significantly increased with

increase in the level of nitrogen application. The nitrogen application at 100 kg ha^{-1} recorded higher crude protein content which was significantly higher than all other levels of nitrogen. The lowest crude protein content was observed due to application of 40 kg N ha^{-1}.

Interaction effect

The data presented in Table 20 reveled that, interaction effect between varieties and nitrogen levels in respect with crude protein content was not significant.

4.4.2 Crude protein yield

Data on the mean crude protein yield in q ha^{-1} influenced by different treatments are presented in Table 20 and graphically depicted in Fig. 13.

Effect of varieties

It was seen from the Table 20 that, varieties did not differ significantly with each other in respect of crude protein yield in oat. Variety RO-19 recorded numerically higher crude protein yield than varieties Kent and OS-6.

Effect of nitrogen levels

Scrutiny of data presented in Table 20 denoted that, the nitrogen application produced beneficial effect on crude protein yield of oat. Increase in the level of nitrogen fertilization significantly increased the crude protein yield at all the levels. The nitrogen application at 100 kg ha^{-1} recorded significantly higher crude protein yield than 80, 60 and 40 kg N ha^{-1}. However, it was found lowest at application of 40 kg N ha^{-1}.

Interaction effect

It was seen from the data presented in Table 20 that, the interaction effect between varieties and nitrogen levels was not significant.

4.4.3 Crude fibre content

Data on the percentage of crude fibre content in the plant as influenced by different treatments at harvest are presented in Table

21 and graphically depicted in Fig. 14. The mean crude fiber content in oat at harvest was 25.95 per cent.

Table 21. Crude fiber content and yield of oat at harvest as influenced by different treatments

Effect of varieties

Data presented in Table 21 reveled that, the different oat

Treatments	**Crude fiber Content (per cent)**	**Crude fiber yield (q ha^{-1})**
Varieties		
V_1 : RO-19	26.41	24.20
V_2 : Kent	25.98	21.61
V_3 : OS-6	25.48	21.18
S.E.m ±	0.18	0.58
C.D. at 5 %	N.S.	2.27
Nitrogen levels		
N_1 : 40 kg ha^{-1}	25.38	18.25
N_2 : 60 kg ha^{-1}	25.32	19.70
N_3 : 80 kg ha^{-1}	26.00	23.06
N_4 : 100 kg ha^{-1}	27.12	28.31
S.E.m±	0.26	0.53
C.D. at 5 %	0.78	1.57
Interaction		
S.E.m±	0.46	0.91
C.D. at 5 %	N.S.	N.S.
General mean	25.95	22.33

varieties did not show significant variation in respect of crude fibre content in oat crop. However, variety RO-19 recorded numerically higher crude fibre content than Kent and OS-6.

Effect of nitrogen levels

It was seen from the Table 21 that, the crude fiber content significantly increased with increase in the level of nitrogen application. The application of 100 kg N ha^{-1} resulted into significantly higher crude fiber content as compared to 80, 60 and 40 kg N ha^{-1}. However, application of 80 kg N ha^{-1} was found to be at par with 60 kg N ha^{-1} and 60 kg N ha^{-1} remained same bar with 40 kg N ha^{-1}.

Interaction effect

The data from the Table 21 revealed that, the interaction effect between varieties and nitrogen levels was not significant in respect with crude fibre content.

4.4.4 Crude fiber yield

Data regarding mean crude fiber yield (q ha^{-1}) influenced by different treatments at harvest are presented in Table 21 and graphically depicted in Fig. 15. The mean crude fiber yield at harvest was 22.33 q ha^{-1}.

Effect of varieties

It was revealed from the data presented in Table 21 that, different oat varieties showed significant variation in respect of crude fiber yield (q ha^{-1}) at harvest. Variety RO-19 recorded significantly higher crude fibre yield than varieties Kent and OS-6. However, variety Kent was statistically similar with OS-6.

Effect of nitrogen levels

Different levels of nitrogen significantly influenced the crude fibre yield in oat. Application of 100 kg N ha^{-1} resulted in significantly higher crude fiber yield followed by 80, 60 and 40 kg N ha^{-1} in that descending order of significance. However, application of 60 kg N ha^{-1} was found to be statistically identical with 40 kg N ha^{-1}.

Interaction effect

The interaction effect between varieties and different levels of nitrogen in respect with crude fibre yield was not significant.

4.4.5 Acid Detergent Fibre content (ADF)

Data regarding Acid detergent fibre content (per cent) in oat plant as influenced by different treatments are presented in Table 22 and graphically depicted in Fig. 16. The mean ADF content was 45.06 per cent.

Effect of varieties

The data from Table 22 denoted that, different oat varieties did not differ significantly with each other in respect with acid detergent fiber content in oat crop. Variety OS-6 was numerically superior to Kent and RO-19 in case of ADF content.

Table 22. Acid detergent fiber content in oat at harvest as influenced by different treatments

Treatments	**ADF (per cent)**
Varieties	
V_1 : RO-19	45.00
V_2 : Kent	45.05
V_3 : OS-6	45.14
S.E.m ±	0.16
C.D. at 5 %	N.S.
Nitrogen levels	
N_1 : 40 kg ha^{-1}	43.76
N_2 : 60 kg ha^{-1}	44.14
N_3 : 80 kg ha^{-1}	45.20
N_4 : 100 kg ha^{-1}	47.15
S.E.m±	0.26
C.D. at 5 %	0.79
Interaction	
S.E.m±	0.46
C.D. at 5 %	N.S.
General mean	45.06

Effect of nitrogen levels

Data furnished in Table 22 indicated that, the application of 100 kg N ha^{-1} resulted in significant increase in acid detergent fibre content as compared to application of 80, 60 and 40 kg N ha^{-1}. However, application of 60 kg N ha^{-1} was statistically identical with 40 kg N ha^{-1}.

Interaction effect

The interaction effect between varieties and different levels of nitrogen in respect with acid detergent fibre content was not significant.

4.4.6 Neutral Detergent Fibre content (NDF)

Data pertaining to neutral detergent fibre content (per cent) in oat as affected by various treatments are presented in Table 23 and graphically depicted in Fig. 17. The mean neutral detergent fibre content at harvest was 55.70 per cent.

Table 23. Neutral detergent fiber content in oat at harvest as influenced by different treatment

Treatments	NDF (per cent)
Varieties	
V_1 : RO-19	56.09
V_2 : Kent	55.85
V_3 : OS-6	55.18
S.E.m ±	0.37
C.D. at 5 %	N.S.
Nitrogen levels	
N_1 : 40 kg ha^{-1}	54.17
N_2 : 60 kg ha^{-1}	55.37
N_3 : 80 kg ha^{-1}	56.27
N_4 : 100 kg ha^{-1}	57.02
S.E.m±	0.33
C.D. at 5 %	0.98
Interaction	
S.E.m±	0.57
C.D. at 5 %	N.S.
General mean	55.70

Effect of varieties

Data furnished in Table 23 revealed that, oat varieties did not differ significantly in respect of neutral detergent fiber content in oat crop. Variety RO-19 recorded numerically higher neutral detergent fibre content than varieties Kent and OS-6.

Effect of nitrogen levels

It is revealed from the data presented in Table 23 that application of 100 kg N ha^{-1} significantly increased neutral detergent fibre content in oat crop as compared to 40 and 60 kg N ha^{-1}. However, application of 80 kg N ha^{-1} was found to be statistically identical with application of 60 as well as 100 kg N ha^{-1} at harvest. The significantly lowest neutral detergent fibre content was found at application of 40 kg N ha^{-1}.

Interaction effect

The interaction effect between varieties and different nitrogen levels was found to be not significant in respect with NDF.

4.5 Nutrient uptake studies

4.5.1 Nitrogen content (per cent) in crop

Data pertaining to nitrogen content (per cent) in different varieties of oat as affected by various nitrogen treatments are presented in Table 24. The mean nitrogen content in oat was 1.895 per cent.

Effect of varieties

The data presented in Table 24 reveled that, different oat varieties in respect with nitrogen content did not differ significantly. However, variety RO-19 recorded numerically higher nitrogen content followed by variety Kent and OS-6, respectively.

Effect of nitrogen levels

Nitrogen content in oat was significantly influenced due to different nitrogen levels under study. Application of nitrogen at 100 kg ha^{-1} significantly increased nitrogen content in the crop. The response to nitrogen was graded and significant. The lowest nitrogen content was observed due to application of 40 kg N ha^{-1}.

Interaction effect

The interaction effect between varieties and different nitrogen levels was not significant in respect with nitrogen content in oat.

4.5.2 Nitrogen uptake (kg ha^{-1}) in crop

Data pertaining to nitrogen uptake in oat verities as influenced by various nitrogen treatments are presented in Table 24 and graphically depicted in Fig. 18. The mean nitrogen uptake by crop was 164.70 Kg ha^{-1}.

Table 24. Mean nitrogen content (per cent) and uptake (kg ha^{-1}) in oat at harvest as influenced by different treatments

Treatments	Nitrogen Content (per cent)	Nitrogen uptake (kg ha^{-1})
Varieties		
V_1 : RO-19	1.92	177.37
V_2 : Kent	1.88	158.27
V_3 : OS-6	1.89	158.47
S.E.m ±	0.02	5.40
C.D. at 5 %	N.S.	N.S.
Nitrogen levels		
N_1 : 40 kg ha^{-1}	1.68	121.16
N_2 : 60 kg ha^{-1}	1.77	138.22
N_3 : 80 kg ha^{-1}	1.98	175.92
N_4 : 100 kg ha^{-1}	2.14	223.50
S.E.m±	0.02	3.54
C.D. at 5 %	0.05	10.52
Interaction		
S.E.m±	0.03	6.13
C.D. at 5 %	N.S.	N.S.
General mean	1.895	164.70

Effect of varieties

The data in Table 24 regarding with nitrogen uptake in varieties did not show any significant variation. Numerically variety RO-19 recorded highest nitrogen uptake than Kent and OS-6.

Effect of nitrogen levels

The data presented in Table 24 revealed that, application of 100 kg N ha^{-1} noted significantly higher nitrogen uptake in oat plant as compared to 80, 60 and 40 kg N ha^{-1}. However, the significantly lower nitrogen uptake was recorded from application of 40 kg N ha^{-1}.

