COMPARATIVE PERFORMANCE OF LENTIL (*Lens esculenta* L.) LOCAL GENOTYPES TO DIFFEENT FERTILIZER LEVELS

by

Mr. Shashidhar Adrushappa Savadi

(Reg. No. 19/028)

DIVISION OF AGRONOMY

R.C.S.M. COLLEGE OF AGRICULTURE, KOLHAPUR

MAHATMA PHULE KRISHI VIDYAPEETH
RAHURI-413722, DIST-AHMEDNAGAR
MAHARASHTRA,INDIA

2021

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A Thesis submitted to the

**MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI- 413 722, DIST- AHMEDNAGAR,
MAHARASHTRA, INDIA.**

In partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

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APPROVED BY

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2021

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part
thereof has not been submitted
by me or other person to
any other University,
or Institutefor
a Degree or
Diploma

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CERTIFICATE

This is to certify that the thesis entitled,**“COMPARATIVE PERFORMANCE OF LENTIL (*Lens esculenta* L.) LOCAL GENOTYPES TO DIFFERENT FERTILIZER LEVELS.”**submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) in partial fulfilment of the requirement for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRONOMY**, embodies the result of a piece ofbonafide research work carried out by **Mr. SHASHIDHAR ADRUSHAPPA SAVADI** under my guidance and supervision of and that no part of the thesis has been submitted to any other university for degree, diploma or publication.

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

Place:Kolhapur **(Dr. A. A. Pisal)**
Date : / /2021 **Research guide**

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Date: / /2021

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RCSM College of Agriculture, Kolhapur.
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Place: Kolhapur
Date: / / 2021.

Dr. U. B. Hole
(Associate Dean)

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At the end I owe my inexpressible gratitude to my parents to whom I dedicate the work done.

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Place: Kolhapur

Date : / /2021 (S. A. Savadi)

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LIST OF ABBREVIATIONS

%	:Per cent
^0C	: Degree celsius
@	: At the rate of
Agric.	: Agriculture
Agron.	: Agronomy
Anon.	: Anonymous
B	: Boron
Biotech.	: Biotechnology
B: C ratio	: Benefit: Cost ratio
C.D.	: Critical difference
cm	: Centimeter (s)
cm^2	: Centimeter square
cv.	: Cultivar
DAP	: Di-ammonium phosphate
DAS	: Days after sowing
dm^2	: Decimeter square
et al.	: et alli (and others)
Fig.	: Figure
FYM	: Farm yard manure
g	: Gram
ha	: Hectare
i.e.	: id est (that is)
J.	: Journal
K	: Potassium
K_2O	: Potash (Potassium oxide)
kg	: Kilogram (s)
M	: Meter
m. eq.	: Milli equivalent
MOP	: Muriate of potash
mm	: Millimetre
Max.	: Maximum

Min.	: Minimum
M^2	: Meter square
Mg	: Milligram
MOP	: Muriate of Potash
N	: Nitrogen
NARP	: National Agriculture Research Project
NS	: Non-significant
No.	: Number
P	: Phosphorus
P_2O_5	: Phosphorus penta oxide
pH	: Soil reaction
PSB	: Phosphate solubilizing bacteria
ppm	: Parts per million
q	: Quintal
RDF	: Recommend dose of fertilizer
Res.	: Research
Rs.	: Rupees
Sci.	: Science
SOP	; Sulphate of Potash
SSP	: Single super phosphate
S.E. ±	: Standard error
Sig.	: Significant
t	: Tonne
Univ.	: University
var.	: Variety
viz.,	: Namely
wt.	: Weight
Zn	: Zinc

ABSTRACT

"COMPARATIVE PERFORMANCE OF LENTIL *(Lens esculenta* L.*)* LOCAL GENOTYPES TO DIFFEENT FERTILIZER LEVELS "

By

Mr. SHASHIDHAR ADRUSHAPPA SAVADI

A candidate for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRONOMY

2021

Research Guide	**: Dr. A. A. Pisal**
Division	**: Agronomy**

The investigation entitled,"Comparative Performance of Lentil *(lens esculenta L.)* Local Genotypes to Different Fertilizer Levels", was undertaken at Post Graduate Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur during *rabi*, 2019.

The experiment was laid out in Factorial randomized block design with three replications and twelve treatment combinations of three genotypes G_1- Gandigwad local, G_2- Itagi local and G_3-Nesari local and four fertilizer levels F_1-75% RDF,F_2-100% RDF,F_3-125% RDF and F_4-150% RDF. The gross and net plot size were 4.5 m x 3.5 m and 4 m x 3 m respectively.

The soil of the experimental plot was medium black, fairlyleveled well drained,low in available nitrogen (238.80kg ha^{-1}), moderately high in available phosphorus (25.82 kg ha^{-1}) and moderately high in available potassium (266.20kg ha^{-1}). The soil was slightly alkaline in reaction (pH 7.7).

The crop was sown on 19th of December, 2019 by line sowing method with different nitrogen, phosphorus levels and potassium levels. The crop was fertilized as per treatments by using urea, diammonium phosphate and muriate of potash and fertilizer was given by placement method.

The plant population at the initial stage and at harvest did not reach to the level of significance due to different genotypes. The growth attributes were influenced significantly due to different genotypes. The growth attributes at harvest *viz*.,plant height (29.18 cm), number of branches plant^{-1} (11.52), number of leaves plant^{-1}(353.54), dry matter plant^{-1} (3.72 g) were recorded highest with the genotype Gandigwad local followed by genotype Itagi local and Nesari local.

The yield attributes *viz*.,number of pods plant^{-1}(41.46), weight of pods plant^{-1}(1.43 g), weight of seeds plant^{-1}(1.19 g), number of seeds pod^{-1}(1.11),weight of100 seeds (2.76 g), were also maximum with the genotype Gandigwad local which was significantly superior over genotype Itagi local and Nesari local, respectively. As a result, the genotype Gandigwad local recorded highest seed yield (9.52 q ha^{-1}), stover yield (16.60 q ha^{-1}), biological yield (26.32 q ha^{-1}) and harvest index (35.72%)and which remained significantly superior over rest of genotype and it was followed by genotypes Itagi local and Nesari local.

The highest protein content 27.32% in seeds was recorded by Gandigwad local lthat was differed significantly by different genotypes under study. The mean N, P and K content in seeds and stover were also not influenced significantly by different genotypes except N content in seed and stover.The content of N, P and K in seed were (4.37%, 0.40% & 0.72%) and stover (1.18%, 0.23% & 1.35%) respectively, and it was higher in genotype Gandigwad local. The total uptake of nutrients was N (61.57kg ha^{-1}), P (7.66 kg ha^{-1}) and K (29.17kg ha^{-1}) respectively by lentil crop and influenced significantly by genotypes where it was maximum with genotype Gandigwad local. The next in order were genotype Itagi local and Nesarilocal. The Residual N (257.91kg ha^{-1}), P (29.00kg ha^{-1}) and K (268.02 kg ha^{-1}) respectively in soil after harvest were recorded by Nesari local genotype which was followed by Itagi local, Gandigwad local, respectively.

The gross monetary returns (Rs.81120ha^{-1}), the net monetary returns (Rs.44494ha^{-1}) and benefit: cost ratio (2.21) was significantly more with the genotype Gandigwad local. The next in order were Itagi local and Nesari local.

The fertilizer levels included in the study were 75% RDFha^{-1}, 100% RDF ha^{-1}, 125% RDF ha^{-1}and 150% RDF ha^{-1}. The plant population at the initial stages and at harvest did not reach to the level of significance due to different fertilizer levels. Different fertilizer levels to the lentil showed significant influence on growth parameters. The growth parameters at harvest *viz.*, plant height (29.98 cm), numbers of branches plant^{-1}(11.51), number of functional leaves plant^{-1}(356.76), and dry matter plant^{-1} (3.24 g) were significantly more with the application of 125% RDFha^{-1} which was at par with application of 150% RDF ha^{-1} and significantly superior over 100% RDFha^{-1}and75% RDF ha^{-1}

The yield contributing characters like, number of pods plant^{-1}(37.03), weight of pods plant^{-1}(1.38 g), weight of seeds plant^{-1}(1.19 g), number of seeds pod^{-1}(1.33), weight of 100 seeds (2.82 g) and seed yield (8.30 q ha^{-1}), stover yield (15.44 q ha^{-1}), biological yield (23.95 q ha^{-1}) and harvest index (35.28%) were also significantly maximum with the application of 125% RDFha^{-1}which was at par with application of 150% RDF ha^{-1}and significantly superior over 100% RDF ha^{-1} and 75% RDF ha^{-1}

The protein content (27.33%) in seeds was significant and recorded highest with 125% RDF ha^{-1} and remained at par with 150% RDF ha^{-1}. Mean P and K content in seeds and stover were also not influenced significantly by different fertilizer levels except N. The content of N, P and K in seed were (4.37%, 0.41% & 0.72%) and stover (1.16%, 0.24% & 1.33%) respectively, and the N content was higher with application of 125% RDF ha^{-1} and comparable with 150 RDF ha^{-1}.The total uptake of nutrients was N (56.14 kg ha^{-1}), P (7.28 kg ha^{-1}) and K (26.81 kg ha^{-1}) respectively by 125% RDF ha^{-1} and influenced significantly by different fertilizer levels except uptake of K. Available N and P in soil after harvest found significant due to different fertilizer levels except available K, The highest available N, P and K were (267.30, 30.18 & 270.18) respectively in soil after harvest were found maximum with the application of 150% RDF ha^{-1} followed by 125% RDF ha^{-1},100% RDF ha^{-1}, 75% RDF ha^{-1} respectively.

The application of 125% RDF ha^{-1} had significantly maximum gross monetary returns (Rs. 72403 ha^{-1}), net monetary returns (Rs. 35587 ha^{-1}) and B: C ratio (1.96) which was significantly superior over rest of the fertilizer levels.

The growth and yield characters and consequently the yield of lentil were not influenced by the interaction effect of both the factors. This indicates that the both factors under study *viz*., lentil local genotypes and fertilizer levels behaved independently in respect of growth, yield and quality of *rabi* lentil crop.

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1. INTRODUCTION

Grain legumes being rich in protein provide balanced human diet especially when taken in combination with cereals. Besides a high protein level, which on an average amounting to 23.7% (Pellett & Shadarovian, 1970). Legume grain possesses a considerable amount of iron, calcium, sodium, phosphorus and magnesium. Legume crops are able to fix atmospheric nitrogen and enrich the soil with nitrogen when included in different crop rotations practiced by the farmers.

Lentil is derived from Latin word Lens, that denotes exactly the shape of the seed, which is cultivated legume known as *Lens culinaris*, a name given by the German botanist Medikus in 1788 (Cubero, 1981). The seeds are mostly consumed as dal in soups and the flour can be mixed with cereal flour which used is in the preparation of cake, bread and also some baby foods. Tender pods of lentil can also be used as green vegetables and the seeds of lentil can be a source of starch for textile and printing industries (Annon,1981). Additionally, lentil straw used as a livestock feed because straw has high content of protein and crude fibre (Kay, 1979).

Lentil (*Lens culinaris Medick.*), belongs to Fabaceae family frequently known as an ancient crop for modern times, is a nutritious annual food legume. It is a nutrient-dense grain legume grown in temperate regions whose seed contain relatively higher amounts of dietary protein (341-347 g), carbohydrate (66.0%) and calories (340-347 g) compared to other legumes. Besides, seed is considered as good source of fiber (5 g), ash (2.2 g), Ca (66 mg), P (324 mg), Fe (6.0 mg), Na (28 mg), K (770 mg), thiamine (0.45 mg), riboflavin (0.32 mg) and niacin (1.4 mg). Lentil is the best source of important amino acids (lysine, arginine, leucine and also other S-containing amino acids) among all the winter season legumes. Beside dietetic significances, lentil also has got large number of applications in agriculture sector which are necessary for maintaining of agricultural sustainability. Despite having good nutritional quality over cereals and even though well adapted under local conditions including marginal soil, the cultivation of lentil is less by the farmers in recent years, and its cultivation area has slowed down and also its productivity is less than its actual potential. In many countries, the cultivation area of lentil crop is still surviving in subsistence farming, thanks solely to the initiatives of poor farmers. There is a real fear that if this practice continues, cultivation of pulses may become extinct in future. The total area of lentil crop across worldwide was about 6.57 million ha with the production of about 7.60 million tons with an average yield of 1155 kg/ha during 2017-18 (FAO, 2019). In India, lentil recorded an ever-highest production of 1.62 million tons from an area of 1.56 million ha with a productivity level of 1035 kg /ha, the ever-highest yield level (MoA & FW, 2018).

India ranked first in area and second in the production with 39.79% and 22.79% of world area and production, respectively. The highest productivity was recorded in Croatia (2862 kg/ha) followed by New Zealand (2469 kg/ha). Canada rank first in production (41.16%) due to very high level of productivity (1633 kg/ha) as compared to India (611 kg/ha) (Annon, 2017).

In India area under Lentil was 14.79 lakh hectares with a production of 10.38 lakh tonnes. In Maharashtra lentil crop is not so popular and it is cultivated in some parts of Maharashtra. Madhya Pradesh ranks 1st in acreage i.e., 39.56% (5.85 lakh ha) followed by Uttar Pradesh 34.36 % and Bihar 12.40%. While in terms of production Uttar Pradesh ranks 1st at 36.65% (3.80 lakh tonnes) followed by Madhya Pradesh (28.82%) and Bihar (18.49%). The highest yield was recorded by the state of Bihar (1124 kg/ha) followed by West Bengal. (961 kg/ha) and Jharkhand (956 kg/ha). The National yield average was (753 kg/ha). The lowest yield was observed in the state of Maharashtra (379 kg/ha), Chhattisgarh (410 kg/ha) followed by and Madhya Pradesh. (634 kg/ha) (Annon, 2017).

Lentil is grown in different cropping systems under irrigated (10%) as well as rainfed conditions (90%) in most regions of the world. It is grown as mono cropping, mixed cropping, intercropping and relay cropping. As intercropping, it better exploits the resources than sole crops and also provides “Biological Insurance” *i.e.* when one crop fails then second crop provides some returns. It can be intercropped successfully in wheat, barley, mustard and linseed.

Lentil is valued for its high protein content, which is double than that in cereals. It is also called “A poor man’s meat” because of cheapest and concentrate source of dietary protein. It contains 23.25% protein, 59% carbohydrates, 1.8% oil, 0.2% ash and traces of iron, calcium, phosphorus and magnesium.

Lentil is predominantly cultivated in Asia which occupies nearly 80 per cent of global area and also 75 per cent of world production. Lentil (*Lens culinaris* Medik.) is one of the oldest annual seed legumes consumed and cultivated in the world. Today India, Canada, Australia, Nepal, USA, Bangladesh and China are the world’s leading producers of lentil. India is being the largest producer and Canada is the second and the largest exporter in the world. Lentil was known to be one of the first crops domesticated and has become an important food legume crop. In the farming and food systems of many countries globally. Lentil seeds are rich source of protein, minerals (K, P, Fe, Zn, Mn,) and vitamins required for human nutrition (Bhatty,1988 and Savage 1988) whereas, straw is considered as valued animal feed (Erskine *et al*. ,1990). Lentil seed contains high amount of protein nearly about 27 per cent (Erskine and Witcombe,1984) and 58 per cent carbohydrate (Bakhsh *et al*..,1991). In addition, because of its high lysine and tryptophan content, its consumption with jowar or rice brings a balance in the essential amino acids for human nutrition. Its cultivation improves soil nitrogen, carbon and organic matter status, thus ensures soil health also providing sustainability in production system.

One of the most important reasons for unstable yield of lentil is the indeterminate growth habit of the plant. They are, extensive vegetative growth, lodging, pod abortion. It may be because of limited light interception in the lower part of the canopy, and excessive flower, pod shedding and also competition between pods and vegetative parts for photosynthates. These aspects results in the consequences of indeterminacy and late maturity of lentil. All lentil genotypes are indeterminate and branched (Annon 1991).

It requires nitrogen in less amount but phosphorus and potassium are very vital nutrients for higher yield. Moreover, different cultivars of lentil have different potential and vary in response to different fertilizer levels (Sadiq *et al.,* 2001). Lentils can usually fix enough N for their own requirements, although if sown in soil with extremely low available N or in cold wet soil. It requires a small amount of starter N dose to ensure adequate early growth to support nodulation and N fixation. However, lentil cultivars vary in their response to applied fertilizers (Iqbal,1996). Application of phosphorus @ 40-60 kg per hectare can help to increase yield. Application of potassium @ 35 kg per hectare appeared as the best rate of potassium in respect of grain and stover yield of lentil (Jahan *et al.*, 2009). For the growth and development of root nodules, phosphorus is absolutely necessary. However, imbalance of NPK would likely aggravate the already existing soil fertility problems. The impact of such imbalanced fertilizer use would be more severe in pulses. Soil phosphorus supply that exceeds phosphorus requirements of the crop, may preclude mycorrhizal development. To encourage mycorrhizal association, threshold levels of soluble phosphorus and other nutrients that restrict mycorrhizal development must be avoided (Grant, *et al.*, 2005).

Effect of nitrogen, phosphorus and potassium application on yield and seed protein content of lentil is well established (Ghafoor, A. 1985). Judicious use of P in lentil increases yield and improves quality (Zeidan, 2007). However, combined application of NPK appears to be more effective than the single application of N, P or K (Adsule *et al.*, 1989). Phosphorus @ 90 kg per hectare with recommended application of N gives higher seed yield against control in soybean (Malik *et al*., 1983). Application of phosphorus in lentil is essential as it increases fruiting potential, number of pods per plant, number of seeds per pod, 1000-seed weight and seed yield per hectare (Hussain, *et al*., 2003). Final increased grain and straw yields of lentil cultivars is attributed to more number of pods per plant, seed weight per plant and 1000-seed weight (Krishna reddy, *et al*., 1996). Improvement in quality may be due to increased levels of proteins and minerals like Ca, Mg, K, P and phytic acid (Iqbal,1996).

Lentil is known to fix atmospheric nitrogen in the soil and thereby a considerable requirement of nitrogen of the and the total crop is met through nitrogen fixation. However, the crop requires some amount of nitrogen for early growth of the crop till the symbiosis becomes effective (Annon,2009). Phosphorus is essential for effective nodulation, nitrogen fixation, growth and yield of lentil (Haider,1995). Genotypes of lentil do differ in seed size (Hussain, 2002) and grain yields (Iqbal,1996) and therefore, may differ in their nutrient requirements. Therefore, it is necessary to study the effect of fertilizer levels on the growth and yield of lentil genotypes.

Keeping in view the importance of N, P and K, present study was designed to observe effect of NPK application in different proportions on the yield potential of local lentil genotypes at the Post Graduate Research farm, Agronomy section of Rajarshee Chatrapati Shahu Maharaj College of Agriculture, Kolhapur under protective irrigation conditions with the following objectives.

1) To find out suitable local genotype of Lentil

2) To find out suitable fertilizer level for Lentil

3) To study interaction between genotypes and fertilizer levels

2. REVIEW OF LITERATURE

The field experiment entitled **"Comparative Performance of Lentil (*Lens esculenta* L.) Local Genotypes to Different Fertilizer Levels",** was conducted during *rabi*, 2019 at Post Graduate Research Farm, RCSM College of Agriculture, Kolhapur. The literature pertaining to the present investigation has been reviewed in this chapter. Limited research works have been carried out earlier on these aspects. Hence, the research works done by the eminent scientists in India and abroad on these aspects of lentil in particular and other crops in general summarized here under following heads.

2.1 Effect of Genotypes

2.1.1 Effect of genotypes on growth and growth attributes of lentil

2.1.2 Effect of genotypes on yield attributing characters and yield of lentil

2.1.3 Effect of genotypes on availability of N, P and K in soil and nutrient uptake by lentil crop after harvest

2.1.4 Effect of genotypes on economics of lentil

2.2 Effect of Fertilizer Levels

2.2.1 Effect of fertilizer levels on growth and growth attributes of lentil

2.2.2 Effect of fertilizer levels on yield attributing characters and yield of lentil

2.2.3 Effect of fertilizer levels on availability of N, P and K in soil and nutrient uptake by lentil crop after harvest

2.2.4 Effect of fertilizer levels on economics of lentil

2.3 Interaction Effects between Genotypes and Fertilizer Levels on lentil Crop

2.1 Effect of Genotypes

2.1.1 Effect of Genotypes on Growth and Growth Attributes of lentil

Slinkard and Bhatty (1979) reported that, Laired first lentil variety licensed in Canada which was large seeded lentil with yellow cotyledons. It was taller (42 cm) than commercial Chilean variety (34 cm).

Posypanoy (1987) from an experiment at Penza, USSR, reported that the variety PSE-2 had an erect habit and reached a height of 44 cm with lowest pods occurring at 24 cm.

Swarup and Lal (1987) conducted an experiment at Sehore (M.P) for two years in which 28 high yielding and bold seeded lines were evaluated. They reported that, the plant height varied from 28.7 cm in SL-143 to 33.9 cm in SL-598. Time to 50 per cent flowering ranged from 55 days in SL-143 to 69 days in SL-598.

Tripathi and Singh (1988) reported with an experiment was conducted at Pantanagar with four lentil varieties during *rabi* seasons of 1979-1980 and 1980-81, the variety L9-12 had lowest NAR, CGR and RGR (0.078 $g^{-1}g^{-1}$day, 0.143 $g^{-1}dm^{-2}$day and 0.029 $g^{-1}g^{-1}$day, respectively) and variety Pant L-234 had the highest NAR, CGR and RGR (0.108 $g^{-1}g^{-1}$day, 0.160 g^{-2} day and 0.039 $g^{-1}g^{-1}$day, respectively) during 90-110 days after sowing.

Tripathi and Singh (1989) revealed that, out of the four varieties tested, the variety Pant L-234 was shortest (48.7 cm) with least number of branches (8.4 $plant^{-1}$), with least lateral spread (20.67 cm) and permitted maximum light to reach the ground at middle canopy level (32.4%). While the variety Pant L-639 was the tallest (50.2 cm) with maximum number of branches (9.0 $plant^{-1}$) with widest lateral spread (21.8 cm) and permitted least amount of light to reach the ground at middle canopy level (28.7 %).

Matranga and Govoni (1990) conducted an experiment near Bongana with five large seeded, two medium seeded and three small seeded lentil varieties. Results of the experiment showed that plants were taller in large seeded varieties. Small seeded varieties flowered in 47 days after emergence while medium and large seeded varieties flowered at 50 and 57-61 days after emergence, respectively.

Abdellah *et al*., (1990) reported that, lentil variety Giza-9 flowered 31 days earlier than the local variety, the growth rate was also higher in ‘Giza-9’, but branching rate was highest with local variety. With respect to straw yield local variety recorded higher yield during first year but there was no significant difference found during second year.

Hussain (2002) reported that, among the cultivars tested, ‘Masoor-93’produced significantly more number of branches per plant (5.25) than Masoor-local (4.63) but was on par with Masoor-85 (5.10 $plant^{-1}$). Masoor-93 and Masoor-85 took significantly more number of days to maturity than Masoor-local but results were non-significant during the second year.

Sharar *et al*., (2003) conducted field experiments with three varieties viz., Masoor-Local, Masoor-85 and Masoor-93. The cultivar Masoor-Local produced significantly taller plants.

Mohammadjanloo *et al*., (2009) revealed that, local variety generally recorded higher plant height than the new variety ‘ILL1180’. They concluded that the local variety needed less potassium than the ILL1180 to express its phenotypic characters. The variety ILL1180 produced more auxiliary branches with an average of 19.88 per plant than the local variety with an average of 16.46 per plant. The variety ILL1180 had shown higher fertilizer efficiency than local variety.

Singh *et al*., (2011) conducted field experiments during *rabi* 2006-07 and 2007-08 on a loamy sand soil with four genotypes (LL 147, LL 699, LL 875 and LL 931). Among them, genotype LL 931 was the shortest in height and it had lowest number of branches. At 60 DAS, highest number nodules per plant, nodules dry weight, shoot dry weight and root dry weight per plant were recorded in LL 931, followed by LL 699 and LL 147.

Gill *et al*., (2012) conducted the experiment with 16 lentil genotypes including seven small seeded and nine large seeded for evaluation in respect of seed yield and its component traits during *rabi* 2007-08 and 2008-09. Among all varieties LL 1031 was the earliest (89 days) and LL 999 was the latest (92.8 days) genotype for days to 50 percent flowering considering all the environments. The genotypes LL 1049 (19.54 plant^{-1}) and LL 992 (19.06 plant^{-1}) recorded maximum number of fruiting branches during 2007-08. However, under late sown conditions, the genotypes LL 991 (17.30 plant^{-1}) and LL 999 (15.92 plant^{-1}) recorded maximum number of fruiting branches.

Rahman *et al*., (2013) reported that cultivar NIAB Masoor (NM)-2006 produced the maximum number of branches per plant (11.32) followed by NM-2002 and PM-2009 producing 10.28 and 8.62 number of branches per plant, respectively.

Rahman *et al.*, (2013) evaluated the effect of nitrogen application on different morpho-physiological traits of three lentil cultivars. They reported that branching plays a vital role in enhancing the yield of a plant. Cultivar NIAB Masur (NM)-2006 produced the maximum number of branches per plant (11.32) followed by NM -2002 and PM-2009, producing 10.28 and 8.62 number of branches per plant, respectively.