Interaction effect

The interaction effect between varieties and different nitrogen level was not differ significantly in respect with nitrogen uptake in oat.

4.5.3 Phosphorus content (per cent) in crop

Data regarding phosphorus content (per cent) in oat plant as influenced by various treatments are presented in Table 25. The mean phosphorus content recorded was 0.201 per cent.

Effect of varieties

The data regarding phosphorus content (per cent) in oat plants as influenced by different varieties are presented in Table 25 which did not show any significant variation. Numerically, variety RO-19 recorded highest phosphorus content than Kent and OS-6.

Effect of nitrogen

With respect to phosphorus content in oat, the effect of various nitrogen levels was found to be significant. Among different nitrogen levels, phosphorus content in oat was significantly higher under application of 100 kg N ha^{-1} was superior over rest of the treatments except 80 kg N ha^{-1}. However, application of 80 kg N ha^{-1} was found statistically identical with 60 kg N ha^{-1}. The significantly lower phosphorus content was recorded at 40 kg N ha^{-1}.

Table 25. Mean phosphorus content (per cent) and uptake (kg ha^{-1}) in oat at harvest as influenced by different treatments

Treatments	Phosphorous content (per cent)	Phosphorous uptake (kg ha^{-1})
Varieties		
V_1 : RO-19	0.206	18.84
V_2 : Kent	0.195	16.39
V_3 : OS-6	0.203	17.07
S.E.m ±	0.009	1.15
C.D. at 5 %	N.S.	N.S.
Nitrogen levels		
N_1 : 40 kg ha^{-1}	0.184	13.35
N_2 : 60 kg ha^{-1}	0.198	15.44
N_3 : 80 kg ha^{-1}	0.207	18.31
N_4 : 100 kg ha^{-1}	0.217	22.64
S.E.m±	0.004	0.63
C.D. at 5 %	0.011	1.86
Interaction		
S.E.m±	0.006	1.09
C.D. at 5 %	N.S.	N.S.
General mean	0.201	17.43

Interaction effect

The interaction effect between varieties and different nitrogen levels was not significantly influenced on phosphorus content in oat.

4.5.4 Phosphorus uptake (kg ha^{-1}) in crop

Data regarding phosphorus uptake (kg ha^{-1}) in oat as influenced by various treatments are presented in Table 25 and graphically depicted in Fig. 19. The mean phosphorus uptake recorded was 17.43 kg ha^{-1}.

Effect of varieties

The data regarding phosphorus uptake (kg ha^{-1}) in oat varieties are presented in Table 25, which did not show any

significant variation. Numerically variety RO-19 recorded highest phosphorus uptake than Kent and OS-6.

Effect of nitrogen levels

Phosphorus uptake in oat was significantly influenced due to various nitrogen levels under study. Significantly, higher phosphorus uptake by oat was found under application of 100 kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1} in that descending order of significance. The response was well marked and the differences between any two consecutive nitrogen levels were significant. The lowest phosphorus uptake recorded by application of 40 kg N ha^{-1}.

Interaction effect

The interaction effect between varieties and different nitrogen level was not significantly influence on phosphorus uptake in oat.

4.5.5 Potassium content (per cent) in crop

Data pertaining to potassium content (per cent) in different varieties of oat plants as influenced by various treatments are presented in Table 26. The mean potassium content recorded was 1.860 per cent.

Effect of varieties

It is seen from the Table 26 that, the different oat varieties did not show any significant variation in respect with potassium content (%) after harvest. Numerically RO-19 recorded higher potassium content followed by variety Kent and OS-6 respectively.

Effect of nitrogen levels

Data regarding effect of different levels of nitrogen application significantly influenced the potassium content in oat. Among different treatments, application of 100 kg N ha^{-1} recorded significantly higher potassium content (per cent) in oat plants over rest of the nitrogen levels. However, application of 80 kg N ha^{-1} was found at par with application of 60 kg N ha^{-1} and 60 kg N ha^{-1} remained same bar with 40 kg N ha^{-1} at harvest.

Interaction effect

It is seen from the Table 26 that, the interaction effect between varieties and different nitrogen levels was not significant in respect with potassium content in oat.

Table 26. Mean potassium content (per cent) and uptake (kg ha^{-1}) in oat at harvest as influenced by different treatments

Treatments	Potassium content (per cent)	Potassium uptake (kg ha^{-1})
Varieties		
V_1 : RO-19	1.883	173.09
V_2 : Kent	1.850	154.67
V_3 : OS-6	1.848	154.14
S.E.m ±	0.013	4.88
C.D. at 5 %	N.S.	N.S.
Nitrogen levels		
N_1 : 40 kg ha^{-1}	1.781	128.63
N_2 : 60 kg ha^{-1}	1.804	140.45
N_3 : 80 kg ha^{-1}	1.854	164.39
N_4 : 100 kg ha^{-1}	2.001	209.06
S.E.m±	0.025	4.50
C.D. at 5 %	0.073	13.36
Interaction		
S.E.m±	0.043	7.79
C.D. at 5 %	N.S.	N.S.
General mean	1.860	16O.63

4.5.6 Potassium uptake (kg ha^{-1}) in crop

Data regarding potassium uptake (kg ha^{-1}) in oat as influenced by various treatments are presented in Table 26 and graphically depicted in Fig. 20. The mean value of potassium uptake recorded was 160.63 kg ha^{-1}.

Effect of varieties

The data presented in Table 26 revealed that, different oat varieties did not show any significant variation in potassium uptake (kg ha^{-1}) after harvest. However, variety RO-19 was numerically superior to Kent and OS-6.

Effect of nitrogen levels

With respect to potassium uptake in oat, the effect of various nitrogen levels was found to be significant. Among different nitrogen levels, potassium uptake in oat was significantly higher under application of 100 kg N ha^{-1} than the other levels of nitrogen. However, nitrogen level 60 kg ha^{-1} noted statistically similar potassium uptake as that of 40 kg N ha^{-1}.

Interaction effect

The interaction effect between varieties and different nitrogen levels was not differ significantly in respect with potassium uptake in oat.

4.5.7 Soil studies

4.5.7.1 Available nitrogen

Data pertaining to available nitrogen in the soil after harvest of oat crop as affected by various treatments are given in Table 27 and graphically depicted in Fig. 21. The mean available nitrogen in the soil was 222.07 kg ha^{-1}.

Effect of varieties

Availability of nutrients in the soil after harvest of oat crop was significantly influenced by different oat varieties. The data presented in Table 27 revealed that, variety Kent recorded significantly higher available nitrogen in soil than the variety RO-19. However, varieties RO-19 and OS-6 were at par with each other.

Effect of nitrogen levels

Increasing levels of nitrogen significantly increased available nitrogen in soil. Data given in Table 27 revealed that application of 100 kg N ha^{-1} recorded significantly higher available nitrogen followed by 80, 60 and 40 kg N ha^{-1} in that descending order. Application of 40 kg N ha^{-1} recorded significantly lower available nitrogen in the soil.

Table 27. Mean available Nitrogen, Phosphorus and Potassium (kg ha^{-1}) in soil after harvest of oat as influenced by different treatments

Interaction effect

It is observed from the data presented in Table 27 that, the

Treatments	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Varieties			
V_1 : RO-19	216.63	22.61	203.63
V_2 : Kent	226.93	22.85	213.35
V_3 : OS-6	222.66	21.27	206.76
S.E.m ±	1.66	0.32	0.90
C.D. at 5 %	6.52	1.25	3.53
Nitrogen levels			
N_1 : 40 kg ha^{-1}	184.94	19.52	194.48
N_2 : 60 kg ha^{-1}	212.07	22.03	201.33
N_3 : 80 kg ha^{-1}	235.52	22.92	211.85
N_4 : 100 kg ha^{-1}	255.75	24.50	224.00
S.E.m±	2.54	0.30	1.19
C.D. at 5 %	7.56	0.90	3.54
Interaction			
S.E.m±	4.40	0.52	2.06
C.D. at 5 %	N.S.	N.S.	N.S.
General mean	222.07	22.24	207.91

interaction effect between different varieties of oat and nitrogen levels with respect to available nitrogen in soil after harvest was not significant.

4.5.7.2 Available Phosphorus

Data pertaining to available phosphorus in the soil after harvest of oat crop as influenced by various treatments are given in Table 27 and graphically depicted in Fig. 21. The mean available phosphorus in soil was recorded 22.24 kg ha^{-1}.

Effect of varieties

Data regarding available phosphorus in soil as influenced by different oat varieties are presented in Table 27. It was revealed that variety Kent recorded significantly higher available phosphorus in soil followed by variety RO-19 which were found to be at par with each other. Variety OS-6 recorded lower available phosphorus in soil than rest of the varieties.

Effect of nitrogen levels

Availability of phosphorus in the soil after harvest of oat crop was significantly influenced by different levels of nitrogen. Increasing levels of nitrogen significantly increased the available phosphorus in the soil. Available phosphorus in soil was significantly more available due to nitrogen application at 100 kg ha^{-1} as compared to rest of the treatments. However, application of 80 kg N ha^{-1} and 60 kg N ha-^{1} behaved statistically similar.

Interaction effect

The interaction effect between varieties and nitrogen levels due to different treatments was found to be non significant.

4.5.7.3 Available Potassium

Data regarding available potassium in soil after harvest of oat crops as affected by various treatments are given in Table 27 and graphically depicted in Fig. 21. The mean available potassium in soil was 207.91 kg ha^{-1}.

Effect of varieties

It was found from the data depicted in Table 27 that, variety Kent showed significantly higher available potassium in soil then OS-6 and RO-19. However, variety OS-6 was at par with RO-19 in this respect.

Effect of nitrogen levels

Nitrogen application significantly increased the available potassium in soil. The response was graded and significant up to application of 100 kg N ha^{-1}. The lowest available potassium in the soil was recorded at 40 kg N ha^{-1}.

Interaction effect

The interaction effect between varieties and nitrogen levels in respect with potassium availability in soil was found to be non significant**.**

4.6 Economics of the treatments

The data regarding the economics of oat cultivation as influenced by different nitrogen levels and varieties are presented in Table 28.