Haque *et al.,* (2014) conducted field experiment at the farm of Bangladesh Agricultural University, Mymensingh during November 2009 to March 2010 to study the response of three lentil varieties (viz., BARI Masur-1, BARI Masur-2 and BARI Masur-3) to *Rhizobium* inoculations regarding yield. There were three *Rhizobium* inoculants (*Rhizobium* strain BINA L4, *Rhizobium* strain TAL 640 and mixed culture) with uninoculated control and urea @ 50 kg ha^{-1}. The experiment was laid out in split plot design having varieties in main plots and 5 inoculations in sub plots. It was observed that, the maximum plant height was produced by the variety BARI Masur-3 (11.12 cm) followed by BARI Masur-1 (11.09 cm) and BARI Masur-2 (10.93 cm). Variety BARI Masur-3 gave tallest plants (16.92 cm) at 60 days of sowing, which were statistically superior to all other varieties. At 80 days of sowing, variety BARI Masur-2 gave the maximum plant height (27.54 cm) which was statistically similar to BARI Masur-3 (27.40 cm) but significantly higher than BARI Masur-1. Variety BARI Masur-3 gave the maximum plant height (33.26 cm) at 95 days of sowing which was statistically similar to BARI Masur-2 (32.83 cm) but significantly higher than BARI Masur-1 (31.23 cm).

Hasan *et al*., (2015) conducted an experiment and reported that the highest plant height (45.83 cm) was found from BARI Masur -5 and the lowest (34.67 cm) from BARI Masur -7.

Awal and Roy (2015) conducted an experiment at the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, during the period from November, 2010 to March, 2011 to study the effect of weeding on the growth and yield of three lentil varieties viz. Binamasur-1, Binamasur-2 and Binamasur-3. The experiment was laid out in a Randomized Complete Block Design with three replications. They reported that, the plant height of lentil varied significantly due to the different varieties. The tallest plants (21.50 cm) were recorded in Binamasur-3. The Binamasur-1 (19.20 cm) and Binamasur-2 (19.50 cm) showed the similar result. They also reported that the number of branches plant^{-1} of the different lentil varieties had significant variation throughout the growing period except in 70 DAS. The highest number of branches plant^{-1} was produced in Binamasur-3 (20.32) which was statistically similar with Binamasur-2 (19.53) while the Binamasur-1 variety produced the lowest (18.50) branches plant^{-1}.

Alam *et al*., (2015) conducted a field experiment to study dry matter production and crop growth rate of lentil as influenced by irrigation management. The experiment was laid out in split plot design and comprised of six irrigation levels viz. control irrigation, irrigation at pre-sowing, irrigation at post sowing, irrigation at vegetative stage (25-30 DAS), irrigation at pre-flowering (45-50 DAS) and irrigation at post flowering (70 DAS) and four varieties of lentil viz. BARI Masur-3, BARI Masur-4, BARI Masur-5 and BARI Masur-6. The results of the study indicated that, at 50 DAS the highest total dry matter (TDM) (29.67 g m^{-2}) was found in V4 (BARI Masur-6) and lowest (25.37 g m^{-2}) in V1 (BARI Masur-3). At 60 DAS, the highest TDM (47.60g m^{-2}) was produced by V4 (BARI Masure-6) and lowest (41.49 g m^{-2}) by V1 (BARI Masur-3). At 70 DAS, the highest TDM (98.03 g m^{-2}) was observed in the variety V4 (BARI Masur-6) and the lowest (76.90 g m^{-2}) in V1 (BARI Masur-3). The highest TDM (157.29 g m^{-2}) and the lowest (135.12 g m^{-2}) was produced by BARI Masur-6 and BARI Masur-3, respectively at 80 DAS.

2.1.2 Effect of Genotypes on Yield Attributing Characters and Yield of Lentil

Dimitrov (1974) conducted long term varietal trials of lentil in various parts of Bulgaria. The result revealed that, the highest yielding variety was Tadzhikakaya-95 and yield of which ranged from 1.04 to 2.15 t ha^{-1}

Tomenzei and Tirda (1975) after studying 11 lentil cultivars reported that, the weight of the seeds per plant ranged from 0.79 g in variety VIR-444 to 2.31 g in variety VIR-210. Ramakrishna and Maurya (1987) reported that lentil cultivars T-36, T-8 and Pant L-406 had a 1000-seed weight of 17 g, 21 g and 19 g, respectively.

Singh (1977) based on the experiment conducted at Ludhiana, observed the positive association of harvest index with seed yield but no association with plant dry matter. Seed yield and plant dry matter yield showed positive correlation with pod number, plant height and number of primary and secondary branches but negative correlation with test weight.

Shrivastav (1979) conducted an experiment during rabi season of 1997-98 with four lentil varieties. He reported that the variety L9-12 had maximum number of pods per plant (63.27) with 1000-seed weight (19.15 g) and the variety Pant L-406 had the least number of pods per plant (50.54) with a 1000-seed weight of 19.04 g.

Saharia (1980) conducted an experiment at Newgong (Assam) with four lentil varieties and reported that Pant L-209 significantly out-yielded than other varieties.

Ahlawat *et al.,* (1982) conducted an experiment in winter with three varieties of lentil at IARI, New Delhi. They reported that variety Pant L-209 gave the highest seed yield (1.44 t ha^{-1}) followed by Pant L-406 (1.35 t ha^{-1}) and Pusa-4 (1.34 t ha^{-1}) and were on par with one another.

Sinha and Choudhary (1984) conducted an experiment with 12 lentil cultivars for late sown conditions of Bihar. Results revealed that, pre-release variety RAU-101 produced the highest seed yield of 1.56 t ha^{-1} while varieties, LL-78 and L9-12 produced 1.35 and 1.32 t ha^{-1}, respectively.

An experiment at Pantanagar with four lentil varieties during *rabi* seasons of 1979-1980 was conducted by Tripathi and Singh (1987) and 1980-81 on loamy soil. They concluded that Pant L-406 had the highest number of pods (121.6 $plant^{-1}$) and number of seeds (1.74 pod^{-1}) with 1000-seed weight of 18.72 g. While, Pant L-234 had the least number of pods (105.8 $plant^{-1}$), number of seeds per pod (1.50 pod^{-1}) and 1000-seed weight of 23.27 g.

Ali-Khan and Kiehn (1988) revealed that the small-seeded cultivar, Eston recorded significantly higher yields compare to large-seeded cultivar Laird in all the three years of experimentation.

Mahamad *et al*., (1989) conducted an experiment with nine Egyptian lentil varieties and Sudanence variety Salaim at Hudieba and Rubatab in northern Sudan. Maximum seed yield of 804 kg ha^{-1} was recorded with variety NEL-788 and 688 kg ha^{-1} with variety NEL-795 at Hudeiba and 1899 kg ha^{-1} with variety Salaim and 1633 kg ha^{-1} with NEL-788 at Rubatab.

Abdellah *et al*., (1990) reported that yield as well as seeds per plant of local variety was significantly higher than Giza-9 during first year but during second year, the compensating effect of the plant yield on per unit area production was consistent. Giza-9 did not showed significant increase in individual plant yield and seed yield per ha.

Hussain (2002) revealed that, lentil genotypes Masoor-93 and Masoor-85 produced significantly more number of pods per plant and also more seeds per pod than Masoor-local. Weight per 1000 seeds was highest in Masoor-93 and the lowest in Masoor-local as well as Masoor-93 produced significantly higher seed yield per plant than Masoor-85 which also differed significantly from Masoor-local.

Sharar *et al.,* (2003) conducted field experiments with three varieties viz., Masoor-Local, Masoor-85 and Masoor-93. Among the cultivars, Masoor-93 owing to more number of pods per plant and 1000-seed weight recorded significantly higher seed yield (2340 kg ha^{-1}) against the minimum of 1616 kg ha^{-1} in Masoor-Local.

Mohammadjanloo *et al*., (2009) reported that, lentil variety ILL1180 produced more filled pods than the local variety, in which average values of filled pods allocated to ILL1180 and the local variety were 58.54 and 49.62, respectively. The average seed number per plant in the improved variety (ILL1180) was 78.58 and in the local variety 52.46. Regarding 100-seed weight, means of the local variety was twice as much as the improved one (ILL1180) with values of 6.02 and 3.93 g, respectively.

Singh *et al.,* (2011) conducted the field experiments during *rabi* 2006-07 and 2007-08 on a loamy sand soil with four genotypes (LL 147, LL 699, LL875 and LL 931). The genotype LL 699 recorded the higher number of pods per plant, biological and seed yield. The 100-seed weight was higher in LL 931 (2.4 g) than in LL 699, LL 875 and LL 147 (2.1, 2.2 and 1.7 g, respectively). Nodulation was highest in genotype LL 931 followed by LL 699 and LL 147.

Gill *et al*., (2012) evaluated 16 lentil genotypes including seven small seeded and nine large ones for seed yield and its component traits during *rabi* 2007-08 and 2008-09. Among all the varieties, the genotype LL 1024 recorded the highest number of pods per plant (91.63 and 100.75) under normal sowing during both the years. The genotype LL 1031 recorded highest biological yield (4062 and 3670 kg ha^{-1}) under normal sowing during both the years, while LL 991 had the highest value under late sown condition (3037 kg ha^{-1}).

Rahman *et al*., (2013) conducted field experiments with three lentil cultivars viz., Punjab Masoor (PM)-2009, NIAB Masoor (NM)-2006 and NIAB Masoor (NM)-2002. The cultivar PM-2009 gave the highest seed yield (972 kg ha^{-1}), maximum number of pods per plant (47.29), number of seeds per pod (1.80), 1000-seed weight (21.89 g) and biological yield (3954 kg ha^{-1}).

The field experiment at the farm of Bangladesh Agricultural University, Mymensingh during November 2009 to March 2010 was conducted by Haque *et al.,* (2014) to study the response of three lentil varieties (viz., BARI Masur-1, BARI Masur-2 and BARI Masur-3) to *Rhizobium* inoculations for yield. It was observed that, BARI Masur-3 recorded the highest grain yield (1,276 kg ha^{-1}), which was statistically superior to both varieties. Also, it was observed that, the highest crop residue (2,482 kg ha^{-1}) was obtained by the variety BARI Masur-3, which was statistically superior to BARI Masur-1 (2,199 kg ha^{-1}) but similar to BARI Masur-2 (2,404 kg ha^{-1}).

Awal and Roy (2015) conducted an experiment at the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, during the period extended from November 2010 to March 2011 to study the effect of weeding on the growth and yield of three lentil varieties viz. Binamasur-1, Binamasur-2 and Binamasur-3. The experiment was laid out in a Randomized Complete Block Design with three replications. They reported that, the maximum number of pods $plant^{-1}$ (84) was recorded from Binamasur-3 and minimum number of pods $plant^{-1}$ (77) was recorded from Binamasur-2. They also reported that, the maximum number of seeds pod^{-1} (1.43) was recorded from Binamasur -3 and minimum (1.33) from Binamasur-1.

Hasan *et al.,* (2015) stated that the highest seeds pod^{-1}(98) was found from BARI Masur-5 and the lowest (49) from BARI Masur-7. Similarly the variety BARI Masur-5 was the best in respect of seed yield also.

2.1.3 Effect of Genotypes on Availability of N, P and K in Soil and Nutrient Uptake by Lentil Crop after Harvest

Shahjahan (2003) found that lentil seeds contained 3.53 to 4.03% Nitrogen, and highest N uptake was achieved by BARI Masur-4 in both years of experimentation which differed from other two varieties under comparison in 2004-05 but identical with these varieties in 2005-06. The lowest N uptake was observed in cultivar BARI Masur-2. Afzal *et al*., (2003) also reported similar results for nitrogen uptake in lentil.

Gahoonia *et al*., (2005) found the significant difference in terms of nutrient uptake in dry matter of ten lentil cultivars. The K uptake in dry matter of BM-4 (28.12 g kg^{-1}) was statistically ($p<0.05$) higher as compared to BLX-79542 (22.81 g kg^{-1}), GP-8407-5 (21.33 g kg^{-1}), BM-3 (20.43 g kg^{-1}), GP-8407 (20.21g kg^{-1}), L5x8704 (2) (20.14 g kg^{-1}), L5x87272 (19.98 g kg^{-1}), L-107x87102 (19.50 g kg^{-1}), PLX-79542 (19.14 g kg^{-1}) and 8406-122 (17.76 g 10 kg^{-1}). Similarly, the cultivar BM-4 (3.95) and BM-3 (3.62) accumulated significantly greater amount of P in plant over the cultivar 8406-122 (3.30 g kg^{-1}), PLX-79542(3.19 g kg^{-1}), GP-8407 (3.22 g kg^{-1}), L-5x87272 (3.14 g kg^{-1}), GP-8407-5(3.11 g k^{-1}), L-107x87102 (2.98 g kg^{-1}), BLX-79542 (2.87 g kg^{-1}), and L-5x8704 (2) (2.63 g kg^{-1})

Khatun *et al*., (2010) stated that the highest N content was observed in BARI Masur-4, which differed from BARI Masur-2 but identical to BARI Masur-3 in two years of study. Although, Afzal *et al*. (2003) said that varietal differences in nitrogen content of lentil were not conspicuous e.g. BARI Masur-4 showed 4.13% N, while BARI Masur-3 had 4.08% and BARI Masur-2 had 4.53% nitrogen.

Yadav *et al.*, (2017) found significantly greater nitrogen and phosphorus uptake in straw of lentil cultivar PL-406 (31.28 N and 1.32 kg P ha^{-1}) over the remaining ten cultivars and statistically at par with NDL-1 (30.95 N and 1.17 P kg ha^{-1}). Similarly, the lowest uptake (16.17 N and 0.61 P kg ha^{-1}) was noted with IPL-81.

2.1.4 Effect of Genotypes on Economics of Lentil

Tyagi (2012) analysed the economics of four lentil cultivars viz., JL 30, JL 31, JL 3 and SL 94 -14 with common cost of cultivation of 10136 □ /ha. The gross monetary return, net return and benefit-cost ratio of all four cultivars varied in the sequence of –JL 30 (28648, 18512 □ /ha, 2.82) > JL 31 (24833, 14153 □ /ha, 2.45) > SL 94-14 (24555, 14419 □ /ha, 2.42) > JL 3 (22692, 12556 □ /ha, 2.24), respectively.

Yadav *et al*., (2017) worked out the economics of different lentil cultivars under investigation. For all the cultivars the cost of cultivation remained same 16854 □ /ha. In case of gross return (90597 and 86600 □ /ha), net return (73743 and 69746 □ /ha) and benefit-cost ratio (4.3 and 4.1), the cultivar PL-406 and NDL-1 exhibited the maximum value, respectively owned by its greater seed and straw yield along with increased net return in corresponding to the cost of cultivation. The cultivar IPL-81 recorded the lowest gross return (45797 □ /ha), net return (28952 □ / ha) and benefit-cost ratio (1.7) among all the twelve cultivars under investigation.

2.2 Effect of Fertilizer Levels

2.2.1 Effect of Fertilizer Levels on Growth and Growth Attributes of Lentil

Clark *et al.*, (1980) observed increased dry matter accumulation with increase in levels of N at all growth stages. The split application of N fertilizer increased the rate of photosynthetic accumulation, leaf dry weight; stem dry weight which finally resulted in increased DM production by plant at each stage of growth in lentil.

Yein *et al.*, (1981) conducted a field experiment on N in combination with phosphorus fertilizer to green gram. They reported that application of 40 kg N ha^{-1} increased plant height.

Verma and Kalera (1983) revealed that phosphorus application at the rate of 60 kg P_2O_5 ha^{-1} significantly improved the growth characters of lentil viz., plant height by 7.84 percent and number of branches by 10.04 percent over 30 kg P_2O_5 ha^{-1}.

Singh *et al.*, (1983) reported that phosphorus application to lentil significantly improved the plant attributes. Average plant height and branches per plant at 30 kg P_2O_5 ha^{-1} were (9.28 percent and 22.79 percent, respectively) higher than the control (no phosphorus application). They also observed increase in the number of nodules per plant.

Sharma and Singh (1986) also reported that application of phosphorus in lentil encouraged the root and nodule development. They also noticed that application of 80 kg P_2O_5 ha^{-1} increased the number of nodules per plant by 31.7 per cent over the control (no phosphorus application).

Singh *et al.*, (1986) revealed that dry matter accumulation of lentil was significantly influenced by phosphorus application from 20 to 60 kg P_2O_5 ha^{-1}. However, an increase of 46.2 percent was recorded in dry matter production at 60 kg P_2O_5 ha^{-1} over the control. They concluded that the favourable effect of phosphorus on vegetative growth may be due to effective root system developed by phosphorus application.

Dingra *et al.*, (1988) observed in lentil that successive increase in phosphorus up to 40 kg P_2O_5 ha^{-1} resulted in the significant increase in dry matter production. They also reported that there was 100 percent increase in nodulation at 60 kg P_2O_5 ha^{-1} over control (no phosphorus application). However, Asghar *et al.*, (1989) reported that effect of phosphorus on the growth parameter such as nodules per plant of lentil was non-significant.

Chandra (1991) reported that phosphorus application at the rate of 40 kg P_2O_5 ha^{-1} Increased the number of nodules per plant. He also reported that nodule dry weight with 40 kg P_2O_5 ha^{-1} was 23.1 percent more than without phosphorus application and concluded that shoot dry weight increased significantly with phosphorus application in lentil

Singh and Singh (1992) observed an increase of 2.8 percent in plant height and 2.87 percent in number of plants m^2 at 26 kg P_2O_5 ha^{-1} over no phosphorus application in lentil

Kumar and Agarwal (1993) reported in lentil that number of branches and dry matter weight per plant at 50 kg P_2O_5 ha^{-1} were significantly higher over 25 kg P_2O_5 ha^{-1}. Plant height, nodules per plant and shoot weight per plant were significantly increased at 60 kg P_2O_5 ha^{-1}.

Santos *et al.* (1993) carried out an experiment on mung bean cv. Berken which was grown in pots in podzolic soil with 7 levels of N (0, 25, 50, 100, 200, 400 and 500 kg ha^{-1}). They noted that application of N up to 200 kg ha^{-1} increased the total dry matter and with use of higher rates of N above 200 kg ha^{-1} the total dry matter decreased.

Kumar *et al*., (1993) observed in lentil that application of phosphorus at the rate of 50 kg P_2O_5 ha^{-1} resulted in significant increase in root length and nodules per plant of lentil.

Singh and Singh (1994) reported in lentil that phosphorus application at the rate of 90 kg P_2O_5 ha^{-1} significantly increased number of branches per plant and root length. However, there was no significant increase in plant height.

Hoque and Haq (1994) revealed that growth attributes of lentil except for number of seeds per pod increased significantly with 30 kg N ha^{-1} as compared to plants receiving no nitrogen fertilizer.

Hussain (2002) reported in lentil crop that there was a linear increase in plant height with each successive dose of phosphorus application from 25 to 75 kg ha^{-1} Phosphorus application at 50 kg ha^{-1}significantly reduced the number of days to 50 percent flowering, increased the number of seeds per pod and also increased the1000-seed weight significantly over check.

Turk *et al*., (2003) reported on crop lentil that branches per plant increased significantly with P application compared with the control. Days to 50 per cent flowering decreased significantly with P application compared with the control.

Zafar *et al*., (2003) revealed that maximum number of branches (15.87 $plant^{-1}$) and maximum plant height (49.92 cm) were recorded in 75 kg P_2O_5 ha^{-1} and minimum number of branches (6.93$plant^{-1}$) and plant height (34.12 cm) were recorded with control in lentil crop.

Islam (2003) found that the number of branches per plant in bush bean significantly increased with increasing N levels from 0 to 36.8 kg ha^{-1}. The highest number of branches per plant was obtained at 36.8 kg N ha^{-1} and the lowest at 0 kg N ha^{-1}.

Zafar *et al*., (2003) conducted a field experiment (2003) to evaluate the growth and yield response of lentil to phosphorus. The experiment was laid out in a randomized complete block design with four replications. Treatments included in this study were: Control, 25, 50 and 75 kg P_2O_5 ha^{-1} at sowing. The result revealed that, the minimum plant height (34.12 cm) was recorded in case of control, whereas, maximum plant height (49.92 cm) was obtained with the application of 75 kg P_2O_5 ha^{-1}.

Jan and Nawabzada (2004) reported that N application compared with no N (control) significantly affected all the parameters. Plots supplied with 20 kg N ha^{-1} had the maximum number of branches per plant and dry matter yield.

Zeidan (2007) carried out two field experiment during the two winter seasons of 2003/ 2004 and 2004/2005 at the Experimental Farm of the National Research Centre at Nubaria to study the effect of organic manure at 0, 10 and 20 m^3/ fed and four phosphorus levels of 0, 30, 45 and 60 Kg P_2O_5 / fed on growth, yield and quality of lentil grown in sandy soil. Results indicated that, the highest plant height (32.90 cm) was recorded from 45 kg P fed^{-1} and the lowest plant height (29.10 cm) was recorded from no P applied plot.

Nasser *et al*., (2008) revealed that biomass dry weight (+35%) and seed yield (+60%) from 1293 kg ha^{-1} to 2640 kg ha^{-1} at the lowest and highest N levels, respectively. Moreover, these values increased with increasing levels of nitrogen in lentil.

Mohammadjanloo *et al*., (2009) reported in lentil that traits like plant height, number of secondary branches per plant and LAI was maximum when 50 kg N ha^{-1} fertilizer was applied.

Niri *et al*., (2010) conducted experiment on lentil crop and concluded that nitrogen application at the rate of 25 kg ha^{-1} increased plant height in lentil crop.

Hussain *et al*., (2011) conducted a field experiment on black gram and reported that plant height, number of branches per plant and dry matter increased significantly with nitrogen application at the rate of 30 kg ha^{-1}.

Choubey *et al*., (2013) conducted the field experiment in Madhya Pradesh and reported that plant height of lentil improved with the application of 60 kg P_20_5 ha^{-1}.

Datta *et al*., (2013) conducted an experiment to study the effect of variety and level of phosphorus fertilizer on the yield and yield components of lentil at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during October 2009 to March 2010.They reported that, the highest plant height (39.32 cm) was observed in P_{45}, which was statistically identical with P_{30} and followed by P_{15} and P_0 treatment.

Fatima *et al*., (2013) reported that phosphorous application significantly increased plant height of lentil by applying up to 50 kg P_20_5 ha^{-1}.

2.2.2 Effect of Fertilizer Levels on Yield Attributing Characters and Yield of Lentil

Werakonphanit *et al.,* (1979) stated that mung bean showed no significant differences in response to different fertilizer levels. NPK levels of 0 - 0 - 0, 3 - 0 - 0 and 3 - 9 - 0 gave seed yield of 156, 168 and 175 kg ha^{-1} respectively. From the results of that study, it was concluded that the fertilizer application in mung bean was not necessary.

Singh *et al*., (1981) observed that seed and straw yields of lentil significantly increased with increased level of phosphorus up to 10, 20 and 30 ppm P_2O_5 on low, medium and high phosphorus soils, respectively.

Verma and Kalera (1983) reported an average increase of 14.9 per cent in number of pods per plant, 1.9 per cent in 1000-seed weight and 15.1 per cent in seed yield per ha with 60 kg P_2O_5 ha^{-1} over 30 kg P_2O_5 ha^{-1}in lentil.

Singh *et al*., (1983) reported that average lentil seed yield significantly increased upto 30 kg P_2O_5 ha^{-1}. An average increase of 26.08 per cent in seed yield and 23.63 per cent in straw yield per ha was recorded with 30 kg P_2O_5 ha^{-1} over the control.

Sharma and Singh (1986) reported that an increase in seed yield of lentil was observed when phosphorus was applied to the level of 40 kg P_2O_5 ha^{-1}.

Singh *et al*., (1986) reported that phosphorus had profound influence on the performance of lentil. An increase of 19.25 per cent in seed yield per ha was recorded with phosphorus application at the rate of 80 kg P_2O_5 ha^{-1} which was significant over the control.

Khare *et al*., (1988) observed in lentil that application of phosphorus at the rate of 60 kg P_2O_5 ha^{-1} recorded an increase of 21.29 per cent in seed yield which was significantly higher than the control.

Lopes *et al.*, (1988) found that the application of 40 kg N/ha produced 96.7% of estimated maximum yield. They conducted field studies to determine the response of lentil to N fertilized at different level (0, 20, 40, and 60 kg ha^{-1}) where N increased the seed yield.

Bali *et al*., (1991) conducted a field trial in kharif seasons on silty clay loam soil. They revealed that seed yield, 1000-seed weight and LAI of mung bean were increased with up to 40 kg N and 60 kg P_2O_5 ha^{-1}.

Chandra (1991) reported that application of phosphorus at the rate of 40 kg P_2O_5 ha^{-1} significantly increased the seed yield (29.12%) and straw yield (25.96%) over the control in lentil crop.

Singh and Singh (1991) noticed in lentil that seed yield increased significantly (58.3%) due to 26 kg P_2O_5 ha^{-1} compared with the control. They concluded that increase in yield was associated with increase in pods per plant (60%), seeds per pod (6.25%) and 1000-seed weight.

Singh *et al*., (1991) revealed that application of 10 kg N ha^{-1} + 40 kg P_2O_5 ha^{-1} resulted in the higher yield over the control. Averaged over three years, data revealed that the maximum seed yield of lentil (6.59 q ha^{-1}) was recorded with 10 kg N + 40 kg P_2O_5 ha^{-1} which were 106.47 per cent higher than the control.

Singh and Singh (1991) observed that phosphorus application exerted significant effect on yield attributes which in turn increased the seed yield. They reported that phosphorus level at the rate of 40 kg P_2O_5 ha^{-1} produced significantly higher seed yield over the control with an increase of 78.53 per cent, 77.72 per cent, 25.9 per cent and 15.38 per cent in seed yield, straw yield, pods per plant and 1000-seed weight, respectively.

Singh and Singh (1992) noticed that lentil seed yield increased with an increase in phosphorus level only upto 26 kg P_2O_5 ha^{-1}.They reported an increase of 65.41 per cent in seed yield per ha over the control.

Chowdhury and Rosario (1992) studied the effect of N levels (0,30,60 or 90 kg ha^{-1}) on the rate of growth and yield performance of lentil at Los Banos, Philippines in 1988. They observed that N above the rate of 40 kg N ha^{-1} reduced the dry matter yield. They also noted that applied N at the levels above 40 kg ha^{-1} reduced the seed yield.

El-Awady *et al.*, (1993) conducted field experiment on crop lentil and concluded that increase in phosphorus level from 0 to 60 kg ha^{-1} increased seed and straw yields as well as seed protein content.

Kumar and Agarwal (1993) reported that seed yield of lentil significantly increased upto 50 kg P_2O_5 ha^{-1}. However, a significant decrease was found with higher doses of phosphorus.

Hoque and Haq (1994) revealed that phosphorus at the rate of 60 kg P_2O_5 ha^{-1} produced highest seed yield (1039 kg ha^{-1}) of lentil.

Kumar *et al.*, (1995) noticed that application of phosphorus at the rate of 50 kg P_2O_5 ha^{-1} significantly increased the lentil seed yield over 25 kg P_2O_5 ha^{-1} (23.46%).

Krishnareddy and Ahlawat (1996) reported that application of 17.2 kg ha^{-1} P_2O_5 to lentil significantly increased number of pods per plant, seed number per pod and seed yield per ha.

Singh and Kumar (1996) revealed that number of pods per plant and 1000-seed weight significantly increased in lentil with increased phosphorus levels. However, phosphorus at the rate of 45 kg P_2O_5 ha^{-1} produced maximum pods per plant and test weight. The seed and straw yields significantly increased with phosphorus at the rate of 45 kg P_2O_5 ha^{-1} over control.

Karle and Pawar (1998) examined the effect of varying levels of N and P fertilizers on lentil. They reported that lentil produced higher seed yield with the application of 35 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1}.

Singh *et al.*, (1999) reported that seed yield of lentil was highest (1182 kg ha^{-1}) with the application of phosphorus at the rate of 60 kg P_2O_5 ha^{-1}.

Chaubey *et al.,* (1999) reported that application of phosphorus at the rate of 40 kg P_2O_5 ha^{-1} significantly increased the number of pods per plant over control (40.26 to 64.33%), in a study at Faisalabad, Pakistan on lentil crop

Shah *et al.*, (2000) observed that higher doses of phosphorus increased the seed yield of lentil which was attributed to increase in the number of seeds per pod, total seed weight per plant and weight per 1000 seeds. They further reported that cooking quality was significantly improved with higher phosphorus application over the control. An increase in seed yield of lentil was observed with the application of diammonium phosphate (DAP) upto 100 kg ha^{-1} (Tomar *et al.*, 2000).

Muhammad *et al*., (2002) reported that application of P to lentil at the rate of 75 kg ha^{-1} recorded the highest values of seed yield (1163 kg ha^{-1}), number of pods (39.89 plant^{-1}), number of seeds (1.74 pod^{-1}), 1000-seed weight (24.21 g) and harvest index (42.45%). Maximum dose of phosphorus proved better than others and contributed to higher lentil seed yield of 1250 kg ha^{-1} (Zafar *et al*., 2003).

Mahboob and Asghar (2002) studied the effect of seed inoculation at different nitrogen levels on the yield and yield components of mung bean at the Agronomic Research Station, Farooqabad in Pakistan during the year of 2000 and 2001. They revealed that various yield components like 1000 grain weight was affected significantly with fertilizer (50 - 50 - 0 NPK kg ha^{-1}) application. They also revealed that seed inoculation + 50- 50-0 NPK kg ha^{-1} exhibited superior performance in respect of seed yield (955 kg ha^{-1}).

Mandal (2002) found that in lentil application of N fertilizer significantly increased seeds per pod. The crop treated with 30 kg N per ha gave the highest seed yield (1.7 t ha^{-1}) which was 150% higher than those in control plot.

Srinivas *et al.,* (2002) examined the effect of nitrogen (0, 20, 40 and 60 kg ha^{-1}) and phosphorus (0, 25, 50 and 75 kg ha^{-1}) on the growth and yield of mung bean. They observed that the number of pods plant^{-1} was increased with the increasing rates of N up to 40 kg ha^{-1} followed by a decrease with further increase in N. Pod length was increased with the increasing rates of N up to 40 kg ha^{-1}which was followed by a decrease with further increase. The 1000 seed weight was generally increased with increasing rates of P along with increasing rates of N up to 40 kg ha^{-1} which was then followed by a decrease with further increase in N.

Jan and Nawabzada (2004) reported that P application to lentil at 60 kg ha^{-1} resulted in the significantly higher number of pods per plant, number of seeds pod, 1000-seed weight, dry matter yield and seed yield, but had no significant effect on nodule number.

Gan *et al*., (2005) revealed that phosphorus fertilizer applied at a rate 15 kg P ha^{-1}did not influenced lentil crop establishment, growth or seed yield.

Deol (2007) noticed that the seed yield of lentil increased by 5.83 and 13.3 per cent during 2004-05 and 2005-06, respectively with the application of 20 kg P_2O_5 ha^{-1} over control and by 14.3 and 26.2 per cent during the respective years with the application of 40 kg P_2O_5 ha^{-1}.

Zeidan (2007) and Togay *et al*., (2008) reported that plots treated with 60 kg P_2O_5 ha^{-1} increased the number of pods per plant, 1000 seed weight, seed yield per plant, seed and straw yield over control treatments in lentil.

Kumar *et al*., (2010) revealed that plant height of lentil increased significantly with 40 kg P_2O_5 ha^{-1} and FYM applications. Nodule number and dry weight per plant increased by 152 and 180 per cent at 40 kg P_2O_5 ha^{-1} increased P_2O_5 levels respectively and decreased pod damage.

Singh *et al*., (2011) conducted field experiments during *rabi* 2006-07 and 2007-08 on a loamy sand soil to study the effect of four nutrient levels involving nitrogen and phosphorus (0+0, 9.4 + 30, 12.5 + 40 and 15.6 + 50 kg N + P_2O_5 ha^{-1}) on nodulation, growth and yield of four genotypes (LL 147, LL 699, LL 875 and LL 931) of lentil. They reported that, the highest 100-seed weight (2.40 g) was produced by application of 15.6 + 50 kg N + P_2O_5 ha^{-1}.

Choubey *et al.,* (2013) reported that application of 60 kg P_2O_5 ha^{-1} along with 20 kg ha^{-1}sulphur recorded more no of pods per plant, highest yield, net return and benefit cost ratio crop lentil.

2.2.3 Effect of Fertilizer Levels on Availability of N, P and K in Soil and Nutrient Uptake by Lentil Crop after Harvest

Sharma *et al*., (1987) reported that total content of phosphorus in lentil shoot increased due to application of P up to 35.2 kg P_2O_5 ha^{-1} and varied from 0.61 percent under the control to 0.88 percent under 35.2 kg P_2O_5 ha^{-1}.

Dwivedi *et al*., (1988) recorded the highest protein content of 26.67 percent in blackgram with 60 kg P_2O_5 ha^{-1} as compared to 26.22, 26.42 and 26.51 percent at 0, 20 and 40 kg P_2O_5 ha^{-1}, respectively.

Singh *et al*., (1996) revealed that uptake of N, P and K increased with increase in fertilizer application. This was also substantiated by the work of Koli *et al.,* (1996) who also reported that the uptake values of N (56.6 kg ha^{-1}), P (7.2 kg ha^{-1}) and K (37.3kg ha^{-1}) were significantly higher due to the application of 60 kg N ha^{-1} compared to zero or 30 kg N ha^{-1} along with 60 kg P_2O_5 ha^{-1}. Whereas, Rana and Singh (1998) reported positive response upto 120 kg N ha^{-1}.

Veeresh (2003) indicated that the treatment receiving 80 kg N ha^{-1} recorded higher nitrogen uptake (76.20 kg ha^{-1}) over 40 kg N ha^{-1} (35.26 kg ha^{-1}). N uptake increased significantly with increasing levels of nitrogen from 0 (74.14 kg ha^{-1}) to 180 kg N ha^{-1} (118.43 kg) ha^{-1} (Singh *et al*., 2006). Protein content in lentil seeds significantly increased up to 30 kg P_2O_5 ha^{-1} (Singh *et al.*,1983). An average increase of 8.07 percent protein content in seed was recorded at 30 kg P_2O_5 ha^{-1} over the control.

Jan and Nawabzada (2004) reported that phosphorus applied to the lentil at the rate of 60 kg ha^{-1} produced more number of pods (84 plant-1), number of seeds (1.61 pod-1),1000 seed weight (14.8g) dry matter yield (2875 kg ha^{-1}) and seed yield (595 Kg ha^{-1}) but had no significant effect on nodule number. The seed protein content decreased with increased number of seeds and number of pods per plant of soybean but increased with increased average seed weight where as, seed oil content increased with increased number of seeds per pod (Benati *et al*.,1988).

Zeidan (2007) reported that lentil plots treated with 60 kg P_2O_5 ha^{-1} recorded the highest levels of protein and P contents in seeds as compared to 0, 30 and 35 kg ha^{-1}.

Niri *et al*., (2010) observed that phosphorus application at the rate of 40 kg ha^{-1} increased the lentil seed protein and nitrogen content. Highest nitrogen uptake occurred under 25 kg N ha^{-1}.

Kumar *et al*., (2010) reported that uptake of nitrogen and phosphorus by lentil increased with seed rate and phosphorus application uniformly, whereas, FYM was found in consistent. The mean uptake of N and P by seed and straw in both the years increased markedly under the higher seed rate of 75 kg ha^{-1}and was significantly superior to the lowest seed rate of 50 kg ha^{-1}. The higher levels of P application significantly increased the uptake of N and P in both seed and straw.

2.2.4 Effect of Fertilizer Levels on Economics of Lentil

Venkateswarlu and Ahlawat (1993) reported that 70 kg P_2O_5 ha^{-1} fetched the maximum net returns in lentil.

Malik *et al*., (2003) reported that highest net income (21374.90 ha^{-1}) in mungbean was also obtained by applying nitrogen and phosphorus at the rate of 25 and 75 kg ha^{-1}, respectively.

Dwiwedi and Sharma (2005) conducted a field experiment at Dindori district of Madhya Pradesh and reported that application of 10 kg N+60 kg P_2O_5 ha^{-1} to utera crop of lentil resulted in the maximum net returns.

Singh *et al.,* (2005) revealed that seed rate of 37.5 kg ha^{-1} recorded higher net income and benefit cost ratio than higher seed rates in crop lentil.

Rasheed *et al*., (2011) reported that application of P-fertilizer to lentil was found to be feasible in economic terms, as the net return, value-to-cost ratio and relative increase in income were enhanced successively at higher phosphorus rates.

Choubey *et al.,* (2013) concluded that application of 60 kg P_2O_5 ha^{-1} along with 20 kg ha^{-1} sulphur gave highest yield, net return and benefit cost ratio.

Vishnoi *et al.*, (2013) revealed that application of recommended dose of fertilizers (20:30:20 kg N:P: K ha^{-1}) along with 1.66 q of fish meal per ha shown maximum net return compared to control (100% RDP through inorganic).

2.3 Interaction Effects between Genotypes and Fertilizer Levels on lentil Crop

Raju and Varma (1984) carried out a field experiment during summer season of 1979 and 1980 to study the response of mung bean var. Pusa Baishaki to varying levels of nitrogen (15, 30, 45 and 60 kg N ha^{-1}) in the presence and absence of seed inoculation with *Rhizobium.* They found that maximum dry matter weight plant^{-1} was obtained by the application of 15 kg N ha^{-1} inoculated with *Rhizobium*. They also reported that seed inoculation and/or application of 15 - 60 kg N ha^{-1} significantly increased seed yields of mung bean.

Azad and Gill (1989) set up a experiment where lentils cv. L9-12 were given 0 to 40 kg P_2O_5 ha^{-1} + 12.5 kg N ha^{-1} or soils low in available P and organic matter in *Rabi* (winter) season and found that seed yield increased with increasing P rate from cv. L9-12 of 285 kg ha^{-1} without applied P to 758 kg with 40 kg P_2O_5. They got the greatest response of P in soil with lowest available P contents.

Patel *et al.,* (1992) conducted a field trial to evaluate the response of mung bean to sulphur fertilization under different levels of nitrogen and phosphorus. Green gram cv. Gujrarat 2 and K 851 were given 10 kg N + 20 kg P_2O_5 ha^{-1} or triple these rates and 0, 10, 20 or 30 kg sulphur ha^{-1} as gypsum. Seed yield was 1.20 and 1.24 t ha^{-1} in Gujrarat 2 and K 851, respectively and was increased with the increase in fertilizer up to 20 kg N + 40 kg P_2O_5 ha^{-1}.

Malik *et al.,* (2003) conducted an experiment to determine the effect of varying levels of nitrogen (0, 25 and 50 kg ha^{-1}) and phosphorus (0, 50, 75 and 100 kg ha^{-1}) on the yield and quality of mung bean cv. NM-98. Growth and yield components were significantly affected by varying levels of nitrogen and phosphorus. A fertilizer combination of 25 kg N + 75 kg P_2O_5 ha^{-1} resulted in the maximum seed yield (1112.96 kg ha^{-1}) and harvest index (41.88%). They also observed that number of flowers plant^{-1} was found to be significantly higher by varying levels of nitrogen and phosphorus and pod length was significantly affected by both nitrogen and phosphorus application.

Hussain *et al.,* (2003) conducted an experiment and observed the effect of different P rates (0, 25, 50 and 75 kg ha^{-1}) on the chemico-qualitative parameters of lentil cultivars Masoor local, Masoor-85 and Masoor-93 under field conditions in Faisalabad, Pakistan on a sandy-clay loam soil for two years. The seed protein concentration was significantly higher (25.36%) in Masur-93 than Masur-85 (23.24%) and Masur-local (23.07%) whereas the seed contents of P, K, Ca, Mg, and phytic acid and cooking quality were similar in all cultivars. By contrast, 50 kg P_2O_5 ha^{-1} significantly improved the cooking quality, seed P and phytic acid content compared to the control.

Amanullah (2004) conducted an experiment during 2000-01 in Pesbawar, Pakistan to investigate the effect of various levels of N (0 and 20 kg ha^{-1} and P (0, 30, 60 and 90 kg ha^{-1}) on the growth and yield components of lentil cultivars Masur-85, Masur-93 and Manshera-89 under rainfed conditions. P application had significantly affected the number of pods plant^{-1}, 1000-seed weight and dry matter yield. Lower number of pods plant^{-1} (81), seeds pod^{-1} (1.5), 1000-seed weight (14.2 g) and grain yield (550 kg ha^{-1}) were recorded without P application. P applied at 60 kg ha^{-1} resulted in the highest number of pods plant^{-1} (84), number seeds pod^{-1} (1.6), 1000-seed weight (14.8 g), dry matter yield (2875 kg ha^{-1}) and grain yield (595 kg ha$^{-1)}$ in case of lentil cultivar Masur-93 but had no significant effect on nodule numbers.

Nadeem *et al.*, (2004) studied the response of mung bean cv. NM - 98 to seed inoculation and different levels of fertilizer (0 - 0, 15 - 30, 30 - 60 and 45 - 90 kg N- P_2O_5 ha^{-1}) under field conditions. Results showed that the application of fertilizer significantly increased the seed yield and the maximum seed yield was obtained when 30 N ha^{-1} was applied.

Datta *et al*., (2013) carried out an experiment to study the effect of variety and level of phosphorus fertilizer on the yield and yield components of lentil at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during October 2009 to March 2010. Three lentil varieties viz. Binamasur-2, Binamasur-3 and BARI Masur-4 and four levels of phosphorus viz. 0 kg P ha^{-1} (P_0),15 kg P ha^{-1} (P_{15}), 30 kg P ha^{-1} (P_{30}) and 45 kg P ha^{-1} (P_{45}) were used in this experiment. They reported that, the highest seed yield (1317 kg ha^{-1}) was observed inV_3 X P_{45} treatment combination, which was statistically identical with (1280 kg ha^{-1}) and (1250 kg ha^{-1}) in V_3 X P_{30} and V_1 X P_{30} treatment combination, respectively and the lowest seed yield (830 kg ha^{-1}) was observed in V_2 X P_0 treatment combination.

3. MATERIAL AND METHODS

The present field investigation was carried out during the *Rabi* season of, 2019 to study ***"*Comparative Performance of Lentil** (***Lens esculenta*** **L.**) **Local Genotypes to Different Fertilizer Levels".** The details of the material used and experimental techniques adopted during the course of present investigation are discussed in this chapter.

3.1 General Description

3.1.1 Experimental Site

The field experiment was laid out during *Rabi*, 2019 in Survey No. 4A at the Post Graduate Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur.

3.1.2 Soil

The soil of experimental plot was clay in texture. The topography of experimental plot was uniform and fairly leveled, soil samples from 30 cm depth were taken from randomly selected plots all over experimental field before laying out the experiment. A composite soil sample about 0.5 kg gross was taken and analyzed for the determination of various physical and chemical properties of soil. The results obtained are presented in Table 3.1 along with the analytical method used for estimation.

Data in Table 3.1 showed that the soil of the experimental plot was clayey in texture, slightly alkaline in reaction (pH 7.70), having electrical conductivity 0.30 dS m^{-1} and organic carbon content was very low (0.18%), low in available nitrogen (207.10 kg ha^{-1}) medium in available phosphorus (28.80 kg ha^{-1}) and high in available potassium (287.10 kg ha^{-1}).

3.1.3 Climatic Conditions and Location

3.1.3.1 General

The experimental farm of Rajarshee Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur, is situated in tropical region at 16^0 42' North latitude and $74^0$14' East longitude. Ecologically, this area comes under the sub- mountain zone with average annual rainfall of 1075.60 mm, out of this 80 percent receives from south west monsoon in June to September while rest of rainfall receives in the month of October and November from north-west monsoon. In order to get clear idea about the prevailing climatic conditions during the period of experimentation, the weekly weather data was obtained from the Agronomy section, Rajarshee Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur and presented in Table 3.2 and graphically depicted in Figure 3.1.

The weather data presented in Table 3.2 indicated that the maximum temperature recorded during crop growth period ranged between 28.2^{o}C to 37.9^{o}C and minimum temperature

Table-3.1: Physical and chemical properties of the soil of experimental plot

Sr. No.	Characteristics	Composition	Method used
A	**Physical properties**		
1	Sand (%)	40.2	International pipette method (Piper, 1966)
2	Silt (%)	30.1	
3	Clay (%)	29.7	
B	**Chemical properties**		
1	P^H	7.70	Potentiometric method (Jackson, 1973)
2	EC (dS m^{-1})	0.30	Conductometric method (Jackson, 1973)
3	Organic carbon (%)	0.18	Walkley and Black's rapid titration method (Jackson, 1973)
4	Available N (kg ha^{-1})	207.10	Alkaline $KMnO_4$ method (Subbiah and Asija, 1956)
5	Available P_2O_5 (kg ha^{-1})	28.80	Olsen method (Olsen,1954)
6	Available K_2O (kg ha^{-1})	287.10	Flame photometer method (Jackson, 1973)

ranged between 11.0 °C to 19.1°C. The relative humidity during the morning and evening ranged between 56 to 87 per cent and 36 to 73 percent respectively. The total rainfall received during the period of experimentation was 31.1 mm, in two rainy days only.

The highest evaporation was recorded as 8.6 mm and the lowest being 3.5 mm.

3.1.3 Cropping History of the Experimental Plot

The cropping history of the experimental plot for previous three years is presented in Table 3.3.

3.2 Experimental Details

Experiment was laid out in Randomized block design (Factorial) with three replications. The twelve treatment combinations comprising of three local genotypes and four fertilizer levels. The treatment details are as under. The plan of layout with relevant details is given on Fig. 3.2.

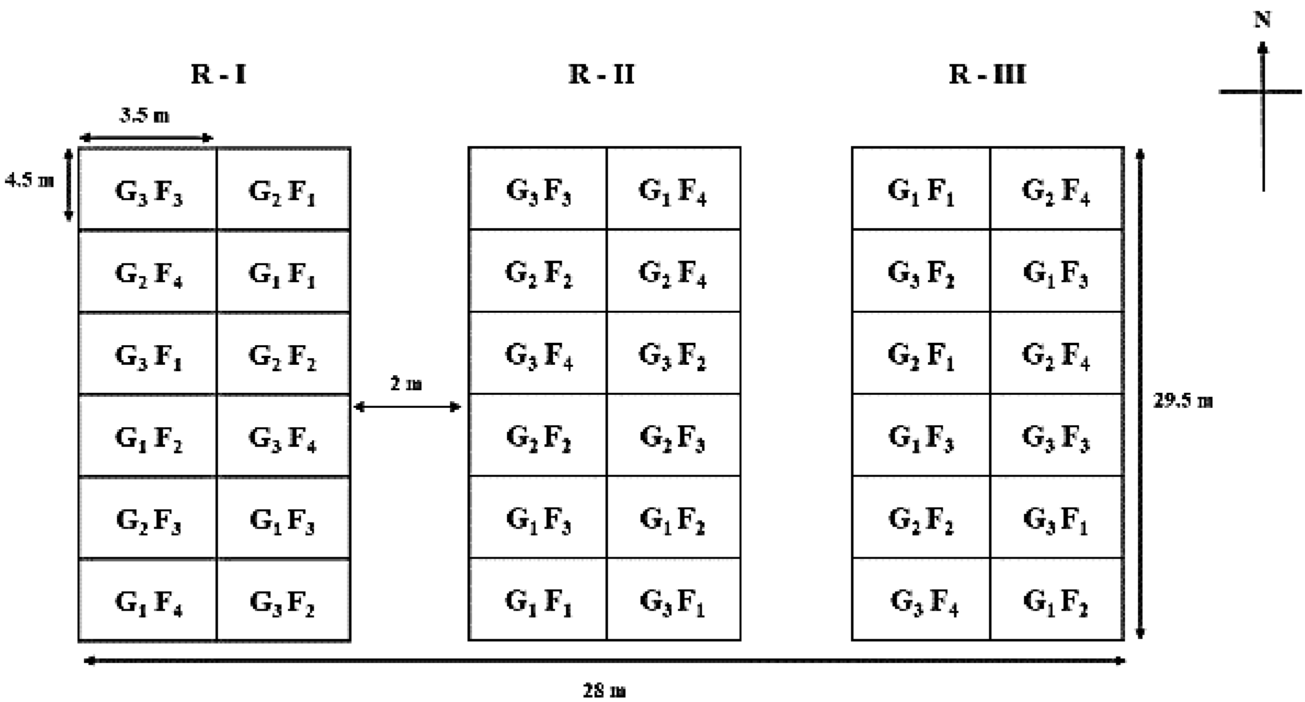
Crop	:	Lentil
Genotypes	:	Itagi local genotype Gandigwad local genotype Nesari local genotype
Season	:	*Rabi*, 2019
Design	:	Randomized block design (Factorial).
Replications	:	3
No. treatment Combinations	:	12
Spacing	:	25 cm
Plot size	:	Gross plot: 4.50 m × 3.50 m Net plot: 4.00 m × 3.00 m
Method of sowing	:	Line sowing
Seed rate	:	40 kg ha^{-1}
Date of sowing	:	19-12-2019
Location	:	Post Graduate Research Farm, RCSM College of Agriculture, Kolhapur.