Table 28. Mean total cost, gross return, net return and B: C ratio (after harvest) of oat plant as influenced by different treatments

4.6.1 Total cost

The data presented in Table 28 implied that the mean value of total cost was Rs. 58451.03 ha^{-1}.

Treatments	**Total cost (₹ ha^{-1})**	**Gross return (₹ ha^{-1})**	**Net return (₹ ha^{-1})**	**B:C ratio (₹ ha^{-1})**
Varieties				
V_1 : RO-19	60135.51	116239.38	56103.86	1.93
V_2 : Kent	57657.46	101371.08	43713.62	1.75
V_3 : OS-6	57560.12	100787.04	43226.92	1.75
Nitrogen levels				
N_1 : 40 kg N ha^{-1}	55986.46	93993.35	38006.89	1.68
N_2 : 60 kg N ha^{-1}	57284.99	100018.99	42734.01	1.74
N_3 : 80 kg N ha^{-1}	59056.76	108884.14	49827.38	1.84
N_4 : 100 kg N ha^{-1}	61475.91	121633.51	60157.60	1.97
General mean	58451.03	106132.50	47681.47	1.81

Effect of varieties

Glimpses of the Table 28 insinuated that, the cost of cultivation was numerically higher under variety RO-19 (Rs. 60135.51

ha^{-1}) followed by variety Kent (Rs. 57657.46 ha^{-1}) and OS-6 (Rs. 57560.12 ha^{-1}).

Effect of nitrogen levels

Cost of cultivation was numerically maximum under application of 100 kg N ha^{-1} (Rs. 61475.91 ha^{-1}) followed by treatments 80 kg N ha^{-1} (Rs. 59056.76 ha^{-1}), 60 kg N ha^{-1} (Rs. 57284.99 ha^{-1}) and 40 kg N ha^{-1} (Rs. 55986.46 ha^{-1}).

4.6.2 Gross return

Data furnished in Table 28 revealed that, the mean gross return of oat was Rs.106132.50 ha^{-1}.

Effect of varieties

Scrutiny of the Table 28 implied that, gross returns were numerically higher in variety RO-19 (Rs. 116239.38 ha^{-1}) followed by variety Kent (Rs. 101371.08 ha^{-1}) and OS-6 (Rs. 100787.04 ha^{-1}).

Effect of nitrogen levels

Gross returns were numerically maximum with application of 100 kg N ha^{-1} (Rs. 121633.51 ha^{-1}) followed by application of 80 kg N ha^{-1} (Rs. 108884.14 ha^{-1}), 60 kg N ha^{-1} (Rs. 100018.99 ha^{-1}) and 40 kg N ha^{-1} (Rs. 93993.35 ha^{-1}).

4.6.3 Net return

Data presented in Table 28 revealed that the mean net returns was Rs. 47681.47 ha^{-1}.

Effect of varieties

Data regarding net profit indicated that, variety RO-19 recorded numerically highest net profit (Rs. 56103.86 ha^{-1}) followed by variety Kent (Rs. 43713.62 ha^{-1}) and OS-6 (Rs.43226.92 ha^{-1}), respectively.

Effect of nitrogen levels

Net returns were found numerically maximum with the application of 100 kg N ha^{-1} (Rs. 60157.60 ha^{-1}) as compared to application of 80 kg N ha^{-1} (Rs. 49827.38 ha^{-1}), 60 kg N ha^{-1} (Rs. 42734.01 ha^{-1}) and 40 kg N ha^{-1} (Rs. 38006.89 ha^{-1}), respectively.

4.6.4 B: C ratio

Data presented in Table 28 showed benefit cost ratio of different treatments. The mean value of B : C ratio was 1.81.

Effect of varieties

The higher B : C ratio was recorded due to the variety RO-19 (1.93) as compared to variety Kent (1.75) and OS-6 (1.75).

Effect of nitrogen levels

The data presented in Table 28 revealed that the application of 100 kg N ha^{-1} was very much remunerative which has given the highest B : C ratio of 1.97 followed by the treatment 80 kg N ha^{-1} (1.84), 60 kg N ha^{-1} (1.74) and 40 kg N ha^{-1} (1.68), respectively.

4.6.5 Economics of the treatment combinations

The data on the total cost, gross returns, net returns and B : C ratio as influenced by different treatments combinations are presented in Table 29 and graphically depicted in Fig. 22.

Table 29. Mean total cost, gross returns, net returns and B: C ratio influenced by different treatment combinations

Treatment combination	Total cost (₹ ha^{-1})	Gross returns (ha^{-1})	Net returns (ha^{-1})	B:C Ratio
V_1N_1	57984.72	105982.91	47998.18	1.83
V_1N_2	59185.91	111424.50	52238.60	1.88
V_1N_3	60109.31	115199.43	55090.12	1.92
V_1N_4	63262.10	132350.67	69088.56	2.09
V_2N_1	54888.81	87407.41	32518.60	1.59
V_2N_2	55441.84	88960.11	33518.27	1.60
V_2N_3	58480.63	105427.35	46946.72	1.81
V_2N_4	61818.57	123689.46	61870.89	2.00
V_3N_1	55085.86	88589.74	33503.88	1.61
V_3N_2	57227.22	99672.36	42445.15	1.74
V_3N_3	58580.35	106025.64	47445.29	1.81
V_3N_4	59347.06	108860.40	49513.34	1.83

It was observed that the higher total cost was recorded by the treatment combination V_1N_4 (RO-19 + 100 kg N ha^{-1}) which was

Rs. 63262.10 ha^{-1}. The lowest cost of production was recorded by the treatment combination V_2N_1 (Kent + 40 kg N ha^{-1}) that of Rs. 54888.81 ha^{-1}.

The highest gross returns was recorded by the treatment combination V_1N_4 (RO-19 + 100 kg N ha^{-1}) which was Rs. 132350.67 ha^{-1} while the lowest gross returns was in the treatment combination V_2N_1 (Kent + 40 kg N ha^{-1}) that of Rs.87407.41 ha^{-1}.

The highest net returns was recorded by the treatment combination V_1N_4 (RO-19+ 100 kg N ha^{-1}) which was Rs. 69088.56 ha^{-1} while the lowest net returns was in the treatment combination V_2N_1 (Kent + 40 kg N ha^{-1}) that of Rs. 32518.60 ha^{-1}.

The highest B : C ratio (2.09) was recorded by the treatment combination V_1N_4 (RO-19 + 100 kg N ha^{-1}) while the lowest B : C ratio (1.59) was in the treatment combination V_2N_1 (Kent + 40 kg N ha^{-1}).

CHAPTER-V

DISCUSSION

The results of the present investigation have been reported in the previous chapter. This chapter deals with the probable reasons for the variation observed in different growth parameters, yield attributes, yield, nutrient content and their uptake, quality parameters, soil fertility and economics as a result of the imposition of treatments and substantiate them, wherever, possible with the available references from the literature in order to establish the effect and cause relationship. The entire chapter has been divided for the sake of convenience into following sub heads.

5.1 Soil, weather and crop growth

5.2 Effect of varieties

5.3 Effect of nitrogen levels

5.4 Interaction

5.4 Economics of different treatment combinations

5.1 Soil, weather and crop growth

The crop growth is basically influenced by soil conditions and weather. Before going into discussion of the present investigation, it is important to discuss the weather conditions to which the crop was exposed and the soil conditions on which it was grown.

The analysis of the initial soil sample indicated that, the soil of the experimental plot was sandy clay loam in texture, slightly acidic in pH and medium in organic carbon content. It was medium in available nitrogen and available potassium and low in available phosphorus (Table 1). The soil was levelled, well drained and uniform in depth.

Among the various factors responsible for affecting the growth and yield performance of crop, the weather conditions plays a key role. The various weather parameters pertaining to *rabi,* 2015 crop season are presented in Table 3 and graphically depicted in Fig. 1. The meteorological data (Table 1) showed that, the average

maximum and minimum temperatures were in the range of 28.9^{0}C to 34.7^{0}C and 11.4^{0}C to 20.6^{0}C, respectively. The mean relative humidity during crop period ranged from 82 to 95 per cent in morning and 29 to 56 per cent in evening, respectively. The sunshine hours were between 6.0 to 8.5 hours day^{-1}.

The metrological data revealed that the weather was, by and large, congenial for the development of oat crop without the incidence of any major pests or diseases during crop growth period. Thus, the observed differences in growth were mainly due to treatment effects.

Nitrogen plays an important role in the growth and development of plants as it is an important constituent of protein and is required by plants in higher quantity. Phosphorus on the other hand is essential for cell division, root development and reproductive growth of the plant. While potassium is important for translocation of photosynthates and maintaining water balance in plants. Soil of Konkan region are low to medium in available nitrogen and phosphorus because of their high fixation ability. Therefore, there is response to the applied nitrogen and phosphorus. In this trial, a remarkable influence of nitrogen on the yield potential of oat crops was observed.

5.2. Effect of varieties.

The forage production trial basically depends upon the crop, its potential variety and the management relating to fertilizer application. The effects of different oat varieties in relation with different growth parameters, yield and yield attributing characters are discussed in this chapter.

5.2.1 Plant population

The number of plants of different varieties of oat *viz.* RO-19, Kent and OS-6 in per meter row length at 15 DAS did not differ significantly due to different nitrogen levels. This indicated that the plant population in experiment plot was uniform in all the treatments. Therefore, the variation observed in different growth, yield attributes

and yield of oat crop in present investigation were entirely due to the imposition of different nitrogen levels.

5.2.2 Growth parameters

It is evident from the data presented in previous chapter (Table 10 to 14) that the growth and development parameters of oat varieties *viz.*, plant height, number of tillers running meter^{-1} and dry matter accumulation running meter^{-1} were significantly influenced by different varieties throughout the crop growth period.