Table-3.2 Meteorological data recorded during the crop season (2019-20)

Month & Date	Met. Week	Rainfall (mm)	Rainy days	Mean Temp (^{0}C)		Humidity (%)		Evaporation (mm)
				Max.	**Min.**	**Morn.**	**Even.**	
December,2019								
3-9	49	8.1	1	28.2	16.6	81	73	3.7
10-16	50	--	--	30.0	13.5	78	64	3.5
17-23	51	--	--	29.7	12.3	81	60	4.2
24-31	52	--	--	30.0	14.8	83	66	3.8
January,2020								
1-7	1	--	--	29.5	11.7	80	63	3.5
8-14	2	--	--	30.3	12.3	84	68	4.1
15-21	3	--	--	30.2	11.1	87	72	3.9
22-28	4	--	--	31.7	11	77	69	4.3
29-4	5	--	--	30.3	11.6	83	67	4.3
February,2020								
5-11	6	--	--	30.7	11.8	73	59	4.2
12-18	7	--	--	32.0	13.3	72	54	4.4
19-25	8	--	--	33.4	13.3	75	56	5.9
26-4	9	--	--	33.2	14.2	63	52	5.8
March,2020								
5-11	10	--	--	31.8	14.0	68	44	5.8
12-18	11	--	--	33.4	15.7	66	42	6.5
19-25	12	--	--	35.3	17.7	56	38	7.8
26-1	13	--	--	36.8	18.7	63	42	8.6
April,2020								
2-8	14	--	--	36.9	17.5	65	43	8.3
9-15	15	--	--	37.7	17.8	71	43	7.9
16-22	16	23	1	37.3	19.1	74	42	7.8
23-29	17	--	--	37.9	18.9	80	46	7.6
30-6	18	--	--	37.9	18.1	76	36	7.7
	Total	31.1	02					119.6

Table-3.3: Cropping history of experimental plot

Year	***Kharif***	***Rabi***	**Summer**
2016-2017	Soybean	Wheat	Groundnut
2017-2018	Cowpea	Wheat	Fallow
2018-2019	Soybean	Wheat	Fallow
2019-2020	Soybean	Lentil (Experiment)	Fallow



G_1 :	Gandigwad local genotype	**F_1 :**	15: 30: 15 N, P_2O_5, K_2O (75 % of RDF) Kg ha^{-1}
G_2 :	Itagi local genotype	**F_2 :**	20: 40: 20 N, P_2O_5, K_2O (100 % of RDF) Kg ha^{-1}
G_3 :	Nesari local genotype	**F_3 :**	25: 50: 25 N, P_2O_5, K_2O (125 % of RDF) Kg ha^{-1}
		F_4 :	30: 60: 30 N, P_2O_5, K_2O (150 % of RDF) Kg ha^{-1}

Plot size: Gross plot - 4.5 m x 3.5 m & **Net plot** – 4.0 m x 3.0 m

Figure 3.2 Plan of layout of the experimental field.

3.3 Field Operations

The schedule of field operations carried out in the experimental plot is presented in Table 3.5.

3.3.1 Land Preparation

The ploughing was carried once with mould board plough by tractor and the clods were crushed with rotavator for obtaining good tilth. The land was leveled and laid out into experimental plots.

Table-3.4 Treatment Details:

Sr. No.	Treatments	Symbol
A.	**Genotypes**	
1.	Gandigwad local genotype	G_1
2.	Itagi local genotype	G_2
3.	Nesari local genotype	G_3
B.	**Fertilizer levels as per northern states (N, P_2O_5, K_2O Kg ha^{-1})**	
1.	15: 30: 15 N, P_2O_5, K_2O (75 % of RDF) Kg ha^{-1}	F_1
2.	20: 40: 20 N, P_2O_5, K_2O (100 % of RDF) Kg ha^{-1}	F_2
3.	25: 50: 25 N, P_2O_5, K_2O (125 % of RDF) Kg ha^{-1}	F_3
4.	30: 60: 30 N, P_2O_5, K_2O (150 % of RDF) Kg ha^{-1}	F_4

3.4 Seed and Sowing

3.4.1 Seed and Selection of Genotypes

Seeds of local Lentil genotypes Itagi, Gandigwad and Nesari were procured from local progressive farmers. Only bold and healthy seeds were used for sowing.

3.4.2 Seed Treatment and Sowing

The lentil seeds were treated with Carbendezim 50 WP @ 2.5 g kg^{-1} and PSB @ 250 g 10 kg^{-1} seed. Very small furrow lines were opened with the help of marker at a distance of 25 cm between the row and sowing of the crop was done on 19th Dec, 2019. The seeds were sown 2 to 3 cm deep in these lines by manual labours and covered with soil. The recommended seed rate of 40 kg ha^{-1} was used.

3.4.3 Gap Filling and Thinning

The gap filling was under taken within seven days after sowing and thinning was carried out fourteen days after sowing for keeping only the required plant populations.

Table-3.5: Schedule of field operations carried out in the experimental plot during *Rabi*, 2019-20

Sr. No.	Name of Operations	Frequency	Date of Operation
A	**Preparatory tillage**		
1	Ploughing	1	18-10-2019
2	Harrowing leveling	1	04-11-2019
3	Preparation of irrigation layout	1	09-11-2019
B	**Application of organic manure**		
	Application of FYM	1	07-11-2019
C	**Seed treatment and sowing**		
1	Seed treatment with fungicid*e* and PSB culture	1	18-12-2019
2	Sowing seed by Line sowing method	1	19-12-2019
D	**Irrigation**	2	05-01-2020 02-02-2020
E	**Post sowing operations**		
1	Gap filling	1	27-12-2019
2	Thinning	1	04-01-2020
F	**Weed management**		
1	Hand weeding	2	09-01-2020 01-02-2020
G	**Application of fertilizers**		
1	Fertilizer dose of N through Urea, P_2O_5 through SSP and K_2O through MOP as per treatments applied to all the plots as basal dose.	1	19-12-2019

H	**Plant Protection**		
	Copper Oxychloride 50% WP to control wilt.	2	19-01-2020 28-01-2020
I	**Harvesting**		
1	Itagi local	1	14-03-2020
2	Gandigwad local	1	22-03-2020
3	Nesari local	1	22-03-2020
J	**Threshing**		
1	Itagi local	1	16-03-2020
2	Gandigwad local	1	24-03-2020
3	Nesari local	1	24-03-2020

3.4.4 Fertilizer Applications

The quantity of nitrogen, phosphorus and potassium were applied as per treatments at the time of sowing.The fertilizers were applied as a basal application by using urea, single super phosphate (SSP) and muriate of potash (MOP), for nitrogen, phosphorus and potash, respectively.

3.4.5 Weed Management

Two hand weedings were taken at 20 days and 40 days after sowing and no herbicides are used.

3.4.6 Plant Protection

Drenching of Copper Oxychloride @ 3 g litre^{-1} of water was done at 30 DAS and 38 DAS to control wilting of plants.

3.4.7 Harvesting and Threshing

The crop was harvested when it was completely matured. Initialy, the border rows were removed from gross plot and then net plots were harvested separately. The plants were cut close to the ground and tied in suitable size bundles. After labeling properly, the bundles were taken to threshing floor. After complete drying, the produce from each net plot was threshed, winnowed, cleaned separately and seed weight was recorded for each net plot.

3.5 Biometric Observations

The various biometric observations of five randomly selected plants from each net plot were recorded. The details of the observations recorded on the growth and yield contributing characters of lentil during the course of investigation are given in Table 3.6.

3.5.1 Plant Count

3.5.1.1 Initial Plant Count

The initial plant count was recorded at 15 days after sowing by counting the plants in one square meter of each treatment net plot and worked out on hectare basis.

3.5.1.2 Final Plant Count

The final plant count was recorded by counting all the plants in one square meter of each net plot at the time of harvest and converted to ha^{-1} basis.

3.5.2 Growth Studies

The periodical biometric observations were recorded at an interval of 15 days from 30 days after sowing onwards till harvest for five selective plants for observation in each net plot.

3.5.2.1 Plant Height

Height of five selected representative plants was measured from the base of the plant to the tip of main shoot. Observations were recorded at 15 days interval till harvest and average height was calculated.

3.5.2.2 Number of Branches Plant^{-1}

The number of branches arising from the main stem were counted periodically at 15 days interval till harvest from five selective plants and mean was worked out.

3.5.2.3 Number of Functional Leaves Plant^{-1}

The number of green and fully opened leaves on the observational plants were counted and recorded periodically at 30, 45, 60, 75 DAS from five selective plants and mean was worked out.

3.5.2.4 Dry Matter Production Plant^{-1} (g)

The above ground parts of one selective plant from each treatment was harvested at 30, 45, 60, 75 DAS and at harvest for dry matter production. The plant samples were first sun dried and later on dried in the oven at 55^0 C till constant weight was noticed. The total dry matter production was recorded as mean dry matter $plant^{-1}$ in lentil.

3.6 Yield and Yield Attributes

The yield contributing characters were recorded on five selected observational plants, which were already used for the growth studies from each net plot and reported on $plant^{-1}$ basis.

3.6.1 Number of Pods $Plant^{-1}$

The number of pods were counted from randomly selected five representative plants and average number of pods $plant^{-1}$ were worked out.

3.6.2 Weight of Pods $Plant^{-1}$

Weight of pods was measured from the pods of five randomly selected plants.

3.6.3 Number of Seeds Pod^{-1}

Number of seeds pod^{-1} was counted from the pods of five randomly selected plants.

3.6.4 Weight of Seed $Plant^{-1}$

Weight of seed was measured from the pods of five randomly selected plants.

3.6.5 100 Seeds Weight (g)

The random samples of 100 seeds were taken from the seed yield of each net plot and weighed on electronic weighing balance and their weights was recorded as test weight.

Table-3.6: Details of biometric observations recorded

Sr. No.	Particulars	Freq	Observations	Plants
A	**Plant count**			
1	Initial	1	15^{th} DAS	$1m^2$
2	Final	1	At harvest	
B	**Growth studies**			
1	Plant height $plant^{-1}$ (cm)	5	30, 45, 60, 75 DAS and at Harvest	5 plants
2	No. of branches $plant^{-1}$	5	30, 45, 60, 75 DAS and at Harvest	5 plants
3	No. of functional leaves $plant^{-1}$	4	30, 45, 60, 75 DAS	5 plants
4	Dry matter $plant^{-1}$ (g)	5	30, 45, 60, 75 DAS and at Harvest	1plant
C	**Yield and yield attributes**			
1	Number of pods $plant^{-1}$	1	At harvest	5 plants
2	Weight of pods $plant^{-1}$	1	At harvest	5 plants
3	Number of seeds pod^{-1}	1	At harvest	5 plants
4	Weight of seeds $plant^{-1}$	1	At harvest	5 plants
5	100 seed weight (g)	1	After harvest	Seed sample
6	Seed yield (kg $plot^{-1}$ and q ha^{-1})	1	At harvest	Net plot
7	Stover yield (kg $plot^{-1}$ and q ha^{-1})	1	At harvest	Net plot
8	Harvest index (%)	1	At harvest	Net plot
D	**Quality attributes**			
1	Protein content in seed (%)	1	After harvest	Seed sample
E	**Soil and plant analysis**			
1	Soil analysis for pH, EC, organic carbon, available N,P,K	2	Initial and at harvest	Sample from net plot
2	Plant analysis for N,P,K	1	At harvest	Sample from net plot

3.6.6 Seed Yield (q ha^{-1})

The sun-dried produce of each net plot was threshed manually. The seed obtained was sun dried, cleaned till constant weight and seed weight per net plot (kg) was recorded and converted into hectare basis.

3.6.7 Stover Yield (q ha^{-1})

Stover yield was estimated by deducting the seed weight from the biological yield of the respective net plot (kg) and converted into hectare basis.

3.6.8 Harvest Index (%)

Seed yield expressed as percentage of total biological yield (seed yield + stover yield) was taken as the harvest index.

$$\text{Harvest index (\%)} = \frac{\text{Economical yield}}{\text{Biological yield}} \times 100$$

3.7 Quality Attributes

The quality characters were recorded from collected seed sample from net plot, which are taken after harvesting by using particular methods.

3.7.1 Protein Content in seed (%)

The nitrogen percentage in lentil seed was estimated by modified micro kjeldhal method (Jackson, 1973). The protein content was calculated by multiplying the nitrogen percentage with factor 6.25 and expressed in percentage.

3.8. Soil and Plant Analysis

3.8.1. Soil Sample Analysis

3.8.1.1 Collection and Preparation of Soil Samples

Before sowing of the experimental plot an initial representative composite soil sample were collected from 30 cm depth and also after the harvest of crop from each treatment plot. The soil samples were dried under shade and ground it with wooden pestle and mortar. The soil is passed through 2 mm sieve and soil samples were preserved in cotton cloth bags.

3.8.1.2 Physical and Chemical Properties of Soil

The soil samples were analyzed for physical properties namely, coarse sand, fine sand, silt and clay by using International pipette method (Piper,1966) and chemical properties namely, pH, EC and OC available N, P and K content by adopting the standard procedures.

3.8.1.3 Soil Reaction (pH)

The pH of soil was determined in 1:2.5 soil-water suspensions after stirring intermittently for half an hour, using a systronics direct digital-331 pH meter (Jackson, 1973).

3.8.1.4 Electrical Conductivity (EC)

The electrical conductivity of the soil was determined in the supernatant solutions of 1:2.5 soil-water suspensions that were used for the pH determination by using systronics direct digital conductivity meter-304 as described by (Jackson, 1973).

3.8.1.5 Organic Carbon (OC)

The soil was grind in pestle and mortar made of agate and passed through 0.5 mm sieve. The organic carbon content of the soil was estimated by Walkely and Black's wet oxidation method by oxidizing the organic carbon in the finely powdered soil with chromic acid and making use of the heat of dilution of sulphuric acid for the reaction as described by Jackson (1973).

3.8.1.6 Available Nitrogen

The available nitrogen in soil was estimated by alkaline permanganate oxidation method as outlined by Subbaiah and Asija (1956).

3.8.1.7 Available Phosphorus

The available phosphorus was estimated by adopting Olsen's method using 0.5 M $NaHCO_3$ as an extract. Phosphorus in the extract was determined by chlorostannous reduced molybdophosphoric blue colour method. The intensity of blue colour was read at 882 nm.

3.8.1.8 Available Potassium

The available potassium content in soil was extracted with neutral normal ammonium acetate (pH=7.0). The potassium in the extract was determined by flame photometer method as described by Jackson (1973).

3.8.2 Plant Sample Analysis

3.8.2.1 Collection and Preparation of Plant Samples

The plant samples collected at harvest were cleaned and then dried in hot air oven at 65^0C. Further, these samples were milled to considerable fineness in a Willey mill and stored in plastic bags for further analysis.

3.8.3.2 Digestion of Plant Samples

The powdered plant sample 0.5 g passed through 100 mm sieve was pre-digested with concentrated nitric acid over night. Further, pre-digested samples were treated with tri-acid (nitric acid: sulphuric acid: perchloric acid in ratio 10:1:4) mixture and kept on sand bath for digestion. After complete digestion the precipitate was dissolved in 6 N HCl and transferred to the 100 ml volumetric flask through Whatman NO.42 filter paper by thoroughly washing with double distilled water and finally the volume was made to 100 ml and preserved for further analysis.

3.8.2.3 Nitrogen (N)

The powdered 0.5 g plant sample was digested with concentrated sulphuric acid and digestion mixture ($CuSO_4$ + K_2SO_4 + selenium powder). The digest was transferred to the micro Kjeldhal distillation flask and the ammonia liberated was distilled in presence of alkali collected in 2 per cent boric acid and the distillate was titrated against standard acid (Jackson, 1973).

3.8.2.4 Phosphorus (P)

The phosphorus in plant sample was determined by Vanado molybdateoposphoric yellow colour method (Jackson, 1973).

3.8.2.5 Potassium (K)

The potassium content in the digested samples was determined by flame photometer after making appropriate dilution (Jackson, 1973).

3.8.3 Uptake Studies

3.8.3.1 Uptake of Nitrogen

The nitrogen uptake kg ha^{-1} was computed by multiplying per cent nitrogen in plant sample with dry matter obtained per hectare at maturity. The nitrogen content in the plant sample was estimated by the modified Microkjeldahl method (Jackson, 1973). From the results of the chemical analysis, nitrogen uptake was calculated as indicated below.

$$\text{N uptake (kg ha}^{-1}\text{)} = \frac{\text{N conc. (\%) x Wt. of dry matter (kg ha}^{-1}\text{)}}{100}$$

3.8.3.2 Uptake of Phosphorus

The phosphorus uptake kg ha^{-1} was computed by multiplying per cent phosphorus in plant sample with dry matter obtained per hectare at maturity. The phosphorus content in the plant sample was estimated by Vanado molybdateoposphoric yellow colour method (Jackson, 1973). From the results of the chemical analysis, phosphorus uptake was calculated as indicated below.

$$\text{P uptake (kg ha}^{-1}\text{)} = \frac{\text{P conc. (\%) x Wt. of dry matter (kg ha}^{-1}\text{)}}{100}$$

3.8.3.3 Uptake of Potassium

The plant samples were analyzed for potassium and uptake kg ha^{-1} was computed by multiplying per cent potassium in plant sample with dry matter obtained ha^{-1} at maturity. The potassium content in the plant sample was estimated by flame photometer after making appropriate dilution (Jackson, 1973). From the results of the chemical analysis, potassium uptake was calculated as indicated below.

$$\text{K uptake (kg ha}^{-1}\text{)} = \frac{\text{K conc. (\%) x Wt. of dry matter (kg ha}^{-1}\text{)}}{100}$$

3.9 Economics of Different Treatment

On the basis of results obtained from the field experiment, the economics of various treatments were worked out by considering prevailing market prices. The gross monetary returns ha^{-1} were calculated on the basis of seed and stover yield from each respective treatment.

The net monetary returns ha^{-1} was calculated by deducting the cost of cultivation ha^{-1} from the gross monetary returns ha^{-1}.

$$\text{B: C ratio} = \frac{\text{Gross returns (Rs. ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs. ha}^{-1}\text{)}}$$

3.10 Statistical Analysis and Interpretation of Data

The experimental data was statistically analyzed by using a standard method of “Anylysis of Variance’’as reported by Panse and Sukhatme, 1967.

The standard error was worked out for each factor under study and the critical difference (C.D.) at 5% level of significance was worked out whenever the results were significant.

4. RESULTS AND DISCUSSION

The field experiment entitled **"Comparative Performance of Lentil** (***Lens esculenta*** **L.**) **Local Genotypes to Different Fertilizer Levels"** was conducted at the Post Graduate Research Farm, Agronomy section of Rajarshee Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur (M.S.), India during *Rabi* 2019-20. The details of results obtained from the present experiment have been presented and discussed in this chapter.

4.1 Plant Count:

The mean data pertaining to initial plant count at 15 DAS and final plant count at harvest m^{-2} and ha^{-1} as influenced by different treatments are presented in Table 4.1. The results showed that the initial plant count on crop establishment and final plant count at harvest was not influenced by different genotypes, different fertilizer levels and also with its interactions. Similarly, the final plant count at harvest was also fairly uniform indicating that the variations shown in the different treatments under study were real effect of treatments. The mean initial plant count of lentil was 13.58 lakh plants per ha at 15 DAS; however, mean final plant count at harvest was 12.89 lakh plants ha^{-1}.

4.1.1 Effect of Genotypes:

The mean initial as well as, final plant count of lentil did not reach the level of significance due to different genotypes under study.

4.1.2 Effect of Fertilizer Levels:

The mean initial as well as final plant count of lentil was uninfluenced due to different fertilizer levels, under study.

4.1.3 Effect of Interactions:

The interaction effects between different local genotypes of lentil and different fertilizer levels, were found non-significant in respect of initial as well as final plant count of lentil.

4.2 Growth Studies:

4.2.1 Mean Plant Height (cm):

The data on plant height recorded during various growth stages are presented in Table 4.2 and depicted in Figure 4.1. Plant height was increased during every growth stages of lentil up to maturity. The mean plant height was increased progressively with an advancement of crop age

Table 4.1: Mean initial and final plant count of lentil as influenced by different treatments

Treatments	Plant count	
	Initial (Lakh ha^{-1})	Final (Lakh ha^{-1})
G: Lentil Genotypes		
G_1 – Gandigwad Local	13.76	13.02
G_2 – Itagi Local	13.53	12.84
G_3 – Nesari Local	13.43	12.81
S. Em±	0.16	0.18
C. D. at 5%	NS	NS
F : Fertilizer Levels		
F_1 – 75% RDF	13.50	12.84
F_2 – 100% RDF	13.56	12.87
F_3 – 125% RDF	13.63	12.96
F_4 – 150% RDF	13.61	12.89
S. Em±	0.22	0.24
C. D. at 5%	NS	NS
Interactions : G × F		
S. Em±	0.65	0.73
C. D. at 5%	NS	NS
General mean	13.58	12.89

and reached maximum at harvest. The rate of increase in height was rapid up to 60 days. The mean plant height plant^{-1} recorded at 30, 45, 60, 75, DAS and at harvest was 7.75, 15.71, 22.25, 26.61 and 27.32 cm, respectively.

4.2.1.1 Effect of Genotypes:

The data in table 4.2 revealed that mean plant height of lentil was influenced significantly by different genotypes at all the days of observations. The genotype Gandigwad local produced significantly maximum plant height and it was superior over rest of the genotypes. While, the genotype Nesari local produced significantly lowest plant height at all the days of observations. Similarly, experimental findings showed that height of the plant, is being varietal character and it was differed significantly among the different cultivars as earlier stated by Shrivastav (1979), Tripathi and Singh (1987).

4.2.1.2 Effect of Fertilizer Levels:

The mean plant height of lentil was significantly influenced by different fertilizer levels at all the days of observations. Application of 125% RDF recorded significantly the highest plant height over other fertilizer levels and remained at par with application of 150% RDF. While, significantly the lowest plant height was produced with the application of 75% RDF and it was measurable with 100% RDF at all the days of observations. Likewise, application of nitrogen and phosphorus beyond certain limit could not improve plant height. These results agreed with those earlier findings of Trung and Yoshida (1983) and Saraf and Shivakumar (1997).

4.2.1.3 Effect of Interactions:

The interaction effects between different genotypes of lentil and different fertilizer levels were found non-significant in respect of mean plant height of lentil during all the days of observations.

4.2.2 Numbers of branches:

The periodical data on mean number of branches as influenced by different treatments are presented in Table 4.3 and graphically depicted in figure 4.2. The mean number of branches were increased progressively with an advancement of crop age and reached maximum at harvest. The mean number of branches plant^{-1} was 3.83, 5.91, 8.60, 10.90 and 10.98 at 30, 45, 60, 75 DAS and at harvest, respectively.

Table 4.2: Mean plant height of lentil as influenced periodically by different treatments

Treatments	Mean plant height (cm)				
	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
G : Lentil Genotypes					
G_1 – Gandigwad Local	8.35	16.47	24.01	28.28	29.18
G_2 – Itagi Local	7.93	15.63	22.55	26.76	27.62
G_3 – Nesari Local	6.97	15.00	20.19	24.78	25.18
S. Em±	0.17	0.35	0.60	0.64	0.63
C. D. at 5%	0.51	1.04	1.79	1.89	1.85
F : Fertilizer Levels					
F_1 – 75% RDF	7.09	14.46	19.80	23.09	24.31
F_2 – 100% RDF	7.73	15.38	21.32	26.00	26.40
F_3 – 125% RDF	8.13	16.84	24.60	29.20	29.98
F_4 – 150% RDF	8.03	16.16	23.28	28.14	28.62
S Em±	0.20	0.40	0.69	0.74	0.73
C. D. at 5%	0.59	1.20	2.04	2.18	2.14
Interactions: G × F					
S. Em±	0.20	0.41	0.70	0.74	0.73
C. D. at 5%	NS	NS	NS	NS	NS
General mean	7.75	15.71	22.25	26.61	27.32

Table 4.3: Mean number of branches plant^{-1} of lentil as influenced periodically by different treatment

Treatments	Number of Branches				
	30 DAS	**45 DAS**	**60 DAS**	**75 DAS**	**At harvest**
G : Lentil Genotypes					
G_1 – Gandigwad Local	4.27	6.41	9.12	11.40	11.52
G_2 – Itagi Local	3.79	5.86	8.51	10.89	10.95
G_3 – Nesari Local	3.42	5.48	8.18	10.42	10.48
S. Em±	0.08	0.13	0.14	0.25	0.24
C. D. at 5%	0.25	0.38	0.44	0.76	0.71
F : Fertilizer Levels					
F_1 – 75% RDF	3.59	5.59	8.21	10.19	10.22
F_2 – 100% RDF	3.74	5.80	8.52	10.78	10.83
F_3 – 125% RDF	4.07	6.19	8.91	11.43	11.51
F_4 – 150% RDF	3.92	6.08	8.77	11.21	11.37
S. Em±	0.09	0.15	0.17	0.29	0.27
C. D. at 5%	0.29	0.44	0.51	0.87	0.81
Interactions : G × F					
S. Em±	0.10	0.15	0.17	0.29	0.28
C. D. at 5%	NS	NS	NS	NS	NS
General mean	3.83	5.91	8.60	10.90	10.98

4.2.2.1 Effect of Genotypes:

The mean number branches plant^{-1} of lentil was significantly influenced by different genotypes at all the days of observations. The genotype Gandigwad local produced significantly maximum number of branches and it was superior over rest of the genotypes. While, the genotype Nesari local produced significantly lower number of branches at all the days of observations. The variability in the number of branches plant^{-1} due to varietal difference was in full agreement with earlier findings of Tripathi and Singh (1987), Awal and Roy (2015).

4.2.2.2 Effect of Fertilizer Levels:

The mean number branches plant^{-1}of lentil was differed significantly by different fertilizer levels at all the days of observations. Application of 125% RDF recorded significantly maximum number of branches plant^{-1}, however it was comparable with application of 150% and followed by 100% RDF. While, significantly lowest number of branches plant^{-1} was recorded with the application of 75% RDF at all the days of observations. The application of nitrogen and phosphorus with higher dose could not improve number of branches plant^{-1}. These results in conformity with those reported earlier by Saxena *et al.* (1996) and Saraf and Shivakumar (1997).

4.2.2.3 Effect of Interactions:

The interaction effects between genotypes of lentil and different fertilizer levels were remained non-significant in respect of mean number of branches plant^{-1} of lentil during all the days of observations.

4.2.3 Number of Functional Leaves Plant^{-1}

The periodical data pertaining to mean number of functional leaves plant^{-1} as influenced by various treatments are presented in Table 4.4 and depicted in figure 4.3. The mean number of functional leaves plant^{-1} was increased with advancement in crop age till 75th day. The mean number of functional leaves plant^{-1} was 47.45, 170.11, 272.07 and 337.50 at 30, 45, 60 and 75 DAS, respectively.

4.2.3.1 Effect of Genotypes:

The mean number of functional leaves plant^{-1} influenced significantly due to different genotypes at all the days of observations. The genotype Gandigwad local produced significantly maximum number of functional leaves plant^{-1} and it was superior over genotype Itagi local and Nesari local. However, the genotype Nesari local produced significantly minimum number of functional leaves plant^{-1} during all the days of observations. These results are confirmed with the findings of Swarup and Lal (1987) and Sharar *et al*. (2003).

Table 4.4: Mean number of functional leaves plant^{-1} of lentil as influenced periodically by different treatments

Treatments	Number of functional leaves			
	30 DAS	45 DAS	60 DAS	75 DAS
G: Lentil Genotypes				
G_1 – Gandigwad Local	55.45	181.76	283.32	353.54
G_2 – Itagi Local	46.96	169.45	272.62	336.61
G_3 – Nesari Local	39.95	159.12	260.27	322.34
S. Em±	0.46	1.35	1.76	2.31
C. D. at 5%	1.35	3.96	5.15	6.76
F: Fertilizer Levels				
F_1 – 75% RDF	43.84	156.09	253.36	317.14
F_2 – 100% RDF	46.22	167.14	268.11	330.50
F_3 – 125% RDF	51.48	181.23	287.08	356.76
F_4 – 150% RDF	48.27	175.98	279.72	345.59
S. Em±	0.61	1.80	2.34	3.07
C. D. at 5%	1.80	5.28	6.87	9.01
Interactions: G × F				
S. Em±	1.84	5.40	7.02	9.22
C. D. at 5%	NS	NS	NS	NS
General mean	47.45	170.11	272.07	337.50

4.2.3.2 Effect of Fertilizer Levels:

The effect of different fertilizer levels on mean number of functional leaves plant^{-1} of lentil was found significantly influenced at all the days observations. Application of 125% RDF recorded significantly maximum number of functional leaves plant^{-1}, which was superior over rest of the fertilizer levels except at 45 DAS and it was followed by 150% RDF and 100% RDF, respectively. While, significantly lowest number of functional leaves plant^{-1} was recorded with the application of 75% RDF at all the days of observations. The results were in conformity with earlier reported by Patel and Parmer (1986).

4.2.3.3 Effect of Interactions:

The interaction effects between lentil genotypes and different fertilizer levels were remained uninfluenced in respect of mean number of functional leaves plant^{-1} of lentil during all the days of observations.

4.2.4 Dry Matter Plant^{-1} (g):

The data on mean dry matter accumulation plant^{-1} during various growth stages are presented in Table 4.5 and depicted in Figure 4.4. The mean dry matter accumulation plant^{-1} recorded at 30, 45, 60,75 DAS and at harvest was 0.67, 0.92, 1.29,1.94, and 2.98 (g), respectively.

4.2.4.1 Effect of Genotypes:

The mean dry matter production plant^{-1} influenced significantly by the different genotypes. The genotype Gandigwad local recorded significantly more dry matter plant^{-1} under present study and followed by genotype Itagi local, while the genotype Nesari local accumulated significantly less dry matter plant^{-1} during all the days of observations. The different behavior of genotypes observed in the studied characters might reflect the differential expressivity of certain genes during autogen etic processes. Similar results also reported by Awal and Roy (2015) and Alam *et al.* (2015).

4.2.4.2 Effect of Fertilizer Levels:

Mean dry matter accumulation plant^{-1} was influenced significantly due to fertilizer levels during various crop growth stages. In general, maximum dry matter accumulation plant^{-1} was recorded due to application of 125 % RDF, which was significantly superior over rest of

Table 4.5: Mean dry matter plant^{-1} of lentil as influenced periodically by different treatments

Treatments	Dry matter Plant^{-1} (g)				
	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
G : Lentil Genotypes					
G_1 – Gandigwad Local	0.92	1.24	1.84	2.61	3.72
G_2 – Itagi Local	0.58	0.80	1.09	1.79	2.93
G_3 – Nesari Local	0.51	0.73	0.95	1.43	2.33
S. Em±	0.022	0.033	0.032	0.04	0.10
C. D. at 5%	0.07	0.10	0.10	0.12	0.30
F : Fertilizer Levels					
F_1 – 75% RDF	0.50	0.73	1.08	1.70	2.72
F_2 – 100% RDF	0.64	0.86	1.22	1.87	2.90
F_3 – 125% RDF	0.77	1.08	1.46	2.13	3.24
F_4 – 150% RDF	0.75	1.03	1.41	2.07	3.10
S. Em±	0.026	0.038	0.037	0.047	0.12
C. D. at 5%	0.08	0.11	0.11	0.14	0.35
Interactions : G × F					
S. Em±	0.04	0.06	0.06	0.08	0.20
C. D. at 5%	NS	NS	NS	NS	NS
General mean	0.67	0.92	1.29	1.94	2.98

treatments during all growth stages, however it was comparable with 150% and followed by 100% RDF respectively, where as significantly lower dry matter accumulated plant^{-1} in case of 75% RDF treatment at all days of observations. It might be stated that dry weight plant^{-1} increased with increasing nitrogen application up to a certain level as well as because of the highest doses of N ha^{-1} under the present study did not showed increase in dry weight plant^{-1}. These findings are agreed with those of Raju and Varma (1984), Chowdhury and Rosario (1992) and Santos *et al.*, (1993).

4.2.4.3 Effect of Interactions:

The interaction effects between lentil genotypes and different fertilizer levels were statistically comparable in respect of mean dry matter plant^{-1} of lentil during all the days of observations.

4.3 Yield and Yield Attributes

4.3.1 Number of Pods Plant^{-1}

The data on mean number of pods plant^{-1} are presented in Table 4.6 and depicted in Figure 4.5 The mean number of pods plant^{-1} was 31.41.

4.3.1.1 Effect of Genotypes:

The mean number of pods plant^{-1} significantly influenced by the different genotypes. The genotype Gandigwad local produced significantly more pods plant^{-1} (41.46) under present investigation and which is significantly superior over rest of the genotypes, Itagi local (30.40), and Nesari Local (22.35) respectively. Highly significant variability in number of pods in lentil germplasm has also been noted by some other scientists Hussain (2002), Rahman *et al*., (2013), Awal and Roy (2015).

4.3.1.2 Effect of Fertilizer Levels:

Significantly the highest pods plant^{-1} were recorded with the application of 125% RDF (37.03) as compared to rest of the fertilizer levels at time of harvest. However, that was comparable with the 150% RDF (33.40) and Significantly lowest pods plant^{-1} observed in 75% RDF (25.21). The increase in fertilizer level above 125% RDF could not increase number of pods plant^{-1}. Similar result was found by Saxena *et al.* (1996) and they observed that seed yield of lentil was positively correlated with number of pods plant^{-1} which was close agreement with the result.

4.3.1.3 Effect of Interactions:

The mean number of pods plant^{-1} were uninfluenced due to the interaction effects between lentil genotypes and different fertilizer levels of lentil at the time of harvest.

4.3.2 Weight of Pods Plant^{-1} (g):

The data pertaining on mean weight of pods plant^{-1} are presented in Table 4.6 and depicted in Figure 4.5. The mean weight of pods plant^{-1} was 1.14 g.

4.3.2.1 Effect of Genotypes:

The genotypes differed significantly with mean value of weight of pods plant^{-1}. The genotype Gandigwad local produced significantly highest weight of pods plant^{-1} (1.43 g) and which is significantly superior over rest of the genotypes, while it is followed by genotype Itagi local (1.16 g), however lowest weight of pods plant^{-1} noticed in case of genotype Nesari local (0.83 g) respectively. The same results were reported by Sharar *et al.,* (2003) and Singh *et al*., (2011).

4.3.2.2 Effect of Fertilizer Levels:

Among the different fertilizer levels the application of 125 % RDF recorded highest weight of pods plant^{-1} (1.38 g) which was significantly superior over rest of the treatments, however, it was followed by 150 % RDF (1.26 g). Where as, significantly lowest weight of pods plant^{-1} noticed with application of 75% RDF (0.85 g). Similar finding were reported by Satyanarayanamma *et al*., (1996) in case of mung bean.

4.3.2.3 Effect of Interactions:

The interaction effects among the lentil genotypes and different fertilizer levels were non-significant in respect of mean weight of pods plant^{-1} of lentil after harvest.

4.3.3 Number of Seeds Pod^{-1}

The data on number of seeds pod^{-1} are presented in Table 4.7 and depicted in Figure 4.6. The mean of number of seeds pod^{-1} was 1.22.

4.3.3.1 Effect of Genotypes:

The different genotypes had significant effect on mean number of seeds pod^{-1}. The genotype Nesari local produced significantly highest seeds pod^{-1} (1.30) and it was measurable with genotype Itagi local (1.25), however significantly lowest seeds pod^{-1} noticed in case of genotype Gandigwad local (1.11) respectively. The quantitative values of yield components found in the present study for the said lentil genotypes are mostly similar to those found earlier by Mahamad *et al*., (1989), Hussain (2002) and Awal and Roy (2015).

Table 4.6: Mean number and weight of pods plant^{-1} (g) of lentil after harvest as influenced by different treatments

Treatments	Number of pods plant^{-1}	Weight of pods plant^{-1} (g)
G: Lentil Genotypes		
G_1 – Gandigwad Local	41.46	1.43
G_2 – Itagi Local	30.40	1.16
G_3 – Nesari Local	22.35	0.83
S. Em±	1.15	0.029
C. D. at 5%	3.39	0.09
F : Fertilizer Levels		
F_1 – 75% RDF	25.21	0.85
F_2 – 100% RDF	29.99	1.08
F_3 – 125% RDF	37.03	1.38
F_4 – 150% RDF	33.40	1.26
S. Em±	1.33	0.034
C. D. at 5%	3.91	0.10
Interactions : G × F		
S. Em±	1.02	0.03
C. D. at 5%	NS	NS
General mean	31.41	1.14

4.3.3.2 Effect of Fertilizer Levels:

Among the fertilizer levels the application of 125% RDF recorded the highest number of seeds pod^{-1} (1.33), which was significantly superior over the 100% RDF (1.19) and 75% RDF (1.09) respectively. However, it was comparable with 150% RDF (1.27). Phosphorus aids in transferring photosynthates from the stalks, leaves and other growing parts to the economically important organs like seed making them plump and bold. These results are strongly in agreement with the findings of Subramanian and Radhak (1981), Malik *et al.* (1991) and Zeidan (2007) who also reported a significant increase in number of seeds per pod with increase in P from 25 to 75 Kg per hectare.

4.3.3.3 Effect of Interactions:

The interaction effects between lentil genotypes and different fertilizer levels were not influenced statistically with respect of mean number of seeds pod^{-1} of lentil at the time of harvest.

4.3.4 Weight of Seeds Plant^{-1} (g):

The data on weight of seeds plant^{-1} are presented in Table 4.7 and depicted in Figure 4.6. The mean weight of seeds plant^{-1} of was 0.92 g.

4.3.4.1 Effect of Genotypes:

The mean weight of seeds plant^{-1} was recorded significantly higher by the genotype Gandigwad local (1.19 g) and which was significantly superior over other genotypes. It was followed by genotype Itagi local (0.94 g) and Nesari local (0.64 g), while significantly lowest mean weight of seeds plant^{-1} was recorded by the genotype Nesari local (0.64 mg). These experimental results are in conformity with findings of Swarup and Lal (1987), Singh *et al*., (2011).

4.3.4.2 Effect of Fertilizer Levels:

Significantly the highest value of mean seed weight plant^{-1} was recorded with the application of 125% RDF (1.19 g), which was significantly superior over other fertilizer levels. The next in order were 150 % RDF (1.08 g), 100% RDF (0.86 g) and 75% RDF (0.58 g), respectively. Significantly lowest mean weight of seeds plant^{-1} was noticed in case of 75% RDF (0.58 g). Similar results are reported by Ali (1979), and El-Awady *et al.* (1993).

4.3.4.3 Effect of Interactions:

The interaction effects between lentil genotypes and different fertilizer levels were did not differed significantly with respect of mean weight seeds plant^{-1} of lentil at the time of harvest.

Table 4.7: Mean number of seeds pod^{-1}, weight of seeds plant^{-1} and test weight (g) of seeds of lentil at harvest as influenced by different treatments

Treatments	Number of seeds pod^{-1}	Weight of seeds plant^{-1} (g)	Test weight(g) (100 seeds)
G: Lentil Genotypes			
G_1 – Gandigwad Local	1.11	1.19	2.76
G_2 – Itagi Local	1.25	0.94	2.71
G_3 – Nesari Local	1.30	0.64	2.52
S. Em±	0.036	0.024	0.06
C. D. at 5%	0.11	0.07	0.18
F : Fertilizer Levels			
F_1 – 75% RDF	1.09	0.58	2.51
F_2 – 100% RDF	1.19	0.86	2.63
F_3 – 125% RDF	1.33	1.19	2.82
F_4 – 150% RDF	1.27	1.08	2.71
S. Em±	0.04	0.027	0.07
C. D. at 5%	0.12	0.08	0.21
Interactions : G × F			
S. Em±	0.04	0.03	0.07
C. D. at 5%	NS	NS	NS
General mean	1.22	0.92	2.66

4.3.5 Test weight of seeds (g)

The data on mean test weight of seeds (g) (100 seeds) influenced significantly due to different treatments are presented in Table 4.7 and depicted in Figure 4.6. The mean test weight of grains was 2.66 g.

4.3.5.1 Effect of Genotypes:

The genotypes had significant effect on mean test weight of lentil. Among genotypes Gandigwad local produced highest mean value of test weight (2.76 g). However, which was comparable with Itagi local (2.71 g) both these genotypes are significantly superior over the genotype Nesari local (2.52 g), where as Nesari local recorded lowest test weight (2.52 g). Generally, 100 grains weight is general character of each lentil genotype. Test weight differs with different types of genotypes. The similar findings were in conformity with earlier reported by Tomenzei and Trida (1975), Tripathi and Singh (1987) and Sharar *et al*., (2003).

4.3.5.2 Effect of Fertilizer Levels:

Among the fertilizer levels the application of 125% RDF recorded the highest value of mean test weight of lentil (2.82 g), which was significantly superior over the 75% RDF (2.51 g), However it was measurable with 150% RDF (2.71 g) and 100% RDF (2.63 g), respectively. Whereas lowest mean value of test weight of seeds noticed in case of 75% RDF (2.51 g). Increase in 1000-seed weight might be due to the influence of cell division, phosphorus contents in the seed as well as the formation of fat and albumin. The results were collaborative with earlier reported by Ali (1979) and Mahmood *et al*., (2010).

4.3.5.3 Effect of Interactions:

The interaction effects between lentil genotypes and different fertilizer levels were non-significant in respect of mean test weight of (100) seeds (g) of lentil at the time of harvest.

4.3.6 Seed Yield (q ha^{-1})

The data pertaining on mean seed yield (q ha^{-1}) differed significantly due to different treatments are presented in Table 4.8 and depicted in Figure 4.7. The mean grain yield was 7.19 q ha^{-1}

4.3.6.1 Effect of Genotypes:

Significantly the highest mean seed yield q ha^{-1} was recorded with the genotype Gandigwad local (9.52 q ha^{-1}) which was superior over rest of the genotypes. The next in order were genotype Itagi local (7.00 q ha^{-1}) and Nesari local (5.05 q ha^{-1}), respectively. The lowest mean seed yield (5.05 q ha^{-1}) produced by Nesari local. The findings of the current study were

Table 4.8: Mean Seed yield (q ha^{-1}), Stover yield (q ha^{-1}), Biological yield (q ha^{-1}) and Harvest index (%) of lentil after harvest as influenced by different treatments

Treatments	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
G: Lentil Genotypes				
G_1 – Gandigwad Local	9.52	16.60	26.32	35.72
G_2 – Itagi Local	7.00	13.57	20.74	34.41
G_3 – Nesari Local	5.05	11.33	16.59	30.05
S. Em±	0.28	0.46	0.75	0.98
C. D. at 5%	0.85	1.35	2.21	2.90
F : Fertilizer Levels				
F_1 – 75% RDF	5.70	11.97	17.93	31.06
F_2 – 100% RDF	6.88	13.42	20.55	32.32
F_3 – 125% RDF	8.30	15.44	23.95	35.28
F_4 – 150% RDF	7.90	14.51	22.42	34.93
S. Em±	0.33	0.53	0.87	1.14
C. D. at 5%	0.98	1.56	2.55	3.35
Interactions : G × F				
S. Em±	0.57	0.92	1.50	1.97
C. D. at 5%	NS	NS	NS	NS
General mean	7.19	13.83	21.21	33.39

consistent with the results of Sinha and Singh (2002), Datta *et al.,* (2013), Awal and Roy (2015), who reported that seed yield of lentil varied due to varietal difference.

4.3.6.2 Effect of Fertilizer Levels:

The mean seed yield q ha^{-1} differed significantly due to different fertilizer levels. Among the fertilizer levels, the application of 125% RDF recorded highest seed yield (8.30 q ha^{-1}) while it remained at par with 150% RDF (7.90 q ha^{-1}). However both these fertilizer levels found significantly superior over 100% RDF (6.88 q ha^{-1}) and 75% RDF (5.70 q ha^{-1}).Where as, lowest grain yield q ha^{-1} produced in case of 75% RDF (5.70 q ha^{-1}), respectively. Similar findings were also obtained by Saxena *et al.*, (1996) and reported that increased phosphorus application demonstrated higher yield of pulse crops at a certain level. Excessive phosphorus may be fixed in soil which will not available for plant. These results were also observed by Gwal *et al.,* (1995) and Singh *et al.,(*2011).

4.3.6.3 Effect of Interactions:

The interaction effects between lentil genotypes and different fertilizer levels were non-significant with respect of mean seed yield (q ha^{-1}) of lentil at the time of harvest.

4.3.7 Stover Yield (q ha^{-1}):

The data on mean stover yield of lentil due to effect of different genotypes and fertilizer levels are presented in Table 4.8 and depicted in Figure 4.7. The mean stover yield was 13.83 q ha^{-1}.

4.3.7.1 Effect of Genotypes:

The genotypes had significant effect on stover yield of lentil. The highest stover yield (16.60 q ha^{-1}) was recorded from genotype Gandigwad local, which was significantly superior over rest of genotypes. However, next best genotype was Itagi local (13.57q ha^{-1}), followed by Nesari local (11.33q ha^{-1}) respectively. Significantly lowest stover yield (11.33 q ha^{-1}) was found from Nesari local. Similar experimental results that had resemblance with present research findings, were observed by Haque *et al.,* (2014), Dziamba and Miroslaw (1994) who confirmed that, stover yield of lentil differed due to varietal variation

4.3.7.2 Effect of Fertilizer Levels:

Significantly the highest mean stover yield ha^{-1} was recorded with the application of 125% RDF (15.44 q ha^{-1}) as compared to rest of the fertilizer levels, that was comparable with the application of 150% RDF (14.51 q ha^{-1}). The lowest mean stover yield ha^{-1} was found with 75% RDF application (11.97q ha^{-1}). Similar trend was also noticed in stover yield by Azad and Gill (1989) and they reported that phosphorus up to 60 kg P_2O_5 ha^{-1}

significantly enhanced straw production of lentil.

4.3.7.3 Effect of Interactions:

The interaction effects between lentil genotypes and different fertilizer levels under study were remained uninfluenced with respect of mean stover yield (q ha^{-1}) of lentil at the time of harvest.

4.3.8 Biological Yield (q ha^{-1}):

The data on mean biological yield of lentil as influenced by different genotypes and fertilizer levels are presented in Table 4.8 and depicted in Figure 4.7. The mean biological yield was 21.21 q ha^{-1}.

4.3.8.1 Effect of Genotypes:

The genotype Gandigwad local produced highest mean biological yield q ha^{-1} (26.32 q ha^{-1}) which was significantly superior over rest of the genotypes, next in order was Itagi local (20.74 q ha^{-1}). While Significantly lowest mean biological yield was recorded by Nesari local (16.59 q ha^{-1}).

4.3.8.2 Effect of Fertilizer Levels:

The mean biological yield q ha^{-1} influenced significantly due to different fertilizer levels. Application of 125% RDF recorded highest mean biological yield (23.95q ha^{-1}), however it was comparable with application of 150% RDF treatment (22.42 q ha^{-1}). However significantly lowest mean biological yield produced with 75% RDF (17.93q ha^{-1}). These results were in conformity with earlier reported by Azad *et al.,* (1991) and Rasool and Singh (2016).

4.3.8.3 Effect of Interaction:

Effect of interaction among the genotypes and fertilizer levels were non-significant in respect of mean biological yield of lentil after harvest.

4.3.9 Harvest index (%):

The data pertaining to harvest index influenced due to the different treatments are presented in Table 4.8 and depicted in Figure 4.7. The mean harvest index was 33.39 %.

4.3.9.1 Effect of Genotypes:

The harvest index significantly influenced the different genotypes. However, the genotype Gandigwad local produced highest harvest index (35.72%) which was significantly superior over Itagi local (34.41%) and Nesari local (30.05%) respectively. The lowest mean harvest index recorded in Nesari local. Different genotype had the different genetic potential to convert photosynthates into economically important parts of the plant Mahmood *et al*., (2010), Awal and Roy (2015) also reported the similar findings.

4.3.9.2 Effect of Fertilizer Levels:

Among the fertilizer levels application of 125% RDF recorded significantly highest mean harvest index (35.28%) over the 100% RDF (32.32%) and 75% RDF (31.06%), respectively. However, it was at par with the application 150% RDF (34.93%). Higher harvest index value may be due to balanced nutrition. The low harvest index at low level of P_2O_5 ha^{-1} might be due to poor development of plant at different growth stages. These results are supported by the findings of previous investigators; Zeidan, (2007) and Mahmood *et al.*, (2010).

4.3.9.3 Effect of Interaction:

Effect of interaction between the genotypes and fertilizer levels were uninfluenced in respect of mean harvest index of lentil after harvest.

4.4 Quality Attributes:

4.4.1 Protein Content in Seed (%):

The data on mean protein content in seed (%) was influenced by different genotypes and different fertilizer levels are presented in Table 4.9 and depicted in Figure 4.8. The mean per cent protein content in seed was 26.44.

4.4.1.1 Effect of Genotypes:

The genotypes had significant effect on mean protein content in seed, Genotype Gandigwad local produced significantly higher protein in seed (27.32%) and which remained superior over the rest of the genotypes. While lowest mean protein content in seed was recorded with genotype Nesari local (25.62%). Similar results also reported by Iliger and Alagundagi (2017), Malik *et al.* (1991).

4.4.1.2 Effect of Fertlizer Levels:

Significantly highest mean protein content in seed was recorded in case of 125% RDF (27.33%), which was significantly superior over the application of 100% RDF (26.25%) and 75% RDF (25.24%), respectively. However, it was at par with the application of 150% RDF (26.93%). Protein content in seed increased with increase in fertilizer levels, this was due to significantly higher nitrogen content in seeds, higher seed yield and higher uptake, respectively. These findings are in conformity with the findings of Dwivedi *et al.*, (1988) and Zeidan (2007).

4.4.1.3 Effect of Interactions:

The interaction effects between lentil genotypes and different fertilizer levels were remained statistically identical with respect to mean protein content in seed (%) of lentil after harvest.

Table 4.9: Mean protein content (%) of lentil seed as influenced by different treatments after harvest

Treatments	Protein content (%)
G: Lentil Genotypes	
G_1 – Gandigwad Local	27.32
G_2 – Itagi Local	26.37
G_3 – Nesari Local	25.62
S. Em±	0.13
C. D. at 5%	0.38
F : Fertilizer Levels	
F_1 – 75% RDF	25.24
F_2 – 100% RDF	26.25
F_3 – 125% RDF	27.33
F_4 – 150% RDF	26.93
S. Em±	0.17
C. D. at 5%	0.51
Interactions : G × F	
S. E m±	0.52
C. D. at 5%	NS
General mean	**26.44**

4.5. Soil and Plant Analysis:

4.5.1 Nitrogen content (%) in seed and stover of lentil

The mean data on nitrogen content in seed and stover of lentil as affected by different treatments are presented in Table 4.10 and graphically depicted in Fig. 4.9. The mean nitrogen content in seed was 4.22% and in stover was 1.10%.