The crop growth become faster from 15, 30, 45, 60, 75 to 90 DAS but thereafter, the rate of increase in plant height was slow at harvest (*i.e.* at 50 % flowering), because at 90 DAS panicle emergence out and growth rate started reducing in terms of height. The higher plant height was observed in variety RO-19 from 30 DAS up to the harvest as compared to variety Kent and OS-6 while the differences between Kent and OS-6 were not up to the mark and remained statistically identical with each other at all growth stages. This might be due to particular characteristics of varieties, which in turn promoted greater photosynthesis and ultimately resulted in increased vegetative growth. Similar results were reported by Pathan and Bhilare, (2009a) who observed that variety RO-19 recorded higher plant height than Kent and OS-6. Roshan *et al.*, (2012) also recorded that the variety OS-6 to be statistically identical with Kent in respect with height. In all the treatments, the number of tillers running meter^{-1} went on increasing with the advancement in age of the crop up to age of 45 DAS and thereafter slowly increased up to 90 DAS and at harvest. Variety RO-19 recorded significantly higher number of tillers at all the growth stages of crop except 30 DAS where it was found to be at par with variety Kent. At 45, 60, 90 DAS and at harvest variety Kent was found same bar with variety OS-6 and OS-6 recorded minimum number of tillers at all the growth stages. Similar type of results were obtained by Singh *et al.,* (2002), Pathan and Bhilare, (2009a), Roshan *et al.,* (2012) and Siloriya *et al.,* (2013).

The mean dry matter accumulation by crop was increased with the increase in the duration of crop and was highest at harvest. Increase in dry matter production per running meter is a first step towards achieving higher fodder yield. Dry matter production is an important pre-requisite for higher dry fodder yield as it signifies photosynthetic ability of the crop and also indicates other synthetic processes during developmental sequences. Mean dry matter production per plant of oat varieties was non significant at 30, 45, 60 and 75 DAS. The increased dry matter per plant may be attributed to the significant increase in morphological and physiological parameters which are responsible for the photosynthetic capacity of the plant thereby, increasing the biological yield. Application of nitrogen at panicle initiation stage produces higher dry matter. At 90 DAS variety RO-19 recorded significantly higher dry matter then rest of the varieties; at the same time variety Kent was found to be statistically similar with variety OS-6. Similarly, at harvest variety RO-19 noted significantly higher dry matter accumulation and was at par with Kent and significantly superior over OS-6. The more number of leaves with better availability of sunshine and moisture has further synthesized more food material which is evident from the accumulation of more dry matter in the oat crop. These results confirm the findings of Singh *et al.*, (2002), Pathan and Bhilare, (2009a) and Roshan *et al.,* (2012).

5.2.3 Yield attributes and yield

Better plant height, more number of tillers, more number and size of leaves and higher leaf: stem ratio are the important yield contributing characters which are related to economic yield of a cereal forage crop therefore main objective of the agronomist is to increase the economic yield which is green fodder yield and dry fodder yield in case of fodder oat. The plant height and number of tillers have been described earlier as growth parameters of the crop.

At harvest, the leaf: stem ratio (Table 15) was found to be higher in variety RO-19 followed by Kent which was statistically

identical with each other, but significantly superior over variety OS-6. The significantly lowest leaf: stem ratio was recorded by variety OS-6 at the time of harvest. This might be associated with phenotypic character of RO-19 variety *i.e.* broader leaf size and thick stem than variety Kent and OS-6. These results are in a close vicinity to those reported by Pathan and Bhilare, (2009a).

The green forage yield (q ha^{-1} and kg day^{-1} ha^{-1}) and dry fodder yield (q ha^{-1} and kg day^{-1} ha^{-1}) as influenced by different treatments are presented in Table 14 and 17, respectively. The data revealed that, green forage yield (q ha^{-1} and kg day^{-1} ha^{-1}) was observed significantly higher under variety RO-19 followed by variety Kent and OS-6. However, variety Kent was found to be at par with variety OS-6 in respect with green forage yield (q ha^{-1}). Variety RO-19 recorded 12.79 per cent and 13.29 per cent higher green forage yield (q ha^{-1}) over variety Kent and OS-6, respectively. However, green forage yield (kg day^{-1} ha^{-1}) produced by variety RO-19 was significantly higher as compared to variety Kent and OS-6. It was recorded 6.49 per cent and 7.04 per cent higher over variety Kent and OS-6, respectively. The nutrients were available for the better growth and development, which resulted in to superior growth and yield attributes and consequently the higher yield of crop. These results are in confirmation with those obtained from Bagul *et al.,* (2008), Shekara *et al.,* (2008), Pathan *et al.,* (2009a) and Pathan and Bhilare, (2009b).

It is clear from the result reported in Table 19 that dry fodder yield in terms of (q ha^{-1} and kg day^{-1} ha^{-1}) did not differ significantly in respect with varieties. However, variety RO-19 recorded higher dry fodder yield in terms of (q ha^{-1} and kg day^{-1} ha^{-1}) than Kent and OS-6. It recorded 8.70 per cent and 8.94 per cent higher dry fodder yield (q ha^{-1}) over Kent and OS-6 respectively. Similar variety recorded 2.94 per cent and 3.20 per cent higher dry fodder yield (kg day^{-1} ha^{-1}) than Kent and OS-6, respectively. Increase in dry fodder yield was the cumulative effect of better growth attributes resulted in better partitioning of photosynthtes into yield

attributes and finally produced maximum dry fodder yield. The better plant growth and improved yield attributes which finally led to higher dry fodder yield was also reported by Mahale *et al.,* (2004), Bagul *et al.,* (2008), Pathan and Bhilare, (2009a) and Pathan *et al.,* (2009b).

5.2.4 Nutrient content, uptake and quality

The data presented in Table 20 and 21 revealed that, no any significant differences was found in crude protein content, crude fibre content, crude protein yield and crude fibre yield in respect with varieties. Variety RO-19 was found numerically higher in above mentioned quality parameters followed by variety Kent and OS-6, respectively. However, variety Kent was at par with OS-6 in respect with crude fibre yield. This might be due to treatment effects and particular characteristics of varieties. Increased primary nutrient uptake by plant also increased crude protein content and yield. These results are in close vicinity with those reported by Raghubanshi *et al.,* (2002), Pathan *et al.,* (2005) and Bagul *et al.,* (2008).

The acid detergent fibre content and neutral detergent fibre content were not influenced significantly by different varieties. Variety OS-6 recorded maximum acid detergent fibre content followed by variety Kent and RO-19. However, variety RO-19 noted higher neutral detergent fibre content than rest of the varieties *viz,* Kent and OS-6.

The different oat varieties *viz.,* RO-19, Kent and OS-6 did not show significant variation in nitrogen content and nitrogen uptake in plants. RO-19 recorded higher nitrogen content and uptake followed by varieties Kent and OS-6.

It is cleared from the result reported in Table 25 and 26 that, different oat varieties did not differ significantly in respect with phosphorus and potassium content and uptake. Variety RO-19 registered maximum phosphorus and potassium content in plants. It also recorded higher uptake of phosphorus and potassium. This might be due to higher accumulation of dry matter and primary nutrient content, which led to higher nutrient removal by the crop.

5.2.5 Available nutrient in soil after harvest of crop

The available N, P_2O_5 and K_2O content in soil after harvest of oat varieties at 50 % flowering were found to be significant in respect with varieties. The data presented in Table 27 revealed that, the plots where variety Kent was grown recorded significantly higher available nitrogen, phosphorus and potassium in soil followed by varieties RO-19 and OS-6 in case of available phosphorous and varieties OS-6 and RO-19 in case of available nitrogen and potassium. This might be due to higher nutrient availability in the rhizosphere and the uptake of respective nutrient by the particular variety.

5.2.6. Economics

Economics of the different oat varieties cultivation indicated that variety RO-19 gave the highest net returns of (Rs. 56103.86 ha^{-1}) followed by variety Kent (Rs. 43713.62 ha^{-1}) and OS-6 (Rs.43226.92 ha^{-1}), respectively. The highest B: C ratio was recorded by variety RO-19 (1.93) followed by the varieties Kent (1.75) and OS-6 (1.75). The increased net returns and benefit: cost ratio in a particular variety were mainly due to its highest green forage yield and dry fodder yield. These results confirmed the findings of Sharma and Bhunia (2001), Jha *et al.,* (2012), Luikham *et al.,* (2012) and Dubey *et al.,* (2013).

5.3 Effect of nitrogen levels

Nitrogen in ample quantity is known to stimulate plant growth by increasing plant height, leaves, tillers or branches and finally help to add dry matter. Data presented in the previous chapter revealed that, nitrogen fertilization favoured a simulative growth which ultimately led to enhance the forage production. The levels of nitrogen studied showed differential responses on growth, yield and nutritive quality of forage oat.

Nitrogen application brought a remarkable effect on the plant height, plant tillers, leaf: stem ratio, dry matter yield, green forage yield, dry fodder yield and nutritive quality of oat.

5.3.1 Plant population

The number of plants of different varieties of oat per meter row length counted at 15 DAS was not influenced significantly due to different nitrogen levels. Application of 100 kg N ha^{-1} recorded numerically higher plant population followed by application of 80 kg N ha^{-1} and 60 kg N ha^{-1}. Lower plant population was recorded due to application of 40 kg N ha^{-1}. These results confirmed the findings of Bhilare and Joshi, (2008), Pathan and Bhilare, (2009a) and Dubey *et al.*, (2013).

5.3.2 Growth parameters

A remarkable influence of nitrogen levels on the growth characters of oat crop was not observed during earlier growth period, it was observed during later growth period which coincided with grand growth stage of oat (Table 10 to 14).

It was observed from Table 10 that, the plant height gave significant responses to application of different nitrogen levels at all the growth stages of crop under study. It was found that, the plant height increased significantly with increase in the levels of nitrogen fertilization. In the present investigation, application of 100 kg N ha^{-1} recorded maximum plant height followed by 80 kg N ha^{-1} which were at par with each other at 15, 30, 45, 60 DAS and at harvest but found significantly superior over rest of the treatments at all the growth stages. However, at 15, 45, 60 and 75 DAS, application of 60 kg N ha^{-1} was found to be statistically identical with 40 kg N ha^{-1}. The plant height increased significantly throughout growth period up to 90 DAS; thereafter, there were no much changes in height.