4.5.1.1.1 Effect of Genotypes:

Effect of genotypes was found significant in respect of nitrogen content in seed and stover of lentil. Maximum nitrogen content in seed (4.37%) and stover (1.18%) of lentil was recorded with the genotype Gandigwad local, however it was statistically at par with Itagi local in seed (4.19%) and stover (1.11%). The genotype Nesari local recorded the significantly lowest nitrogen content in grain (4.11%) and in stover (1.02%).

4.5.1.1.2 Effect of Fertilizer Levels:

Effect of fertilizer levels was found significant in respect of nitrogen content in seed and stover of lentil. The application of 125% RDF recorded the highest nitrogen content in seed (4.37%) and stover (1.16%) of lentil which was statistically comparable with the application of 150% RDF (4.27% in seed and 1.12% in stover) and 100% RDF (4.21% in seed and 1.09 % in stover) respectively. It was statistically superior over the application of 75% RDF (4.04 % in seed and 1.04 % in stover).

4.5.1.1.3 Effect of Interactions:

The interaction effects of different genotypes and fertilizer levels were found non-significant in respect of nitrogen content in seed and stover of lentil.

4.5.1.2 Phosphorus and Potassium Content (%) in Seed and Stover of lentil:

The mean data on phosphorus and potassium content in seed and stover of lentil as affected by different treatments are presented in Table 4.10. The mean phosphorus and potassium content in seed and stover (0.38% and 0.21%) and (0.69 % and 1.30 %) respectively.

4.5.1.2.1 Effect of Genotypes:

Effect of genotypes was found non-significant in respect of mean phosphorus and potassium content in seed and stover of lentil.

4.5.1.2.2 Effect of Fertilizer levels:

The different fertilizer levels did not showed significant response in respect of mean phosphorus and potassium content in seed and stover of lentil.

Table 4.10: Mean N, P and K content of lentil as influenced by different treatments after harvest

Treatments	Nitrogen (%)		Phosphorous (%)		Potassium (%)	
	Seed	Stover	Seed	Stover	Seed	Stover
G: Lentil Genotypes						
G_1 – Gandigwad Local	4.37	1.18	0.40	0.23	0.72	1.35
G_2 – Itagi Local	4.19	1.11	0.39	0.21	0.70	1.30
G_3 – Nesari Local	4.11	1.02	0.36	0.20	0.67	1.27
S. Em±	0.069	0.023	0.012	0.013	0.019	0.030
C. D. at 5%	0.20	0.07	NS	NS	NS	NS
F : Fertilizer Levels						
F_1 – 75% RDF	4.04	1.04	0.36	0.18	0.66	1.27
F_2 – 100% RDF	4.21	1.09	0.38	0.21	0.69	1.30
F_3 – 125% RDF	4.37	1.16	0.41	0.24	0.72	1.33
F_4 – 150% RDF	4.27	1.12	0.39	0.22	0.70	1.32
S. Em±	0.079	0.026	0.014	0.015	0.022	0.035
C. D. at 5%	0.23	0.08	NS	NS	NS	NS
Interactions : G × F						
S. E m±	0.13	0.046	0.024	0.026	0.039	0.061
C. D. at 5%	NS	NS	NS	NS	NS	NS
General mean	**4.22**	**1.10**	**0.38**	**0.21**	**0.69**	**1.30**

4.5.1.1.3 Effect of Interactions:

The interaction effects of different genotypes and fertilizer levels were remained uninfluenced in respect of phosphorus and potassium content in seed and stover of lentil.

4.5.2 Total uptake of Nitrogen by Plant (kg ha^{-1}):

The data on mean uptake of nitrogen as influenced by different treatments are presented in Table 4.11 and depicted in Figure 4.10. The mean nitrogen uptake in plant was 46.72 kg ha^{-1}.

4.5.2.1 Effect of Genotypes:

Among the different genotypes, the genotype Gandigwad local recorded the highest mean total nitrogen uptake (61.57 kg ha^{-1}) which was followed by Itagi local (45.46 kg ha^{-1}) and that was significantly superior over the genotype Nesari local (33.15 kg ha^{-1}). A considerable variation in uptake of macro as well as micronutrients among different lentil cultivars was also observed by Gahoonia *et al*., (2005), Khatun *et al.,* (2010).

4.5.2.2 Effect of Fertilizer Levels:

The application of 125% RDF recorded the highest mean total nitrogen uptake (56.14 kg ha^{-1}) which was at par with the application of 150% RDF (51.83 kg ha^{-1}) and these two treatments were significantly superior over the application of 75% RDF (36.11 kg ha^{-1}). However, Singh *et al*., (1996) revealed that uptake of nitrogen increased with increase in fertilizer application.

4.5.2.3 Effect of Interaction:

The interaction effect between different genotypes and fertilizer levels were found non-significant in respect of mean uptake of total nitrogen by lentil crop.

4.5.3 Total uptake of Phosphorous by Plant (kg ha^{-1}):

The data on mean uptake of phosphorous as influenced by different treatments are presented in Table 4.11 and depicted in Figure 4.10. The mean phosphorous uptake in plant was 5.86 kg ha^{-1}.

4.5.3.1 Effect of Genotypes:

The different genotypes had significant effect with respect to mean total phosphorous uptake in plant. The genotype Gandigwad local recorded significantly highest mean total phosphorous uptake (7.66 kg ha^{-1}), which was followed by Itagi local (5.70 kg ha^{-1}). Significantly lowest mean total phosphorous uptake was noticed in case of genotype Nesari local (4.23 kg ha^{-1}). The findings of the current study were consistent with the results of Gahoonia *et al*., (2005), Khatun *et al.,* (2010).

Table 4.11: Mean total uptake of nutrients (N, P_2O_5 and K_2O) kg ha^{-1} by lentil as influenced by different treatments

Treatments	Nutrient uptake (kg ha^{-1})		
	Nitrogen	Phosphorous	Potassium
G: Lentil Genotypes			
G_1 – Gandigwad Local	61.57	7.66	29.17
G_2 – Itagi Local	45.46	5.70	22.71
G_3 – Nesari Local	33.15	4.23	18.05
S. Em±	1.42	0.21	0.63
C. D. at 5%	4.19	0.62	1.85
F : Fertilizer Levels			
F_1 – 75% RDF	36.11	4.28	19.45
F_2 – 100% RDF	43.97	5.48	22.21
F_3 – 125% RDF	56.14	7.28	26.81
F_4 – 150% RDF	51.83	6.69	24.78
S. Em±	1.64	0.24	0.84
C. D. at 5%	4.83	0.72	NS
Interactions : G × F			
S. E m±	2.85	0.42	2.53
C. D. at 5%	NS	NS	NS
General mean	**46.72**	**5.86**	**23.31**

4.5.3.2 Effect of Fertilizer Levels:

The application of 125% RDF recorded the highest mean total phosphorus uptake (7.28 kg ha^{-1}), which was comparable with the application of 150% RDF (6.69 ha^{-1}) and these two were significantly superior over the application of 100% (5.48 ha^{-1}) and 75% RDF (4.28 ha^{-1}) respectively. Whereas, Singh *et al*., (1996) reported that uptake of phosphorus increased with increase in fertilizer application.

4.5.3.3 Effect of Interaction:

The interaction effect between different genotypes and fertilizer levels was uninfluenced in respect of mean uptake of total phosphorus by lentil crop.

4.5.4 Total uptake of Potassium by Plant (kg ha^{-1}):

The data on mean uptake of potassium as influenced by different treatments are presented in Table 4.11 and depicted in Figure 4.10. The mean potassium uptake in plant was 23.31 kg ha^{-1}.

4.5.4.1 Effect of Genotypes:

The mean total uptake of potassium differed significantly due to different genotypes. The genotype Gandigwad local recorded significantly highest mean total potassium uptake (29.17 kg ha^{-1}), which was significantly superior over rest of the genotypes. Whereas, genotype Nesari local recorded significantly lowest mean total potassium uptake (18.05 kg ha^{-1}). A considerable variation in uptake of macro nutrients among different lentil cultivars was also reported by Gahoonia *et al*., (2005), Khatun *et al.*, (2010).

4.5.4.2 Effect of Fertilizer Levels:

The different fertilizer levels did not show significant response in respect of mean total uptake of potassium by plant.

4.5.4.3 Effect of Interaction:

The interaction effect between different genotypes and fertilizer levels were found statistically identical in respect of mean total uptake of potassium by lentil crop.

4.5.5 Mean Available Nitrogen (kg ha^{-1}) in Soil after Harvesting:

The data on mean available nitrogen as influenced by different treatments are presented in Table 4.12 and depicted in Fig. 4.11 The mean available nitrogen in soil was 252.91 kg ha^{-1}.

4.5.5.1 Effect of Genotypes:

The different genotypes did not shown significant response in respect of mean available nitrogen in soil after harvest of lentil crop.

4.5.5.2 Effect of Fertilizer Levels:

Among the fertilizer levels application of 150% RDF recorded significantly highest available soil nitrogen (267.30 kg ha^{-1}) which was significantly superior over rest of the fertilizer levels. While the 75% RDF recorded significantly lowest available soil nitrogen (241.03 kg ha^{-1}). Similar results were reported by Nandan *et al.,* (2018).

4.5.5.3 Effect of Interaction:

The interaction effect between different genotypes and fertilizer levels were found uninfluenced in respect of mean available soil nitrogen after harvest of lentil.

4.5.6 Mean Available Phosphorus (kg ha^{-1}) in Soil after Harvesting:

The data on mean available phosphorous as influenced by different treatments are presented in Table 4.12 and depicted in Figure 4.11. The mean available phosphorous in soil was 27.40 kg ha^{-1}.

4.5.6.1 Effect of Genotypes:

The genotype Nesari local noticed highest mean available soil phosphorus (29.00 kg ha^{-1}) which was significantly superior over the rest of the genotypes, however it was followed by Itagi local (27.15 kg ha^{-1}). While significantly the lowest mean available soil phosphorus was recorded by Gandigwad local (26.06 kg ha^{-1}). The results were collaborative with earlier reported by Karan *et al*., (2014).

4.5.6.2 Effect of Fertilizer Levels:

Significantly highest mean available soil phosphorus was recorded with the application of 150% RDF (30.18 kg ha^{-1}) which was significantly superior over the rest of the fertilizer levels, however it was followed by application 125% RDF (27.73 kg ha^{-1}) and 100% RDF (26.19 kg ha^{-1}), respectively. Significantly the lowest mean available soil phosphorus was found with application of 75% RDF (25.52 kg ha^{-1}). Similar trend was also noticed by Khairnar and Solanke (2009).

4.5.6.3 Effect of Interaction:

The interaction effect between different genotypes and fertilizer levels were found uninfluenced in respect of mean available soil phosphorus after harvest.

4.5.7 Mean Available Potassium (kg ha^{-1}) in Soil After Harvesting:

The data on mean uptake of available potassium as influenced by different treatments are presented in Table 4.12 and depicted in Figure 4.11. The mean available potassium in soil was 262.78 kg ha^{-1}.

Table 4.12: Mean Available nitrogen, phosphorus and potassium kg ha^{-1} in soil of lentil after harvest as influenced by different treatments

Treatments	Available nitrogen (kg ha^{-1})	Available phosphorous (kg ha^{-1})	Available potassium (kg ha^{-1})
G: Lentil Genotypes			
G_1 – Gandigwad Local	248.47	26.06	257.10
G_2 – Itagi Local	252.35	27.15	262.54
G_3 – Nesari Local	257.91	29.00	268.02
S. Em±	1.16	0.56	3.31
C. D. at 5%	NS	1.66	NS
F : Fertilizer Levels			
F_1 – 75% RDF	241.03	25.52	256.80
F_2 – 100% RDF	248.66	26.19	259.41
F_3 – 125% RDF	254.70	27.73	264.39
F_4 – 150% RDF	267.30	30.18	270.53
S. Em±	1.55	0.65	3.82
C. D. at 5%	4.56	1.92	NS
Interactions : G × F			
S. E m±	4.65	1.13	6.62
C. D. at 5%	NS	NS	NS
General mean	252.91	27.40	262.78

4.5.7.1 Effect of Genotypes:

The different genotypes did not shown significant response in respect of mean available soil potassium after harvest of lentil crop.

4.5.7.2 Effect of Fertilizer Levels:

The different fertilizer levels remained statistically identical with respect to mean available soil potassium after harvest of lentil crop.

4.5.7.3 Effect of Interaction:

The interaction effect between different genotypes and fertilizer levels were found uninfluenced in respect of mean available soil potassium after harvest of lentil crop.

4.6 Economics of Different Treatments:

4.6.1 Cost of Cultivation:

In general, the average cost of cultivation was Rs. 36425.75 ha^{-1}. The cost of cultivation (Rs. 36625 ha^{-1}) recorded with all the genotypes of lentil remained same however, it was the highest with application of 150% RDF (Rs. 37598 ha^{-1}) as compared to other fertilizer levels and the lowest cost of cultivation was (Rs. 35254 ha^{-1}) recorded with application of 75% RDF.

4.6.2 Gross monetary returns (Rs ha^{-1})

The data on mean gross monetary returns (Rs 61796.92 ha^{-1}) as influenced by different genotypes and fertilizer levels are presented in Table 4.13 and depicted in Figure 4.12.

4.6.2.1 Effect of Genotypes:

The gross monetary returns were significantly influenced by different genotypes. Significantly the highest gross monetary returns was observed with the genotype Gandigwad local (Rs. 81120 ha^{-1}) which was significantly superior over the rest of the genotypes. While significantly the lowest gross monetary returns was recorded with the genotype Nesari local (Rs. 42879 ha^{-1}). Similar results were reported by Tyagi (2012) and Yadav *et al.* (2017).

4.6.2.2 Effect of Fertilizer Levels:

The gross monetary returns was significantly influenced by fertilizer levels. The application of 125% RDF recorded significantly higher gross monetary returns (Rs. 72403 ha^{-1}) than the rest of fertilizer levels, which was followed by 150% RDF (Rs. 67157 ha^{-1}) and 100 % RDF (Rs. 58729 ha^{-1}), respectively. The lowest gross monetary returns were recorded with

Table 4.13: Mean Cost of cultivation, Gross monetary returns and Net monetary returns as influenced by different treatments

Treatments	Cost of cultivation (Rs ha^{-1})	Gross monetary returns (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C Ratio
G: Lentil Genotypes				
G_1 – Gandigwad Local	36625	81120	44494	2.21
G_2 – Itagi Local	36625	61391	24765	1.67
G_3 – Nesari Local	36025	42879	6854	1.18
S. Em±	-	892.33	422.33	-
C. D. at 5%	-	2617.13	1238.66	-
F : Fertilizer Levels				
F_1 – 75% RDF	35254	48898	13644	1.38
F_2 – 100% RDF	36035	58729	22694	1.62
F_3 – 125% RDF	36816	72403	35587	1.96
F_4 – 150% RDF	37598	67157	29559	1.78
S. Em±	-	1030.37	487.66	-
C. D. at 5%	-	3022.00	1430.31	-
Interactions : G × F				
S. E m±	-	1784.66	844.66	-
C. D. at 5%	-	NS	NS	-
General mean	**36425.75**	**61796.92**	**25371.17**	**1.68**

application of 75% RDF (Rs. 48898 ha^{-1}). Present findings were in conformity with earlier reported by Dwiwedi and Sharma (2005), Rasheed *et al*., (2011) and Choubey *et al*., (2013).

4.6.2.3 Effect of Interaction:

The interaction effect between different genotypes and fertilizer levels were found statistically identical in respect of mean gross monetary returns of different treatments.

4.6.3 Net Monetary Returns (Rs ha^{-1})

The data on mean net monetary returns (Rs 25371.17 ha^{-1}) as influenced by different genotypes and fertilizer levels are presented in Table 4.13 and depicted in Figure 4.12.

4.6.3.1 Effect of Genotypes:

Among the different genotypes the genotype Gandigwad local recorded the highest net monetary returns (Rs. 44494 ha^{-1}) which was significantly superior over rest of the genotypes. However, it was followed by Itagi local (Rs. 24765 ha^{-1}) and Nesari local (Rs. 6854 ha^{-1}), respectively. The net lowest monetary returns (Rs. 6854 ha^{-1}) was recorded by the genotype Nesari local. Similar results were reported by Tyagi (2012) and Yadav *et al.*, (2017).

4.6.3.2 Effect of Fertilizer Levels:

The application of 125% RDF recorded the highest net monetary returns (Rs. 35587 ha^{-1}) which was significantly superior over rest of the treatments. Next in order was 150% RDF (Rs. 29559 ha^{-1}) and 100% RDF (Rs. 22694 ha^{-1}). Significantly the lowest net monetary returns (Rs 13644 ha^{-1}) was recorded with the application of 75% RDF.

4.6.3.3 Effect of Interaction:

The interaction effect between different genotypes and fertilizer levels were uninfluenced in respect of mean net monetary returns of different treatments.

4.6.4 Benefit: Cost Ratio:

In general, the average benefit: cost ratio was 1.68. The highest benefit: cost ratio was recorded with the genotype Gandigwad local (2.21) and lowest with the genotype Nesari local (1.18) among the various lentil genotypes under study. Among the different fertilizer levels application of 125% RDF recorded highest benefit: cost ratio (1.96) as compared to other fertilizer levels and the lowest benefit: cost ratio (1.38) was recorded with application of 75% RDF.

5. SUMMARY AND CONCLUSIONS

5.1 Summary

The investigation entitled, "Comparative performance of lentil (*Lens esculenta* L.) local genotypes to different fertilizer levels", was undertaken at Post Graduate Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur during *rabi*, 2019.

The experiment was laid out in factorial randomized block design with three replications and twelve treatment combinations of three genotypes G_1- Gandigwad local, G_2- Itagi local and G_3-Nesari local and four fertilizer levels F_1-75% RDF, F_2-100% RDF, F_3-125% RDF and F_4-150% RDF. The gross and net plot size were 4.5 m x 3.5 m and 4.0 m x 3.0 m respectively.

The crop was sown on 19^{th} of December, 2019 by line sowing method with different nitrogen, phosphorus levels and potassium levels. The crop was fertilized as per treatments by using urea, diammonium phosphate and muriate of potash and fertilizer was given by placement method.

The periodical observations on growth, yield and yield contributing characters were recorded periodically after seedling emergence w. e. f. 30 DAS onwards at an 15 days interval up to harvest and at harvest *viz*., plant height (cm), number of branches plant^{-1}, number of leaves plant^{-1}, dry matter plant^{-1} (g). The N, P and K content and protein content was worked out to assess the quality of seeds. The residual fertility of the soil after harvest was also determined in terms of available N, P and K. The important findings of the investigation are summarized below.

5.1.1 Effect of Genotypes:

The plant population at the initial stage and at harvest did not reach at significant level due to different genotypes. The growth attributes were influenced significantly due to different genotypes. The growth attributes at harvest viz., plant height (29.18 cm), number of branches plant^{-1}(11.52), number of leaves plant^{-1}(353.54), dry matter plant^{-1} (3.72 g) were recorded highest with the genotype Gandigwad local followed by genotype Itagi local and Nesari local.

The yield attributes *viz*., number of pods plant^{-1} (41.46), weight of pods plant^{-1} (1.43 g), weight of seeds plant^{-1} (1.19 g), number of seeds pod^{-1} (1.11), weight of 100 seeds (2.76 g), were also maximum with the genotype Gandigwad local which was significantly superior over genotype Itagi local and Nesari local, respectively. As a result, the genotype Gandigwad local recorded highest seed yield (9.52 q ha^{-1}), stover yield (16.60 q ha^{-1}), biological yield (26.32 q ha^{-1}) and harvest index (35.72%) and which remained significantly superior over rest of genotype and it was followed by genotypes Itagi local and Nesari local.

The highest protein content 27.32% in seeds was recorded by Gandigwad local that was differed significantly by different genotypes under study. The mean N, P and K content in seeds and stover were also not influenced significantly by different genotypes except N content in seed and stover. The content of N, P and K in seed were (4.37%, 0.40% & 0.72%) and stover (1.18%, 0.23% & 1.35%) respectively, and it was higher in genotype Gandigwad local. The total uptake of nutrients was N (61.57kg ha^{-1}), P (7.66 kg ha^{-1}) and K (29.17kg ha^{-1}) respectively by lentil crop and influenced significantly by genotypes where it was maximum with genotype Gandigwad local. The next in order were genotype Itagi local and Nesari local. The residual N (257.91kg ha^{-1}), P (29.00kg ha^{-1}) and K (268.02 kg ha^{-1}) respectively in soil after harvest were recorded by Nesari local genotype which was followed by Itagi local, Gandigwad local respectively.

The gross monetary returns (Rs. 81120 ha^{-1}), the net monetary returns (Rs. 44494 ha^{-1}) and benefit: cost ratio (2.21) was significantly more with the genotype Gandigwad local. The next in order were Itagi local and Nesari local.

5.1.2 Effect of fertilizer Levels:

The fertilizer levels included in the study were 75% RDF ha^{-1}, 100% RDF ha^{-1}, 125% RDF $ha^{-1}$and 150% RDF ha^{-1}. The plant population at the initial stage and at harvest did not reach to the level significance due to different fertilizer levels. Different fertilizer levels to the lentil showed significant influence on growth parameters. The growth parameters at harvest *viz.*, plant height (29.98 cm), numbers of branches $plant^{-1}$ (11.51), number of functional leaves $plant^{-1}$ (356.76), and dry matter $plant^{-1}$ (3.24 g) were significantly more with the application of 125% RDF ha^{-1} which was at par with application of 150% RDF ha^{-1} and significantly superior over 100% RDF ha^{-1} and 75% RDF ha^{-1}

The yield contributing characters like, number of pods $plant^{-1}$ (37.03), weight of pods $plant^{-1}$ (1.38 g), weight of seeds $plant^{-1}$ (1.19 g), number of seeds pod^{-1} (1.33), weight of 100 seeds (2.82 g) and seed yield (8.30 q ha^{-1}), stover yield (15.44 q ha^{-1}), biological yield (23.95 q ha^{-1}) and harvest index (35.28%) were also significantly maximum with the application of 125% RDF ha^{-1} which was at par with application of 150% RDF ha^{-1} and significantly superior over 100% RDF ha^{-1} and 75% RDF ha^{-1}

The protein content (27.33%) in seeds was significant and recorded highest with 125% RDF ha^{-1} and remained at par with 150% RDF ha^{-1}. Mean P and K content in seeds and stover were also not influenced significantly by different fertilizer levels except N. The content of N, P and K in seed were (4.37%, 0.41% & 0.72%) and stover (1.16%, 0.24% & 1.33%) respectively, and the N content was higher with application of 125% RDF ha^{-1} and comparable with 150 RDF ha^{-1}.The total uptake of nutrients was N (56.14 kg ha^{-1}), P (7.28 kg ha^{-1}) and K (26.81 kg ha^{-1}) respectively by application of 125% RDF ha^{-1} and influenced significantly by different fertilizer levels except uptake of K. Available N and P in soil after harvest found significant due to different fertilizer levels except available K, The highest available N, P and K (267.30, 30.18 & 270.18) respectively in soil after harvest were found maximum with the application of 150% RDF ha^{-1} followed by 125% RDF ha^{-1},100% RDF ha^{-1},75% RDF ha^{-1} respectively.

The application of 125% RDF ha^{-1} had significantly maximum gross monetary returns (Rs. 72403 ha^{-1}), net monetary returns (Rs. 35587 ha^{-1}) and B: C ratio (1.96) which was significantly superior over rest of the fertilizer levels.

5.1.3 Effect of Interaction

The growth and yield characters and consequently the yield of lentil were not influenced by the interaction effect of both the factors. This indicates that the both factors under study *viz*., lentil local genotypes and fertilizer levels behaved independently in respect of growth, yield and quality of *rabi* lentil crop.

5.2 Conclusions

Based on the present investigation of one year data the following conclusions could be drawn:

1. Among the different lentil local genotypes, the genotype Gandigwad local recorded higher growth and yield components which resulted in increased yield. It would be, therefore, suggested to adopt genotype Gandigwad local for sowing *rabi* lentil in Sub Montane Zone of Maharashtra (Kolhapur region).
2. Among the fertilizer levels application of 125% RDF ha^{-1} found beneficial in increasing growth, yield and quality of *rabi* lentil.
3. The gross and net monetary returns as well as benefit cost ratio for *rabi* production of lentil is found beneficial with genotype Gandigwad local when fertilized with of 125 % RDF.

Hence it is recommended to use the genotype Gandigwad local with application of 125% RDF ha^{-1} for getting higher yields and returns.

By and large, the above conclusions, however, based on one year results. The investigation needs to be repeated for confirmation of these results.