It is generally identified that, nitrogen in ample quantities increases plant growth by cell elongation and cell division, both in terms of enhancing cell multiplication thereby increasing the plant height. Similar findings were also be reported by Mahale *et al.,* (2003), Bhilare *et al.,* (2008) and Pathan *et al.,* (2009a).

In case of mean number of tillers running meter^{-1} (Table 13) significantly response to nitrogen fertilization was observed at all the stages of crop growth. Nitrogen application produced higher number of tillers at all the growth stages. Application of 100 kg N ha^{-1} recorded significantly higher number of tillers per meter row length at all the growth stages except 90 DAS and at harvest where it was at par with 80 kg N ha^{-1}. However, the number of tillers recorded with application of 60 kg N ha^{-1} was at par with 40 kg N ha^{-1} at all the growth stages.

Nitrogen levels enhanced the dry matter accumulation in oat crop significantly from 30 DAS up to harvest. At initial stage, the rate of dry matter production was rather slow. However, at 60 DAS and onwards the crop entered into a phase of rapid rate of dry matter production and at final stage it lowered to some extent, following sigmoid growth curve. At 30, 45, 60, 75 and 90 DAS, mean dry matter was significantly maximum at application of 100 Kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1}. However, at harvest it was found to be at par with 80 kg N ha^{-1}. This might be due to higher level of nitrogen application which helped in synthesizing more photosynthates resulting in higher dry matter accumulation. These results are line with those reported by Kumar *et al.,* (2001), Bhilare and Joshi, (2008), Pathan *et al.,* (2009b) and Jha *et al.,* (2012).

5.3.3 Yield attributes and yield

Leaf: stem ratio was recorded significantly higher in treatment 100 kg N ha^{-1}. However, the lowest leaf: stem ratio was found with application of 40 kg N ha^{-1} at harvest. Generally, nitrogen influenced chlorophyll content of leaf and leaf area, thus, it helped to increase the photosynthetic activity and ultimately reflected into increased growth parameters of oat crop. These result confirm the finding of Pathan and Bhilare, (2009a), Roshan *et al.,* (2012) and Dubey *et al.*, (2013).

The various levels of nitrogen influenced green forage yield significantly presented in Table 16 revealed that, graded levels of

nitrogen influenced all the yield attributing characters. Application of 100 kg N ha^{-1} recorded significantly higher green forage yield in terms of kg ha^{-1} and kg day^{-1} ha^{-1} followed by 80, 60 and 40 kg N ha^{-1} in that descending order.

The maximum yield due to higher application of nitrogen, might be due to the combined effect of taller plants, more number of tillers and more number of leaves per plant. Since the green forage yield is the combined result of these three contributory characters, the yield in the present experiment was increased with increased level of nitrogen. These findings are in conformity with those reported by Bhilare *et al.*, (2008), Pathan *et al.,* (2009b) and Jha *et al.,* (2012).

The data (Table 19) in respect of dry fodder yield at harvest indicated that, the dry fodder yield of oat was significantly influenced due to nitrogen fertilization. Application of 100 kg N ha^{-1} produced significantly higher dry fodder yield in terms of kg ha^{-1} and Kg day^{-1} ha^{-1} followed by 80, 60 and 40 kg N ha^{-1} in that descending order. This might be due to the fact that nitrogen influenced the physiological activity of the dry matter accumulation also increased with nitrogen application and it was optimum at maturity stage due to diversion of food material from source to sink. These result confirm the findings of investigator Mahale *et al.,* (2003), Bhilare and Joshi, (2008), Pathan *et al.,* (2009a) and Jha *et al.,* (2012).

5.3.4 Nutrient content, uptake and quality

The nutritive value of the forage is usually expressed in terms of crude protein, crude fibre, acid detergent fibre and neutral detergent fibre. An examination of the data (Table 20) revealed that, nitrogen application significantly influenced the nutritive value as indicated the quality parameters of oat. The crude protein content and crude protein yield significantly influenced by various nitrogen levels. Application of 100 kg N h^{-1} recorded significantly higher crude protein content and crude protein yield followed by nitrogen levels *viz.,* 80, 60 and 40 kg ha^{-1}, respectively. The above results indicated that, nitrogen fertilization improved the nitrogen content in plant body and

the crude protein content of oat forage. Similar findings was reported by Mahale *et al.,* (2003), Kumar *et al.,* (2001) and Dubey *et al.,* (2013).

It was observed that, the crude fibre content in oat was significantly increase with each increase in the nitrogen application. Data regarding the crude fibre content and crude fibre yield in Table 21 exhibited that all the treatments have highly significant effect on crude fibre content and yield. Application of 100 kg N ha^{-1} recorded significantly higher crude fibre content and yield followed by 80, 60 and 40 kg N ha^{-1}. These results are in line with those reported by Jehangir *et al.*, (2013).

The data presented in (Table 22) revealed that, acid detergent fibre content was found significantly higher with application of 100 kg N ha^{-1}. It might be due to increased level of nitrogen fertilization. These result confirm the findings of Bhilare and Joshi, (2007).

In case of neutral detergent fibre percentage it was clear that application of nitrogen at 100 kg ha^{-1} significantly increased neutral detergent fibre percentage in oat followed by 80 kg N ha^{-1} which were found to be at par with each other and significantly superior over rest of the treatments. However 60 kg N ha^{-1} was statistically identical with 40 kg N ha^{-1}. These results are in line with those reported by Bhilare *et al.,* (2007).

The data of chemical studies showed that nitrogen application at 100 kg ha^{-1} resulted into significantly higher nitrogen content and uptake in oat plants followed by 80, 60 and 40 kg N ha^{-1}.

Phosphorus content in straw was significantly influenced due to application of 100 kg N ha^{-1} followed by 80 kg N ha^{-1} which were at par with each other and significantly superior over rest of the treatments. Similarly, application of 80 kg N ha^{-1} was found statistically identical with 60 kg N ha^{-1}. The significantly lower phosphorus content (%) recorded at 40 kg N ha^{-1} than rest of the nitrogen levels. Phosphorus uptake was found significantly higher at

100 kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1}. However, lower nitrogen uptake recorded at application of 40 kg N ha^{-1}.

Amongst different nitrogen levels, higher potassium content and uptake was recorded with 100 kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1}. Application 80 kg N ha^{-1} was found at par with 60 and 40 kg N ha^{-1} in respect with potassium content. However, 60 kg N ha^{-1} recorded statistical similarity with 40 kg N ha^{-1} in respect with total potassium uptake. The potassium content and uptake was found significantly lowest at application of 40 kg N ha^{-1}. This might be due to poor development of oat plant at low fertility levels whereas, increased levels of nitrogen resulted into better growth of plants and thereby better uptake of nutrients by the crop. These findings are in conformity with the results reported by Bhat *et al.,* (2000) who observed that increased rates of nitrogen from 0-120 kg N ha^{-1} resulted in increased nitrogen, phosphorus and potassium uptake.

5.3.5 Available nutrient in soil after harvest of crop

In case of soil fertility status available nitrogen, phosphorus and potassium were significantly influenced due to different nitrogen levels.

The data after harvest of oat on soil fertility dynamics indicated that the available nitrogen, phosphorus and potassium was maximum with 100 kg N ha^{-1} and was the lowest at 40 kg N ha^{-1}. This might be due to higher nutrient availability but 100 kg N ha^{-1} showed gain in phosphorus, while loss in nitrogen and potassium as compared to initial availability in soil. This might be due to higher depletion of nutrient from soil.

5.3.6 Economics

Gross returns were found to be numerically higher with application of 100 kg N ha^{-1} (Rs. 121633.51 ha^{-1}) followed by application of 80 kg N ha^{-1} (Rs. 108884.14 ha^{-1}), 60 kg N ha^{-1} (Rs. 100018.99 ha^{-1}) and 40 kg N ha^{-1} (Rs. 93993.35 ha^{-1}). Similarly, net return were numerically maximum with the application of 100 kg N ha^{-1} (Rs. 60157.60 ha^{-1}) as compared to application of 80 kg N ha^{-1}

(Rs. 49827.38 ha^{-1}), 60 kg N ha^{-1} (Rs. 42734.01 ha^{-1}) and 40 kg N ha^{-1} (Rs. 38006.89 ha^{-1}). The highest B : C ratio of 1.97 was recorded under 100 kg N ha^{-1} while minimum B : C ratio 1.68 was observed in 40 kg N ha^{-1}. The above observations are in accordance with Singh *et al.,* (2005), Jha *et al.,* (2012) and Dubey *et al.,* (2013).

5.4 Interaction

Interaction amongst varieties and nitrogen levels was significant in respect of plant height (at 90 DAS and at harvest) and green forage yield (q ha^{-1} and kg day^{-1} ha^{-1}). Treatment combination V_1N_4 *i.e.* variety RO-19 along with application of 100 kg N ha^{-1} recorded significantly higher plant height at 90 DAS and at harvest. It was found to be at par with treatment combination V_1N_3 *i.e.* (variety RO-19 along with application of 80 kg N ha^{-1}) and V_2N_4 (variety Kent along with application of 100 kg N ha^{-1}) at 90 DAS and was significantly superior over rest of the treatment combinations. However, treatment combination V_1N_4 recorded significantly higher plant height followed by treatment combination V_2N_4 which were at par with each other but significantly superior over rest of the treatment combinations except V_1N_2, V_1N_3, V_2N_4 and V_3N_4 at harvest. Treatment combination V_3N_1 *i.e.* variety OS-6 along with application of 40 kg N ha^{-1} recorded the lowest plant height at 90 DAS and at harvest.

In respect of green forage yield (q ha^{-1} and kg day^{-1} ha^{-1}), treatment combination V_1N_4 and V_2N_4 *i.e.* variety RO-19 and Kent along with 100 kg N ha^{-1} recorded significantly higher green forage yield over rest of the treatment combinations. Treatment combination V_2N_1 *i.e.* variety Kent along with 40 kg N ha^{-1} recorded the lowest green forage yield (q ha^{-1}) than rest of the treatments. However, it was found to be statistically similar with V_3N_1 and V_2N_2 in respect of green forage yield (kg day^{-1} ha^{-1}). These result confirm the findings reported by Singh *et al.,* (2002), Mahale *et al.,* (2003), Bhilare and Joshi, (2008) and Pathan and Bhilare, (2009a).

5.5 Economics of treatment combinations

In respect of economics, the higher total cost was recorded by the treatment combination V_1N_4 (RO-19 + 100 kg N ha^{-1}) which was Rs. 63262.10 ha^{-1}. This was because of higher cost of fertilizer and labours charges *etc.* in treatment V_1N_4. However, the lowest cost of production was recorded by the treatment combination V_2N_1 (Kent + 40 kg N ha^{-1}) that of Rs. 54888.81 ha^{-1}.

The highest gross income was recorded by the treatment combination V_1N_4 (RO-19 + 100 kg N ha^{-1}) which was Rs. 132350.67 ha^{-1} while the lowest gross income was in the treatment combination V_2N_1 (Kent + 40 kg N ha^{-1}) that of Rs. 87407.41 ha^{-1} which was associated with higher and lower green forage yield, respectively.

The highest net income was recorded by the treatment combination V_1N_4 (RO-19+ 100 kg N ha^{-1}) which was Rs. 69088.56 ha^{-1} while the lowest net income was in the treatment combination V_2N_1 (Kent + 40 kg N ha^{-1}) that of Rs. 32518.60 ha^{-1}.

The highest B : C ratio (2.09) was recorded by the treatment combination V_1N_4 (RO-19 + 100 kg N ha^{-1}) while the lowest B: C ratio (1.59) was in the treatment combination V_2N_1 (Kent + 40 kg N ha^{-1}). This was because of highest green forage yield in these treatment combinations thereby fetching more net return and ultimately higher B: C ratio. Similar results were obtained by Singh *et al.* (2005), Jha *et al.,* (2012) and Dubey *et al.,* (2013).

CHAPTER-VI

SUMMARY AND CONCLUSION

The field trial entitled "Effect of different levels of nitrogen on performance of fodder oat (*Avena sativa* L.) varieties under lateritic soil of *Konkan* region" was carried out during *rabi* season of 2015 at the Agronomy farm, College of Agriculture, Dapoli. The experiment was laid out in split plot design with three replications. The main plot treatment comprised of three oat varieties *viz.,* RO-19, Kent and OS-6 while in sub plot treatment, four nitrogen levels *viz.,* 40, 60, 80 and 100 kg N ha^{-1} were accommodated. The oat was sown on 6th November, 2015. Seeds were sown by drilling method. The gross and net plot sizes were 4.5 m X 3.00 m and 3.9 m X 2.4 m, respectively. Nitrogen application was made through urea.

During the course of present investigation, observations on growth and yield contributing characters with quality parameters were recorded to evaluate the treatment effects. Observations on different growth characters were recorded periodically, while the observations on yield attributing characters and yield of oat were recorded at harvest. Qualitative parameters *i.e.* crude protein content, crude fibre content, acid detergent fibre content and neutral detergent fibre content were recorded at harvest. Chemical analysis of oat plants was carried out at harvest to determine the nutrient content (per cent) and nutrient uptake (kg ha^{-1}).

The analysis of initial soil sample indicated that, the soil of the experimental plot was sandy clay loam in texture, slightly acidic in pH and high in organic carbon content. It was medium in available nitrogen and potassium and low in available phosphorus (Table 1).The final soil fertility status was studied at harvest (Table 25). The soil was levelled, well drained and uniform in depth. Thus, the soil was suitable for growing oat in *rabi* season.

In general, the season was fairly good and the growth of oat was satisfactory without incidence of any major pests or

diseases during the crop growth period. The crop was harvested for green forage at 50 per cent flowering stage.

The important findings emerged out from this investigation are summarized below-

6.1 Effect of varieties

1. Plant population count at initial stage *i.e.,* 15 DAS was not significantly influenced due to different varieties.

2. The growth attributing characters *viz.,* plant height (cm), number of tillers running meter^{-1} and dry matter production per meter row length were significantly influenced due to different varieties under study. At 15 and 30 DAS, a differences in all the growth attributes due to various varieties of oat were very meager. At 45, 60, 75 and 90 DAS, the growth attributes *viz.*, plant height (cm), number of tillers running meter^{-1} and dry matter production running meter^{-1} were more in variety RO-19 followed by Kent and OS-6. At harvest, the significantly higher values was recorded by variety RO-19 followed by variety Kent and OS-6.

3. In case of various yield attributing characters and yield, leaf: stem ratio, green forage and dry fodder yield were recorded. In case of leaf: stem ratio, variety RO-19 was at par with Kent and significantly superior over OS-6. Green forage yield and dry fodder yield in (kg ha^{-1}) and (kg day^{-1} ha^{-1}) recorded by variety RO-19 was significantly higher than Kent and OS-6.

4. In case of nutritive values of oat forage, various quality parameters did not differ significantly with varieties. Variety RO-19 recorded numerically higher crude protein content, crude fibre content and neutral detergent fibre content followed by Kent and OS-6. However, variety OS-6 showed maximum acid detergent fibre content than rest of the varieties.

5. In case of crude protein yield, variety RO-19 was numerically higher than variety Kent and OS-6. However, in crude fibre yield variety RO-19 recorded significantly higher yield as compared to other varieties while Kent was at par with OS-6.

6. Nitrogen, phosphorus and potassium content in oat plants did not differ significantly in respect with varieties. However, variety RO-19 recorded numerically higher values of N, P and K content than Kent and OS-6.

7. Chemical analysis of oat plants indicated that total uptake of N, P and K did not differ significantly with respect to varieties. However, variety RO-19 recorded numerically higher N, P and K uptake than Kent and OS-6.

8. In case of soil fertility status after harvest of crop, available nitrogen, phosphorus and potash content in soil were found to be significant. Variety Kent recorded significantly higher available nitrogen, phosphorus and potassium in the soil than varieties RO-19 and OS-6 where, latter two varieties were found to be at par with each other.

9. From the economic point of view, gross returns, net returns, and B: C ratio were higher under variety RO-19 followed by variety Kent and OS-6 in that descending order.

6.2 Effect of nitrogen levels

1. The plant population count at 15 DAS was not influenced significantly by different levels of nitrogen. Application of 100 kg N ha^{-1} recorded numerically higher plant population than 80, 60 and 40 kg N ha^{-1}.

2. The growth attributing characters *viz.,* plant height (cm), number of tillers running $meter^{-1}$ and dry matter running $meter^{-1}$ were recorded. At 15 DAS a difference in all growth attributes due to

various fertilizer levels was very meager. At 30, 45, 60, 75, 90 DAS and at harvest, plant height of oat was maximum at 100 kg N ha^{-1} followed by 80 kg N ha^{-1} which were at par with each other and significantly superior over 80, 60 and 40 kg N ha^{-1}. Number of tillers were found maximum under 100 kg N ha^{-1} while at 90 DAS and at harvest it was at par with each other. At 30, 45, 60, 75, 90 DAS and at harvest, mean dry matter production was significantly maximum at application of 100 kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1}.

3. The leaf : stem ratio was significantly influenced due to different nitrogen levels under study. Leaf : stem ratio was found significantly higher with 100 kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1} at all the growth stages.

4. In case of green forage yield and dry fodder yield in (kg ha^{-1}) and (kg day^{-1} ha^{-1}), significant effects were noticed due to application of different levels of nitrogen. Significantly higher yields were obtained with the application of 100 kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1} in that descending order.

5. The quality parameters like crude protein content and crude protein yield, crude fibre content and crude fibre yield were significantly influenced by different nitrogen levels. Amongst all the nitrogen levels, application of 100 kg N ha^{-1} recorded significantly higher crude protein and crude fibre content as well as their yields than the application of 80, 60 and 40 kg ha^{-1}.

6. Acid detergent fibre content was found significantly higher due to application of 100 kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1}. However, 60 kg N ha^{-1} was found statistically identical with 40 kg N ha^{-1}. The neutral detergent fibre content was significantly maximum with application of 100 kg N ha^{-1} followed by 80 kg N ha^{-1} which were at par with each other and significantly superior over rest of the treatments.

7. Nitrogen, phosphorus and potassium content in oat plants were significantly influenced due to the application of different nitrogen levels. Nitrogen application at 100 kg N ha^{-1} resulted in to significantly higher nitrogen content and uptake in oat plants followed by 80, 60 and 40 kg N ha^{-1}.

8. Phosphorus content in oat plants was higher due to application of 100 kg N ha^{-1} followed by 80 kg N ha^{-1} which were at par with each other and significantly superior over rest of the treatments. The phosphorus uptake was significantly superior at 100 kg N ha^{-1}, the lowest phosphorus content and uptake being at 40 kg N ha^{-1}.

9. Potassium content and uptake was significantly higher with 100 kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1}. Application 80 kg N ha^{-1} was found at par with 60 and 40 kg N ha^{-1} in respect with potassium content. However, 60 kg N ha^{-1} was statistically similar with 40 kg N ha^{-1} in respect with total potassium uptake.

10. In case of soil fertility status, available nitrogen, phosphorus and potassium at harvest were significantly influenced by different nitrogen levels. The available nitrogen, phosphorus and potassium content was improved due to application of 100 kg N ha^{-1} and was the lowest at 40 kg N ha^{-1}. Application of 100 kg N ha^{-1} showed gain in phosphorus, while loss in nitrogen and potassium as compared to their initial availability status in soil.

11. From the economic point of view, gross returns, net returns and B : C ratio were higher under application of 100 kg N ha^{-1} followed by 80, 60 and 40 kg N ha^{-1} in that descending order.

6.3 Effect of interaction

The interaction effects between varieties and nitrogen levels were non-significant in case of most of the observations, except

plant height and green forage yield (kg ha^{-1} and kg $day^{-1}ha^{-1)}$. Plant height (90 DAS and at harvest) and green forage yield was significantly higher due to the treatment combination V_1N_4 (RO-19 + 100 kg N ha^{-1}). The highest gross returns, net returns and B: C ratio was also recorded by the treatment combination V_1N_4 (RO-19 + 100 kg N ha^{-1}).

CONCLUSION

On the basis of present investigation following broad conclusions can be drawn.