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7. APPENDIX

I. Different input prices used for calculating cost of cultivation

Sr. No.	Particulars	Rate (Rs.)
1.	**Labour charges** Male Female	 307 day^{-1} 209 day^{-1}
2.	**Bullock charges**	1550 day^{-1}
3.	**Cost of lentil seed** Gandigwad local Itagi local Nesari local	 95 kg^{-1} 95 kg^{-1} 80 kg^{-1}
4.	***Rhizobium* and PSB culture**	30 (250 g^{-1})
5.	**Urea**	5.80 kg^{-1}
6.	**Diammonium phosphate**	28.50 kg^{-1}
7.	**MOP**	16 kg^{-1}
8.	**Fungicides** Copper Oxychloride 50% WP	400 kg^{-1}
9.	**Land revenue and other charges**	300 ha^{-1}
10.	**Ploughing (Tractor)**	4,500 ha^{-1}
11.	**Harrowing (Tractor)**	3000 ha^{-1}
12.	**Irrigation charges**	600 ha^{-1}
13.	**FYM**	1500 t^{-1}
14.	**Price of produce** **A) Main produce (Seed)** i) Gandigwad local ii) Itagi local iii) Nesari local	 8000 q^{-1} 8000 q^{-1} 8000 q^{-1}
15.	**Stover price**	300 q^{-1}

8. VITAE

MR. SHASHIDHAR ADRUSHAPPA SAVADI
MASTER OF SCIENCE (AGRICULTURE)
IN
AGRONOMY
2021

Title of thesis		Comparative Performance of Lentil *(Lens esculenta* L.) Local Genotypes to Different Fertilizer Levels
Major field		Agronomy
Biographical information		
Personal	**Date of Birth**	17.07.1997
	Place of Birth	Itagi
	Father's Name	Adrushappa
	Mother's Name	Kasturi
Educational	**Bachelor Degree Obtained**	2019
	Class	First class
	Name of University	Mahatma Phule Krishi Vidyapeeth, Rahuri.
Address		At – Itagi, Post- Itagi, Tal- Khanapur, Dist-Belagavi.
	Email- id	Shashidharsavadi59@gmaail.com
	Contact Number	7795819870

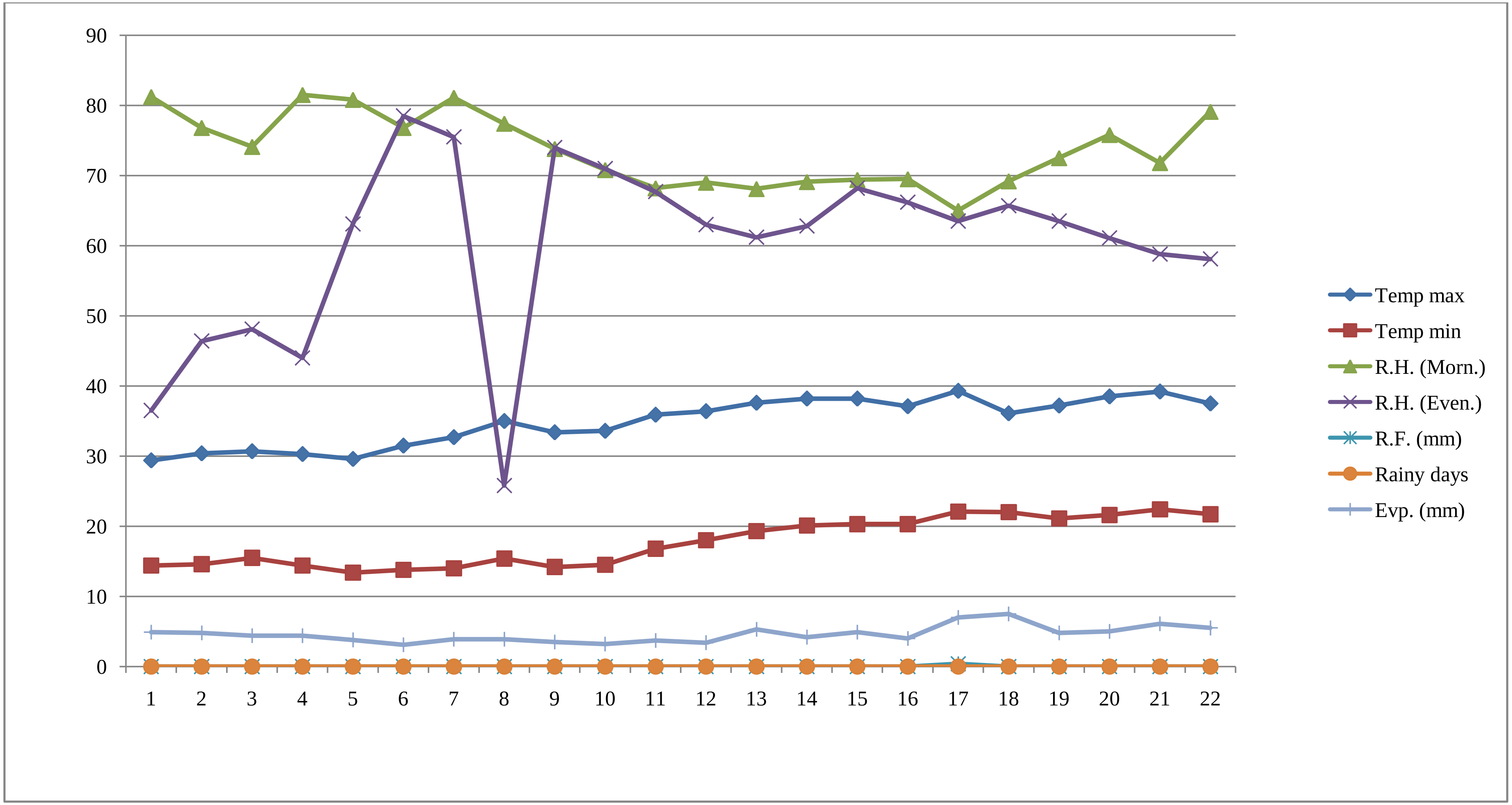
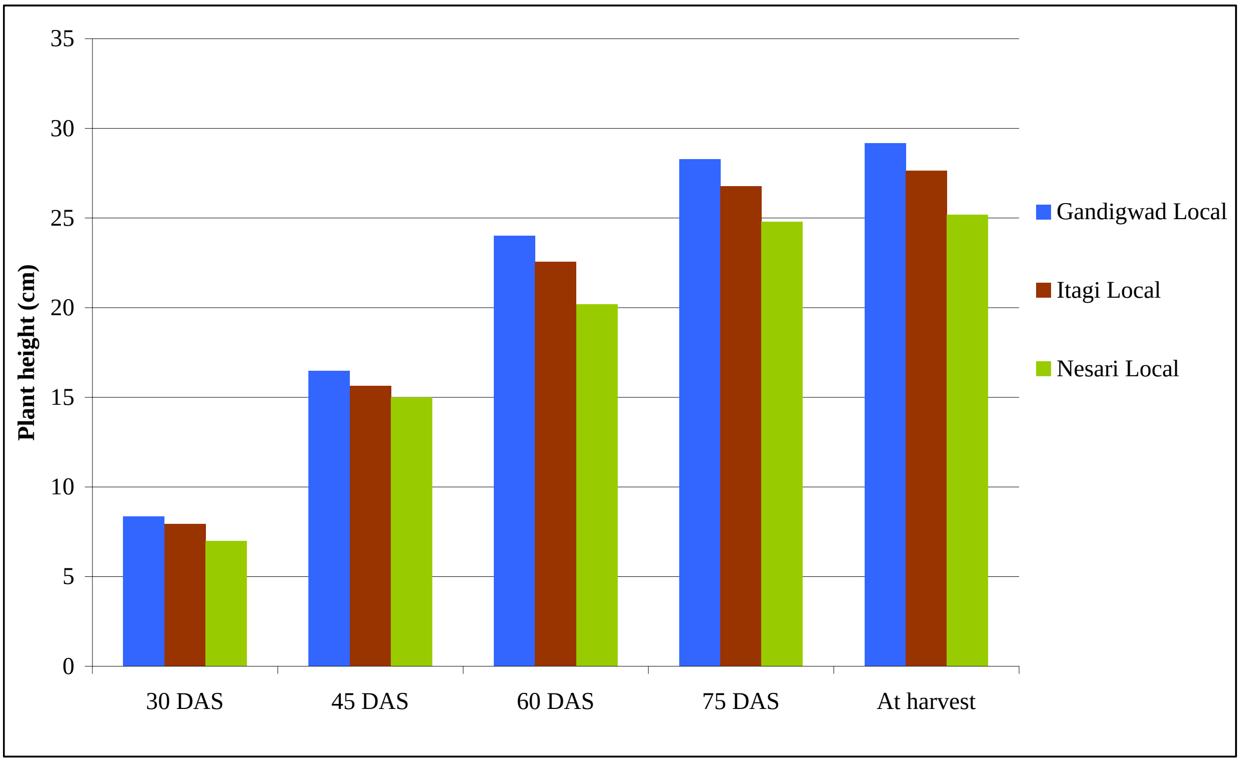


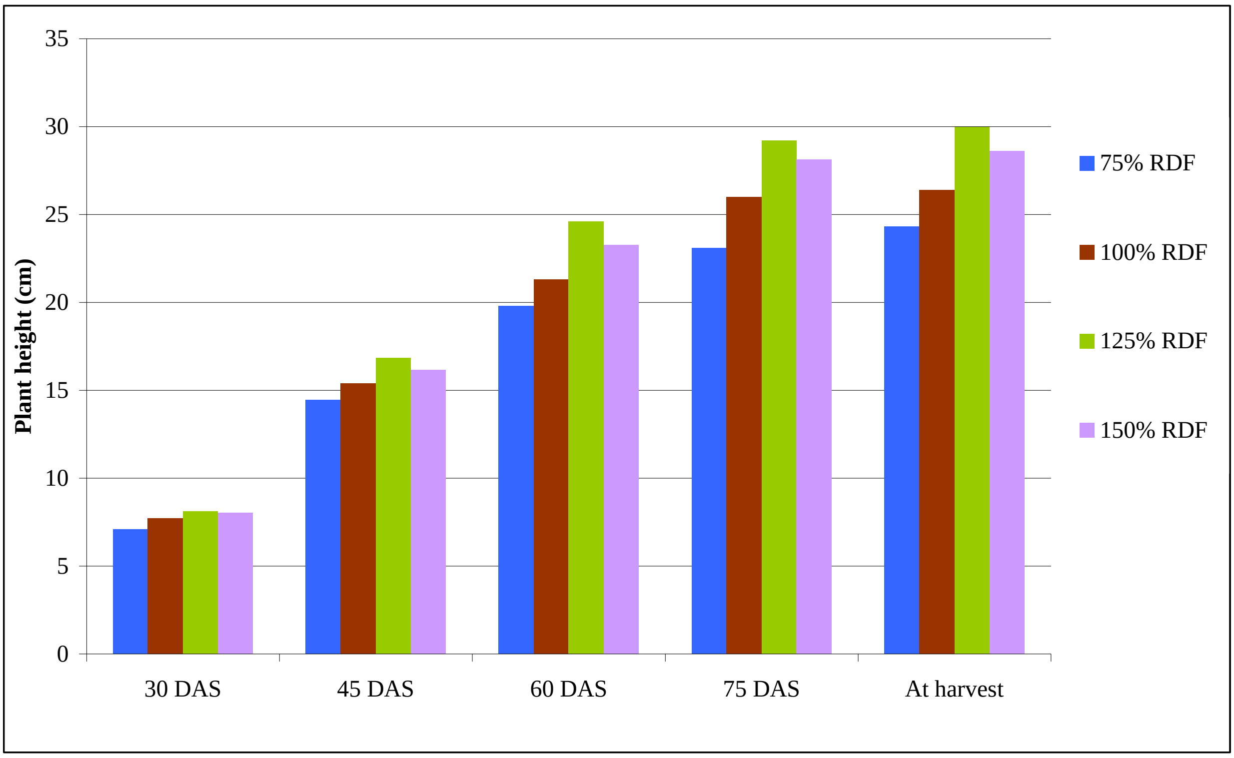
Fig. 3.1 Meteorological data of the*Rabi*, 2019-20 at RCSM College of Agriculture, Kolhapur (M.S.)

Plate 3.1 General view of experimental field

Plate 3.2 Sowing of lentil seeds

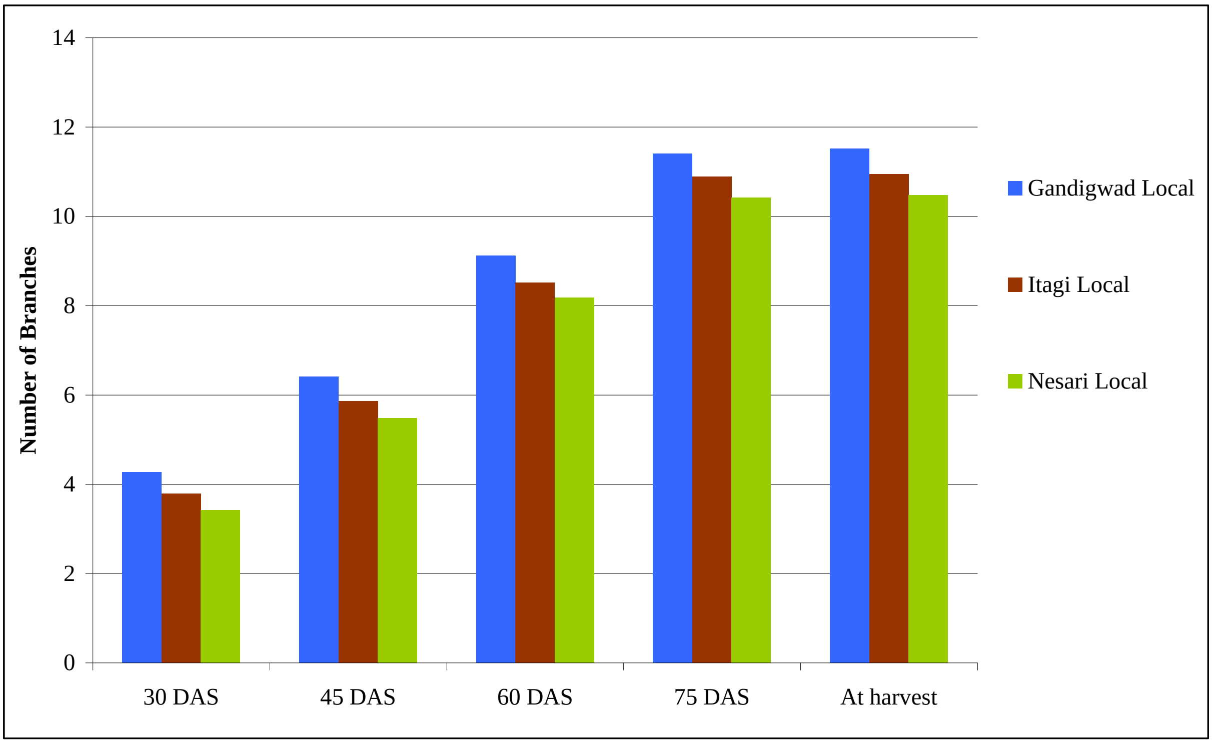


Lentil Genotypes

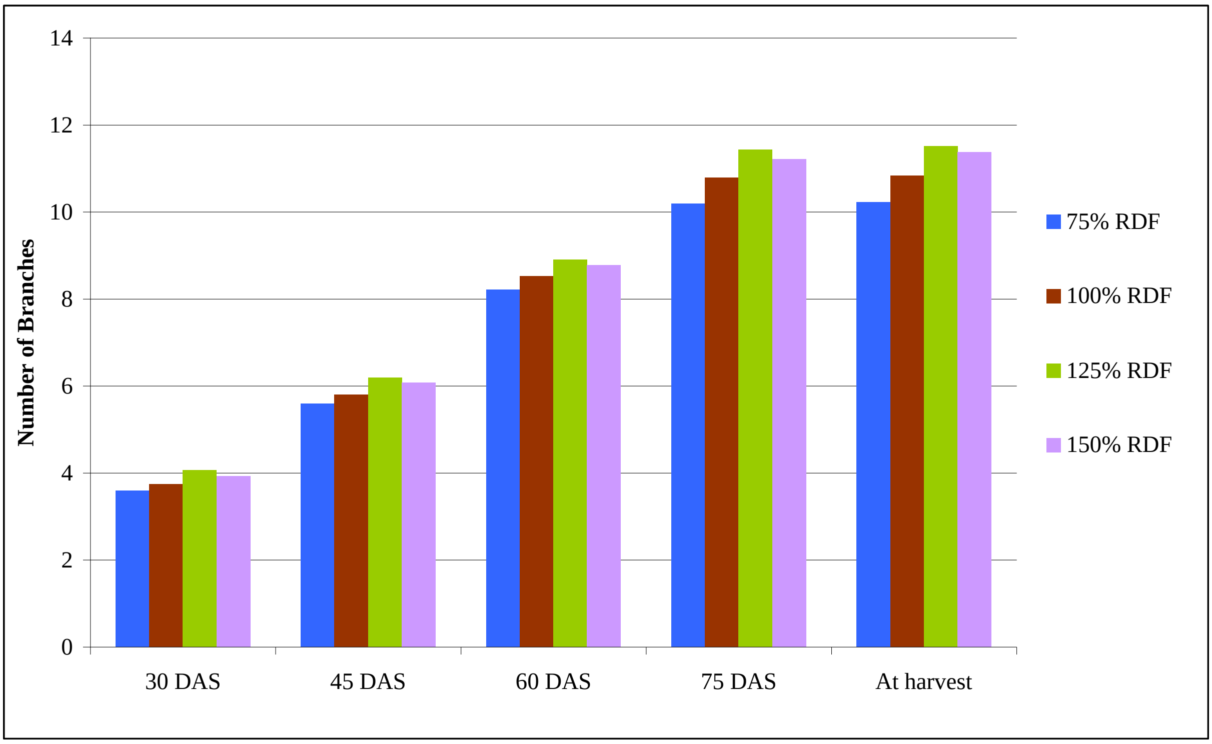


Fertilizer Levels

Fig. 4.1: Plant height of lentil as influenced periodically by different treatments

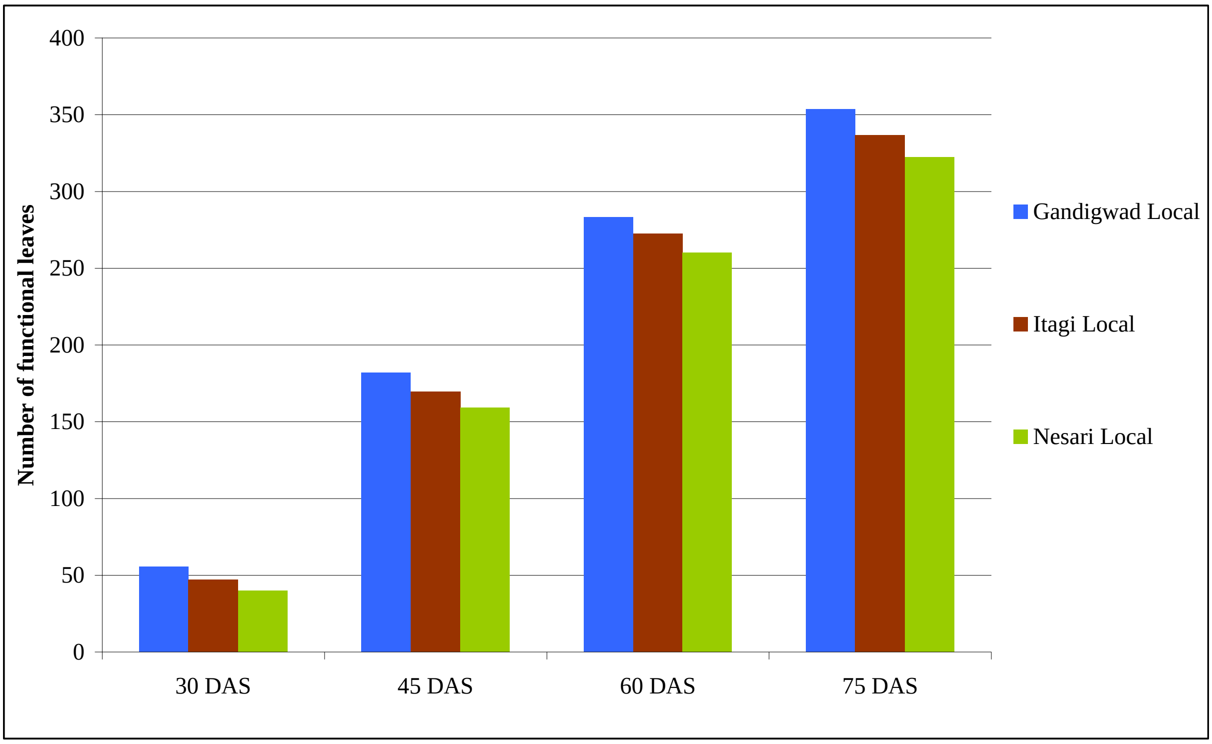


Lentil Genotypes

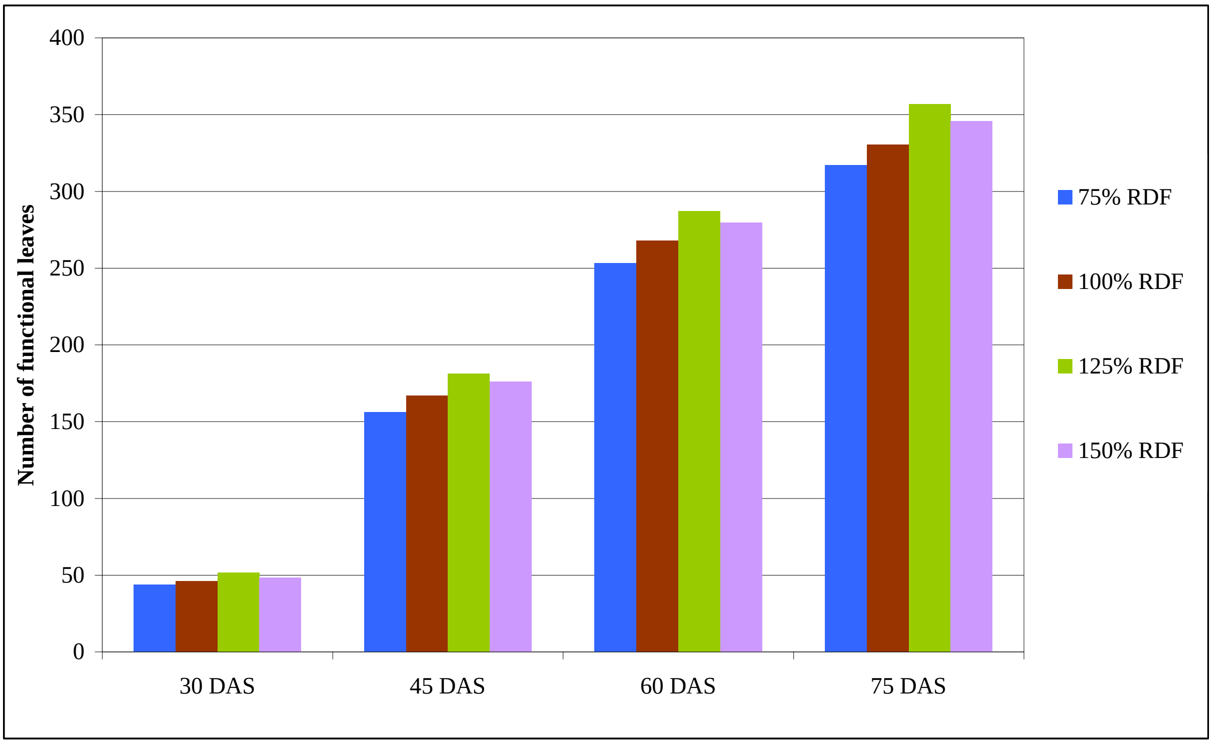


Fertilizer Levels

Fig. 4.2: Number of branches plant^{-1} of lentil as influenced periodically by different treatment