* Fodder oat variety RO-19 showed better performance in respect of growth during *rabi* season in lateritic soil of Konkan region.
* Application of 100 kg nitrogen per hectare produced maximum growth and yield of fodder oat.
* Fodder oat variety RO-19 showed better quality parameters as well as maximum uptake of nutrients.
* Growing of fodder oat variety RO-19 with application of 100 kg N per hectare obtained maximum net returns and higher B:C ratio.

These results are based on one year's field experiment hence, need repetition for confirmation.

LITURATURE CITED

Aher, V.B., Tambe, A.B., Manjare, M.R. and Desale, J.S. (2003). Forage Research in Maharashtra. Book Published by Forage Research Project, M.P.K.V. Rahuri (MS). pp.1.

Anonymous, (2007). http// www.Krishiworld.com

A.O.A.C. (2005). Official Methods of Analysis. 16th ed. Journal of Association of Official Analytical Chemists, Washington, D. C.

Bagul, R.S., Surana, P.P., Manjare, M.R., Tambe, A.B. and Amolic, V.L. (2008). Phule Harita (Ro-19) - A new forage multicut oat variety. *Forage Res.* **34** (3): 190-192.

Bhat, M.D., Singh, K.N., Bali, A and Shah, M.H. (2000). Grain yield of oat (*Avena sativa* L.) as influenced by sowing time and nitrogen levels under temperate conditions of Kashmir. *Indian J. Agron.* **45**(1): 199 – 204.

Bhilare, R.L. and Joshi, Y.P. (2007). Productivity and quality of oat in relation to cutting management and nitrogen levels. *Indian J. Agron.* **52** (3): 247-250.

Bhilare, R.L. and Joshi, Y.P. (2008). Response of oat (*Avena sativa* L.) to nitrogen levels under different cutting management. *J. Maharashtra agric Univ.* **33** (3): 312-314.

*Black, C.A. (1965). Methods of Soil Analysis, Part-II .Am. Soc. Argon., Inc., Madison, Wisconsin, U.S.A.

*Bray, R.H. and Kurtz, L.T. (1945). Determination of total organic and available forms of phosphate in soil. *Soil Sci.* **59**: 39.

DARE/ICAR ANNUAL REPORT (2012–13). Livestock Management **pp**. 55-57

Das, N., Misra, A.K., Maity, S.B., Singh, K.K. and Das, M.M. (2009). Forage for sustainable livestock production. Satish Serial Publishing House, Azadpur, Delhi-33. **pp**. V.

Desai, S.N., Borate, Y.T., Deore, D.D and Bhoi, P.G. (1984). Influence of initial harvest interval of promising oat varieties on green

forage production, nutritive value and seed yield under nitrogen fertilization. *J. Maharashtra agric Univ.* **9**(3):278-281

Devi, U., Singh, k.P., Kumar, S. and Sewhag, M. (2014). Effect of nitrogen levels, organic manures and *Azotobacter* inoculation on yield and economics of multi-cut oats. *Forage Res.* **40** (1): 36-43

Dubey, A., Rathi, G.S. and sahu, R. (2013). Effect of nitrogen levels on green fodder yield of oat (*Avena sativa* L.) varieties. *Forage Res.* **39** (1): 39-41.

Handbook of Agriculture (2007). Forage Crops and Grasses **pp**. 1354-1357

Het Ram R.N., Arora and Kishor, C. (2001). Seed vigour studies in cultivator and wild species of oats. *Forage Research.* **27** (3): 225-228.

Indian livestock census (2007). Graphical data on region wise cattle production.

*Jackson, M.L. (1973). Soil Chemical Analysis, Wisconsin Prentice Hall of India Pvt. Ltd, New Delhi, **pp.** 46 and 128.

Joon, L., Singh, S.H and Sharma K.L (1995). Effect of levels and time of nitrogen application on grain yield of multi cut oat. *Indian J. Agron.* **35**(1): 191 – 198.

Jat, H., Kaushik, M.K., Tiwari, R.C. and Sharma, M. (2015). Growth, yield of fodder oat (*Avena sativa*. L.) and available soil nitrogen as influenced by irrigation and nitrogen Management. *Forage Res.,* **41** (2): 135-136.

Jehangir, I.A., Khan H. U., Khan, M.H., F. Ur-Rasool, Bhat, R.A., Mubarak, T., Bhat, M. A. and Rasool, S. (2013). Effect of sowing dates, fertility levels and cutting managements on growth, yield and quality of oats (*Avena sativa* L.) *Afr. J. Agric. Res.* **8**(7): 648-651

Jha, A.K., Shrivastava, A., Raghuvanshi, N.S. and Sharma J.K. (2012). Relative performance of new single cut oat genotypes to different nitrogen levels under agro-climatic condition of

Kymore plateau zone of Madhya Pradesh. *JNKVV Res J* **46**(1): 44-46

Kumar, A., Jaiswal, R.S., Verma, M.L. and Joshi, Y.P. (2001). Effect of nitrogen level and cutting management on yield and quality of different varieties of oat fodder. *Indian J. Anim Nutr.* **18** (3): 262-266.

Luikham, E., Kamei, S and Mariam anal, P. S. (2012). Yield, quality and economics of oat fodder (*Avena sativa.* L.) as influenced by nitrogen and varieties. *Forage Res.*, **38** (2): 112-114.

Mahale, B.B., Nevase, V.B. and Thorat, S.T. (2003). Effect of non symbiotic fixers on the forage yield of oat. *J. argic Res. New series.* ***24*** (1):121-123.

Mahale, B.B., Nevase, V.B. and Thorat, S.T. (2004). Effect of cutting management and nitrogen levels on forage yield of oat. *J. Soil Crop.* **14** (2): 469-472.

Malavolta, E. (1980) elements of plant nutrition. *Piracicaba: Agronomic Ceres*, pp. 251.

Midha, L. K., Duhan, B. S., and arya, S. (2015). Performance of promising entries of oat (*avena sativa* L.,) under different nitrogen levels. *Forage Res.*, **41** (2): 122-125.

Nawaz, N., Abdul R., Zulifakar A., Sarwar, G. and Yousuf, M. (2004). Performance of different oat varieties under the Agro-climatic conditions of Bahawalpur, Pakistan. *International J. Agriculture and Biology*. **4** (6): 624-626.

*Panse, V.G. and Sukhatme, P.V. (1967). Statistical methods for Agricultural workers. ICAR Publications, New Delhi, **pp.** 199-210.

Patel, J.R and Rajgopal, S. (1998). Effects of nitrogen and phosphorus on growth and forage yield of oat. *J. Maharashtra agric Univ.* **23** (3): 323-324.

Pathan, S.H., Gethe, R.M., Manjare, M.R. and Kadlag, A.D. (2005). Response of multicut oat to spacing and nitrogen for green forage yield. *Forage Res.* **31** (2): 150-151.

Pathan, S.H., Bhilare, R.L., Nawale, K.B. and Jadhav, V.T. (2007). Response of multicut oat varieties to nitrogen levels. *Forage Res.* **32** (4): 267-270.

Pathan, S.H. and Bhilare, R.L. (2009a). Response of nitrogen levels to single cut oat genotypes. *J. Maharashtra agric Univ.* **34** (3): 333-334.

Pathan, S.H., Bhilare, R.L. and Kadlag, A.D. (2009b). Effect of nitrogen levels on forage yield of promising varieties of multicut oat. *J. Maharashtra agric Univ.* **34** (3): 331-332.

*Piper, C.S. (1956). Soil and Plant Analysis. Indian Edn. Hans Publ., Bombay. **pp.** 19-136.

Raghubanshi, N., Verma, M.L. and Jaiswal, R.S. (2002). Nutritional evaluation of oat varieties in crossbred heifers. *Indian J. Anim Nutr.* **19** (3): 232-235.

Roshan, P.K., Naik, K.R. and Nayak, Siddarth. (2012). Response of promising varieties of single cut forage oat to different nitrogen levels under agroclimatic conditions of Kymore plateau zone, Madhya Pradesh. *JNKVV Res J.* **46** (1): 59-61.

Sharma, S.K. and Bhunia, S.R. (2001). Response of oat to cuttting management, method of sowing and nitrogen. *Indian J. Agron.* **46** (3): 563-567.

Shekara, B.G., Lohithaswa, H.C., Sreedher, D. and Saritha, K.S. (2008). Response of single cut oat genotype to nitrogen levels. *Forage Res.* **34** (3): 199-200.

Singh, R.R., Verma, J.S. and Agrawal, I.S. (2002). Studies on forage production potential and quality of different varieties of oats. *Forage Research***. 28** (3): 134-141.

Singh, S.D., Dubey, S.V., Agrawal, S.B. and Rawat, A. (2005). Effect of organic and inorganic sources of nitrogen on yield and quality of fodder oat under different cutting systems. *JNKVV Research J.* **39** (2): 12-15.

Singh, K.A. (2009). Feed and Fodder Development Issues and Options in Forage for sustainable livestock production. Book published by Sathi Serial Publishing House, Delhi-33. **pp.** 1-12.

Siloriya, P.N., Rathi, G.S. and Meena, V.D. (2013). Relative performance of oat (*Avena sativa* L.) varieties for their growth and seed yield. *Afr. J. Agric. Res.* **9**(3): 425-431.

*Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for the estimation of available nitrogen in soil. *J. of Curent Science*. **25** (8): 259-266.

*Tandon, H.L. (1993). Methods of analysis of soil, plant, water and fertilizers development and consultation organization, New Delhi.

Van Soest, P.J., Robertson, J.B. and Lewis B.A. (1991). Methods for dietary fiber, neutral detergent fiber, and non starch polysaccharides in relation to animal nutrition. *J. Dairy Sci.*, **74**. 3583–3597.

Wilkins, P.W., Allen, D.K. and Mytton, L.R. (2000). Differences in the nitrogen use efficiency of perennial rye grass varieties under simulated rotational grazing and their effects on nitrogen recovery and herbage nitrogen content. *Grass and Forage Science* **55**: 69-76

***** Originals not seen

DEPARTMENT OF AGRONOMY
COLLEGE OF AGRICULTURE, DAPOLI.
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth,
Dapoli – 415 712, Dist. Ratnagiri (Maharashtra)

Title of Thesis	**:**	Effect of different levels of nitrogen on performance of fodder oat (*Avena sativa* L.) varieties under lateritic soil of *Konkan* region.
Name of the student	**:**	**Mr. Sawant Sagar Mangesh**
Registration No.	**:**	2330
Name of Research Guide	**:**	**Dr. S. B. Bhagat** Agronomist (ECF), Agriculture Research Station, Palghar, Dist. Palghar 401404.
Year of award of degree	**:**	2016

THESIS ABSTRACT

The field experiment was conducted on plot no. 20 of "B" block of Agronomy Department Farm, College of Agriculture, Dapoli, Dist. Ratnagiri during *rabi* season 2015-16 to study the "Effect of different levels of nitrogen on performance of fodder oat (*Avena sativa* L.) varieties under lateritic soil of Konkan region."

The experiment was laid out in a split plot design with three replications. The main plot treatments were three oat varieties, *viz.,* RO-19 (V_1), Kent (V_2) and OS-6 (V_3). The sub plot treatments comprised of four nitrogen levels *viz.,* 40 Kg N ha^{-1} (N_1), 60 Kg N ha^{-1} (N_2), 80 Kg N ha^{-1} (N_3) and 100 Kg N ha^{-1} (N_4). Thus, there were in all 12 treatment combinations. The gross plot size was 4.5 m X 3.00 m and net plot size was 3.9 m X 2.4 m, respectively.

The soil of the experimental plot was uniform, level and well drained. It was sandy clay loam in texture, medium in available nitrogen (284.2 Kg ha^{-1}) and potassium (264.22 Kg ha^{-1}), low in available phosphorus (10.80 Kg ha^{-1}), medium in organic carbon content (0.97 %) and slightly acidic in reaction (pH 5.68).

The sowing was done in the experimental plot on 6th November, 2015 by drilling method at a distance of 30 cm in between the rows.

The other common package of practices was followed time to time and periodical growth observations were recorded.

Results revealed that variety RO-19 recorded significantly higher growth as well as yield attributes resulting in higher green and dry fodder yield (q ha^{-1}) followed by varieties Kent and OS-6. The chemical studies showed that significantly higher values of Crude Protein, Crude Fibre, Neutral Detergent Fibre, N, P and K content in dry fodder and total uptake were recorded by oat variety RO-19 than Kent and OS-6. However, variety OS-6 showed maximum Acid Detergent Fibre content than rest of the varieties. The highest net returns of Rs. 56103.86 ha^{-1} with B : C ratio 1.93 was obtained from variety RO-19.

Application of 100 Kg N ha^{-1} recorded significantly higher growth as well as yield attributes resulting in higher green and dry fodder yield (q ha^{-1}) as compared to 80, 60 and 40 Kg N ha^{-1}. Significantly higher values of Crude Protein, Crude Fibre, Acid Detergent Fibre, Neutral Detergent Fibre, N, P and K content in dry fodder and total uptake by oat were recorded due to application of 100 Kg N ha^{-1}. The highest net returns of Rs. 60157.60 ha^{-1} with B : C ratio 1.97 was obtained due to application of 100 Kg N ha^{-1}.

In respect of economics, it was observed that the treatment combination V_1N_4 (RO-19 + 100 Kg N ha^{-1}) has given significantly highest net returns Rs. 69088.56 ha^{-1} and B : C ratio (2.09).

APPENDIX-I

Cost of inputs for calculating economics of treatments

Sr. No.	Particulars	Unit	Rate (₹)
1	**Labour wages**		
	a) Male	₹ day^{-1}	180
	b) Female	₹ day^{-1}	180
2	**Seed**	₹ kg^{-1}	25
3	**Tractor**	₹ $hour^{-1}$	650
4	**Farm yard Manure**	₹ kg^{-1}	1.5
5	**Fertilizers**		
	a) Urea	₹ kg^{-1}	6
	b) Single Super Phosphate	₹ kg^{-1}	8
	c) Muriate of potash	₹ kg^{-1}	15
6	**Irrigation charges**	₹ day^{-1}	125
7	**Price of Produce**		
	Green Fodder	₹ qtl^{-1}	400

APPENDIX-II

Abbreviations used

% : Per cent

@	:	At the rate of
$^{-1}$	:	Per
:	:	As to
–	:	to
^{0}	:	degree
ADF	:	Acid Detergent Fibre
B : C	:	Benefit Cost ratio
C.D. at 5 %	:	Critical Difference at 5% level of significance
cm	:	Centimeter (s)
^{o}C	:	Degree Celsius
DAS	:	Days After Sowing
Day^{-1}		Per day
Dist.	:	District
Dr.	:	Doctor
et al.	:	and others
etc.	:	Excettra
Freq.	:	Frequency
Fig.	:	Figure
Even.	:	Evening
g	:	gram (s)
ha	:	Hectare
ha^{-1}	:	Per hectare
hrs^{-1}	:	Per hours
i.e.	:	that is
J		Journal
K	:	Potassium
K_2O	:	Potassium oxide
Kg	:	Kilogram (s)
lit	:	litre
m	:	meter (s)
m^{-2}		Square meter
M.S.	:	Maharashtra State
Max.	:	Maximum
MW	:	Meteorological week
Min.	:	Minimum
mm	:	Millimeter (s)

Morn.	:	Morning
MT	:	Metric ton (s)
mt	:	Million ton (s)
N	:	Nitrogen
NDF	:	Neutral Detergent Fibre
N ha^{-1}	:	Nitrogen Per hectare
No.	:	Number (s)
N.S.	:	Non- significant
P	:	Phosphorous
P_2O_5	:	Phosphorus pentaoxide
q	:	quintal (s)
RDF	:	Recommended Dose of Fertilizers
RH	:	Relative humidity
₹	:	Rupee (s)
Sig.	:	Significant
S.Em.	:	Standard Error of mean
sq.m.	:	Square metre
Sr. No.	:	Serial number
t	:	Ton (s)
var.	:	Variety
viz.	:	Namley
Wt.	:	Weight

Plate I. General view of experimental plot

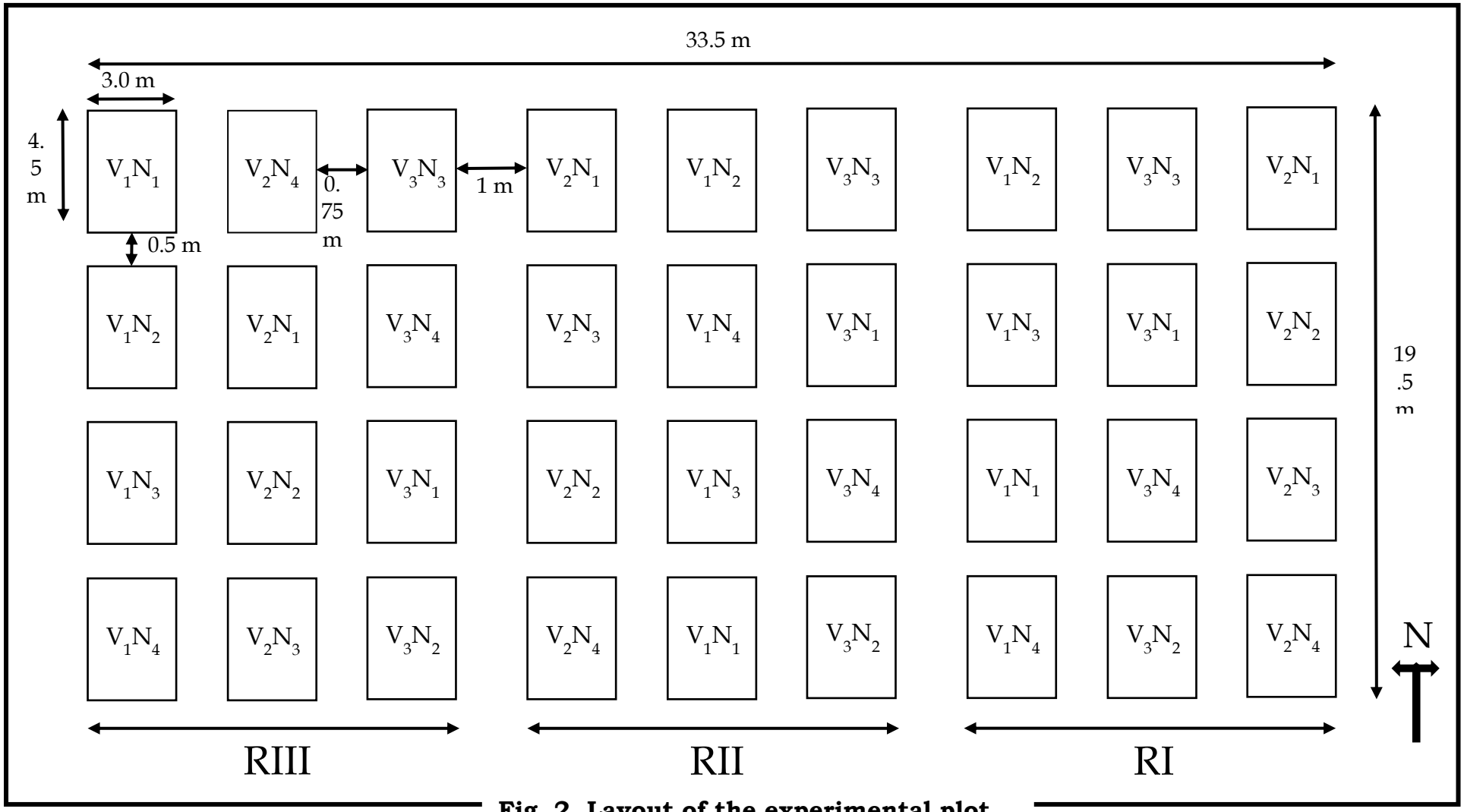

Fig. 2. Layout of the experimental plot

CONTENTS

LIST OF TABLES

Cont. (list of tables)

	influenced by different treatment combinations	

LIST OF FIGURES

Contd. (list of figures)

LIST OF PLATES

Plate II. Variety "RO-19"

Plate III. Variety "Kent"

Plate IV. Variety "Os-6"