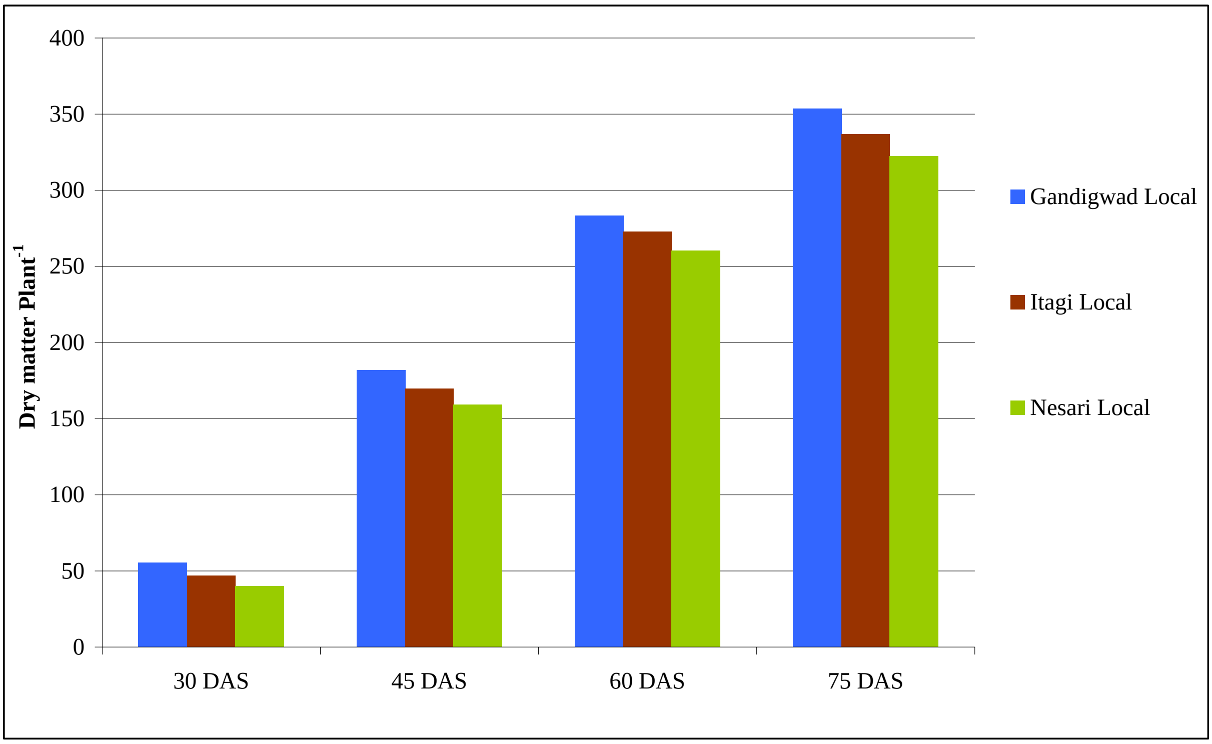


Lentil Genotypes

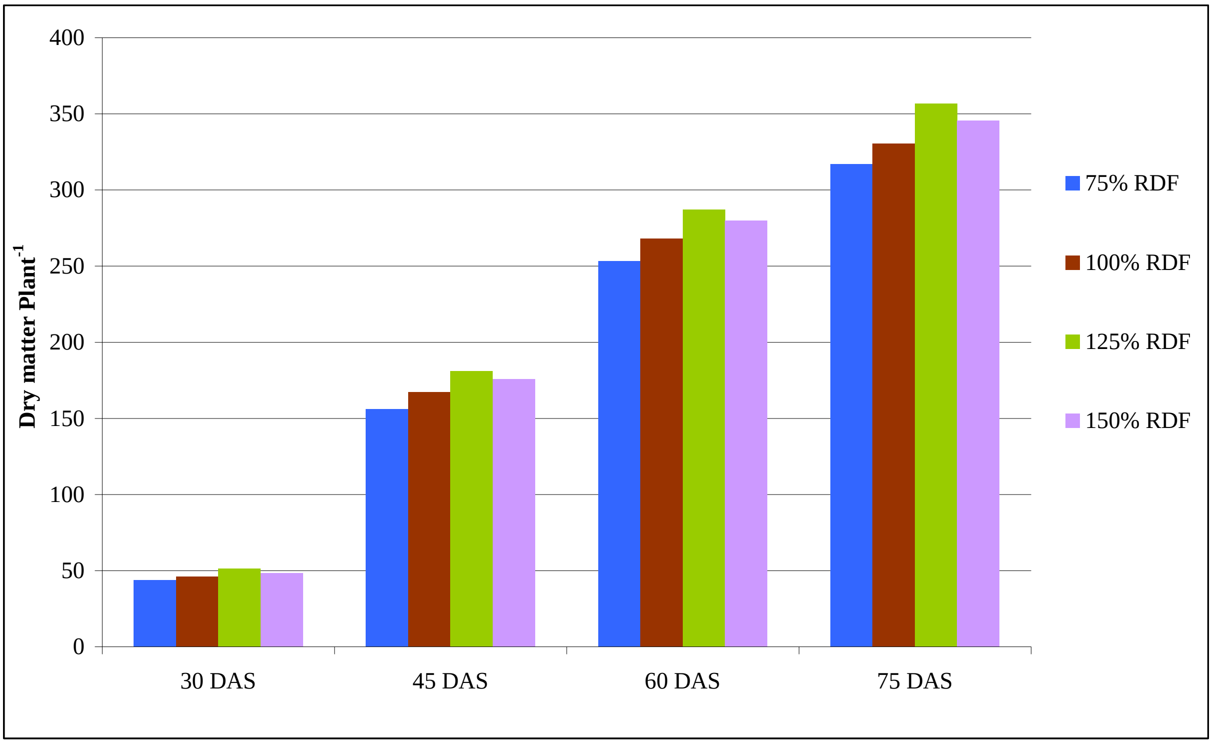


Fertilizer Levels

Fig. 4.3: Number of functional leaves plant^{-1} of lentil as influenced periodically by different treatments

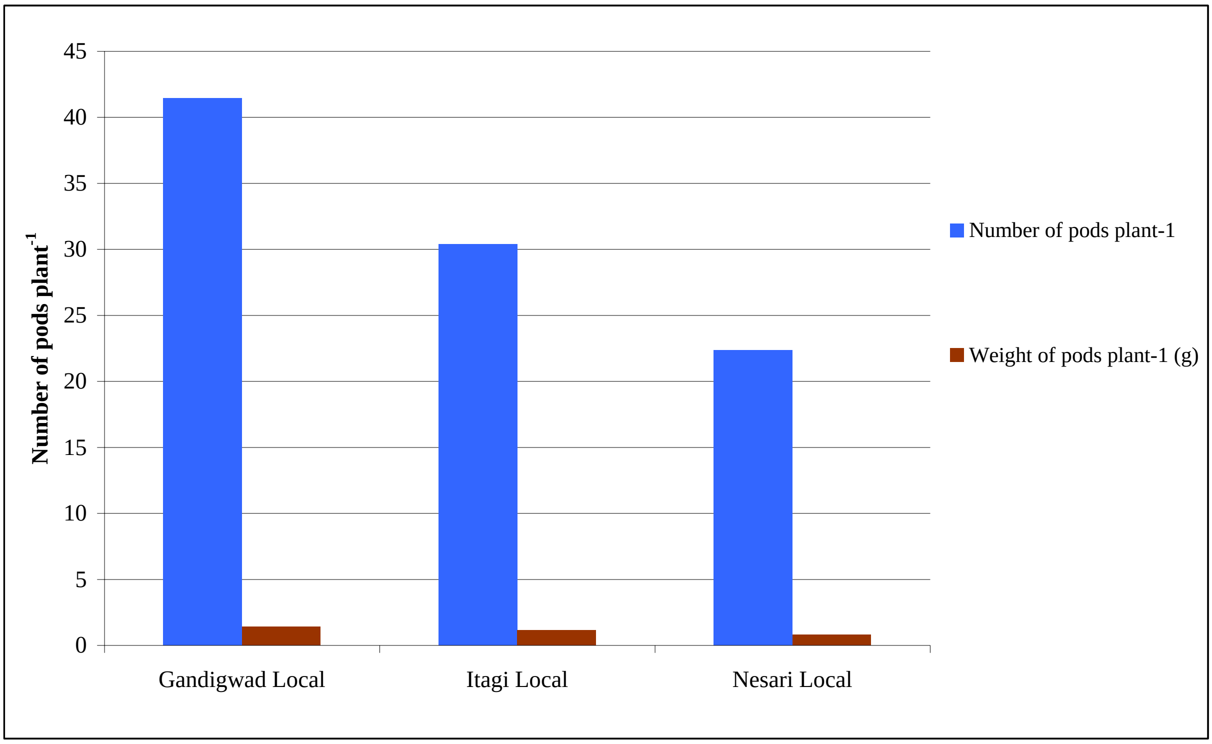


Lentil Genotypes

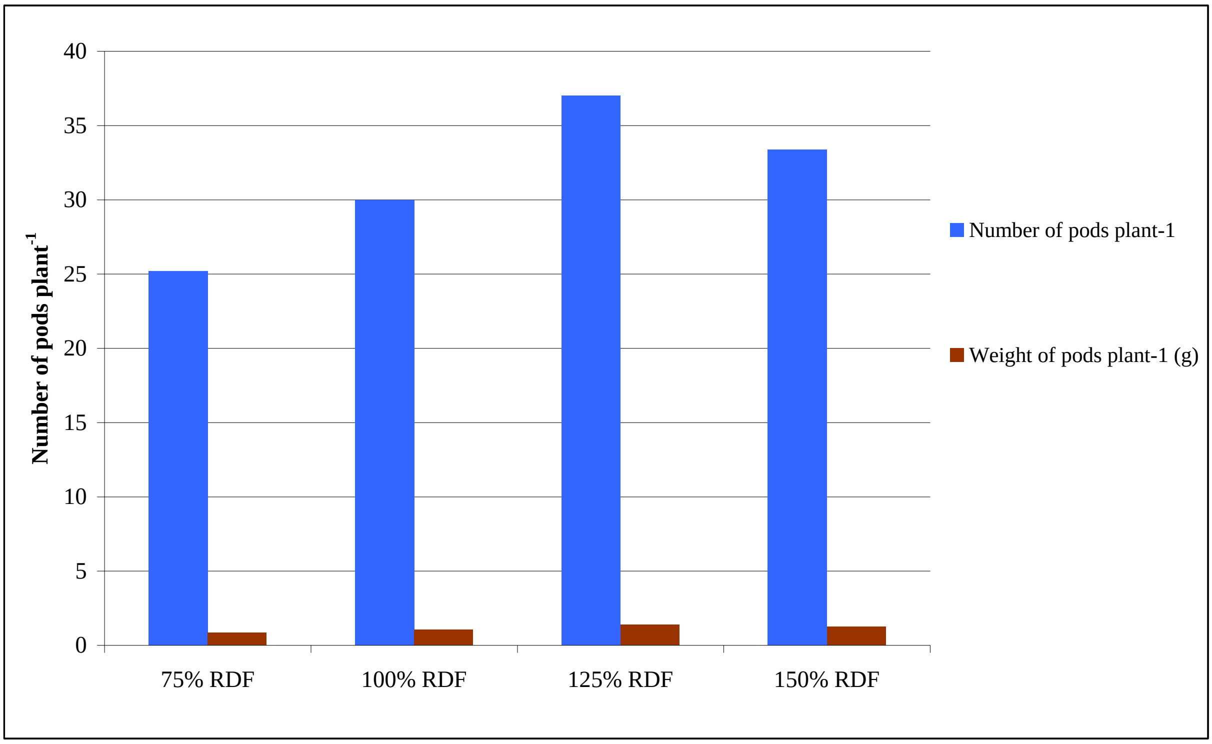


Fertilizer Levels

Fig. 4.4: Dry matter plant^{-1} of lentil as influenced periodically by different treatments

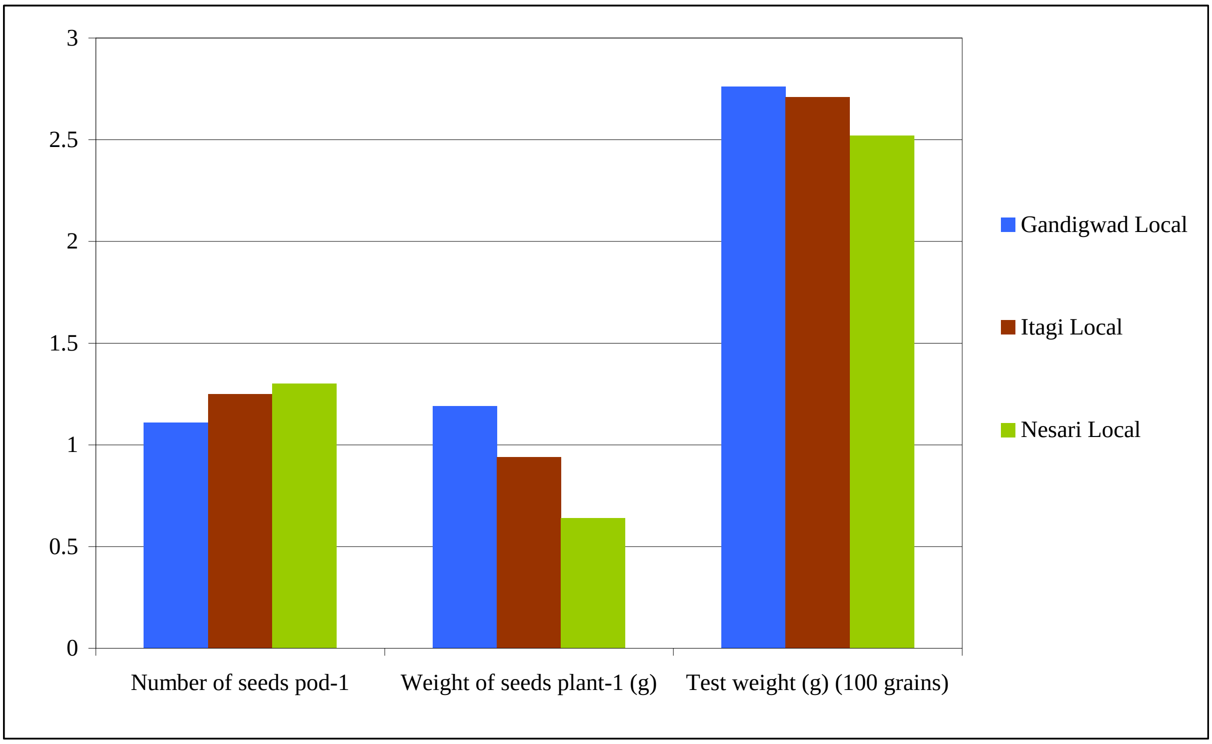


Lentil Genotypes

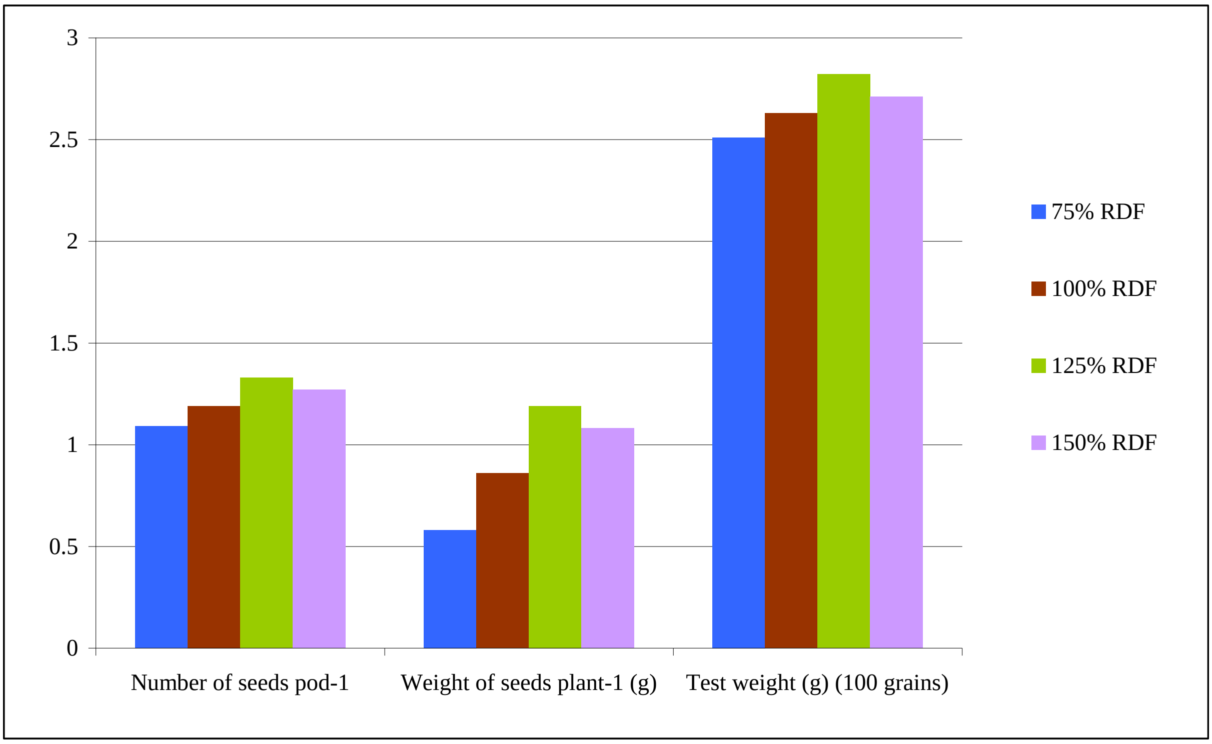


Fertilizer Levels

Fig. 4.5: Number and weight of pods plant^{-1} (g) of lentil after harvest as influenced by different treatments

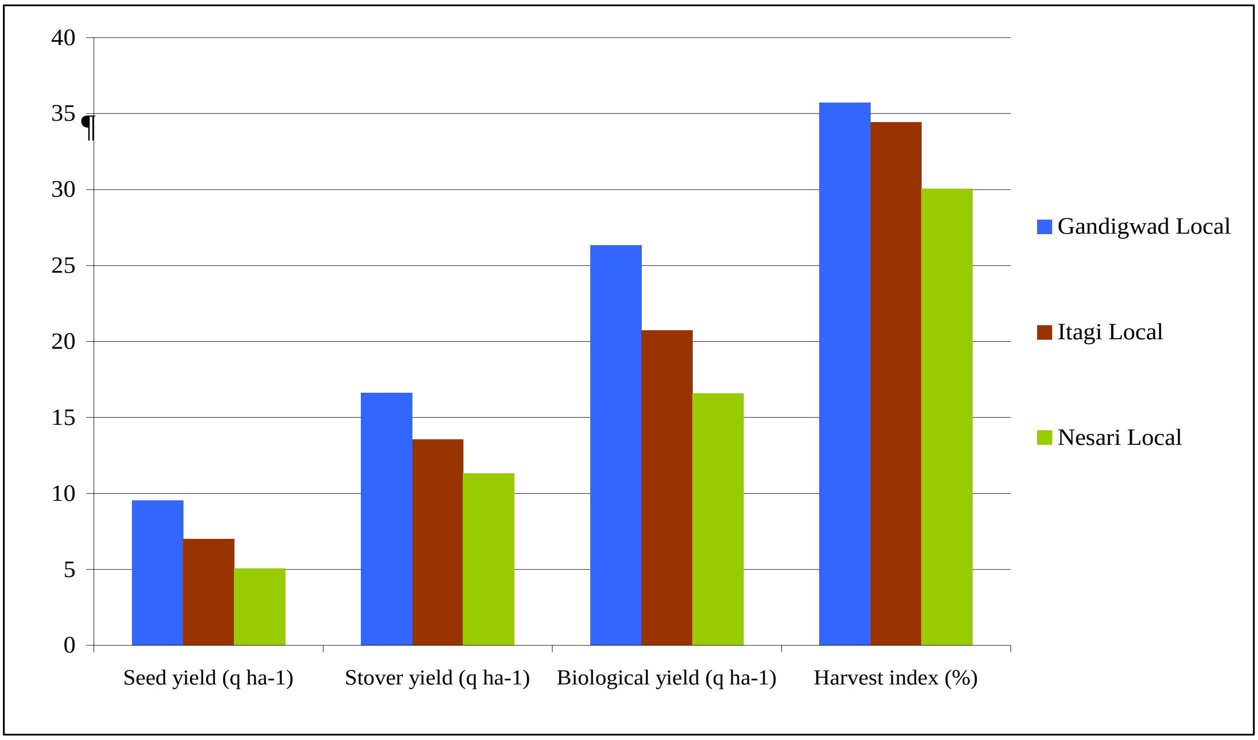


Lentil Genotypes

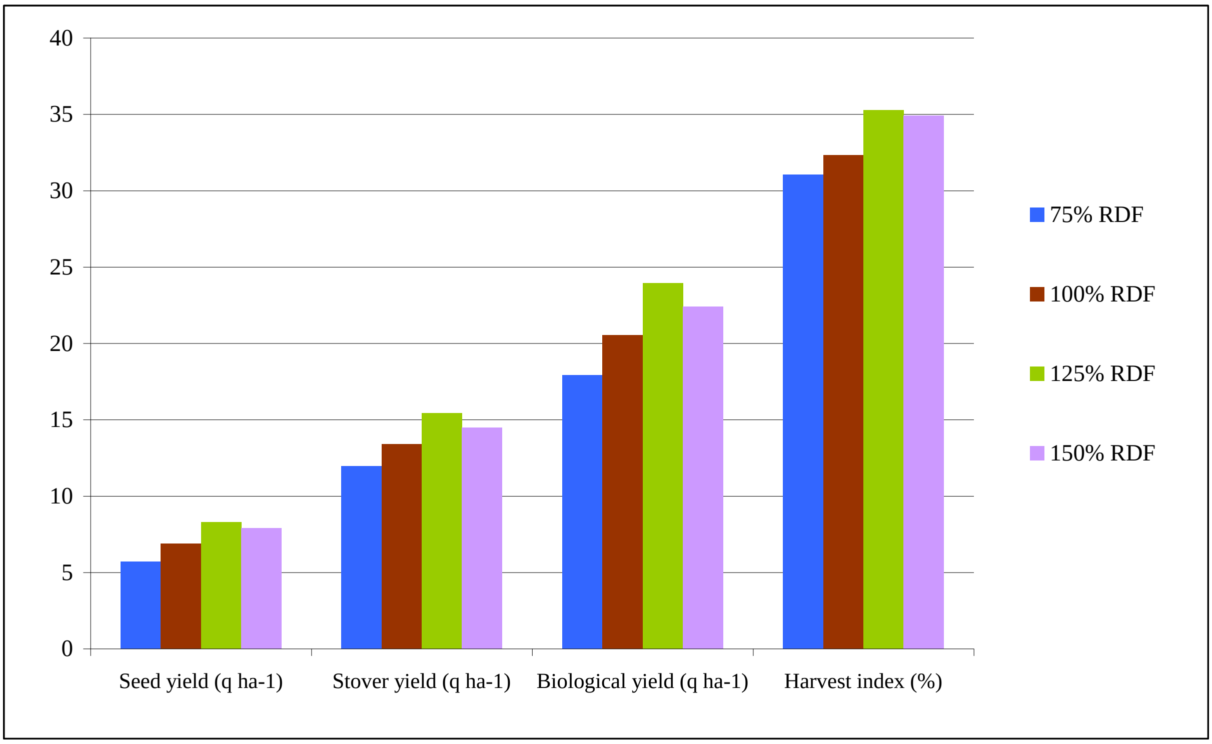


Fertilizer Levels

Fig. 4.6: Number of seeds pod^{-1}, weight of seeds plant^{-1} and test weight (g) of seeds of lentil at harvest as influenced by different treatments

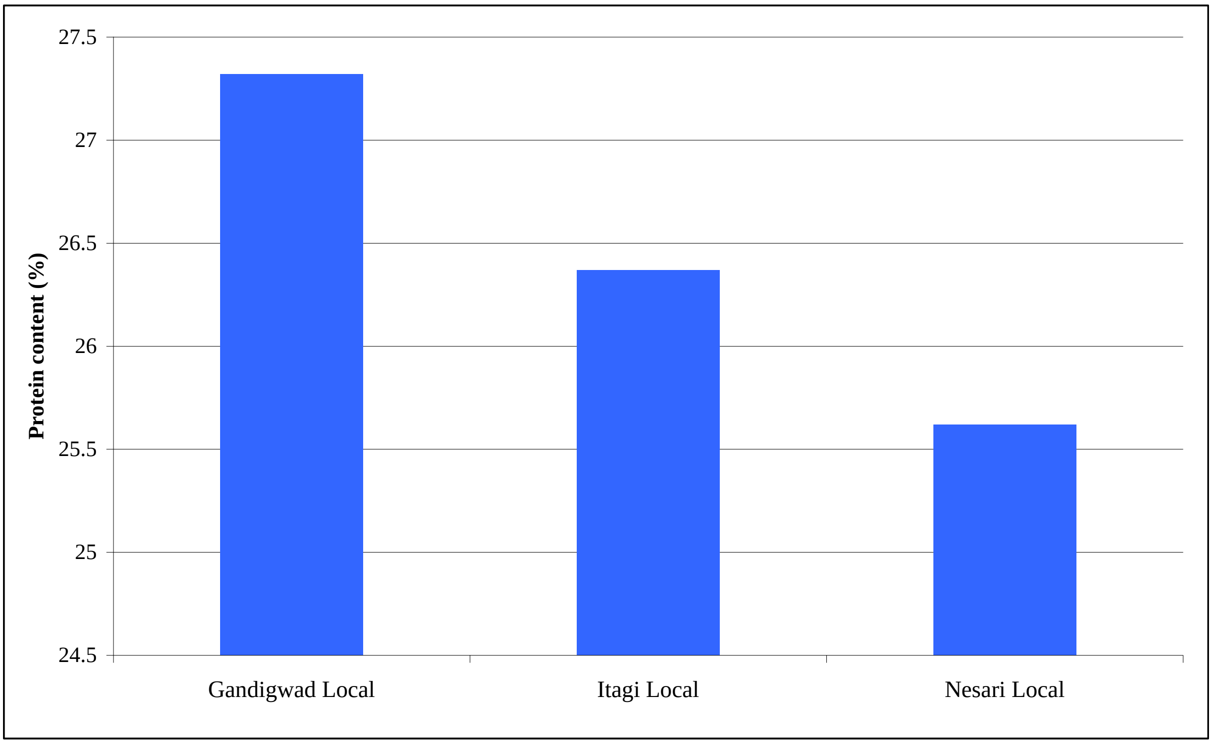


Lentil Genotypes

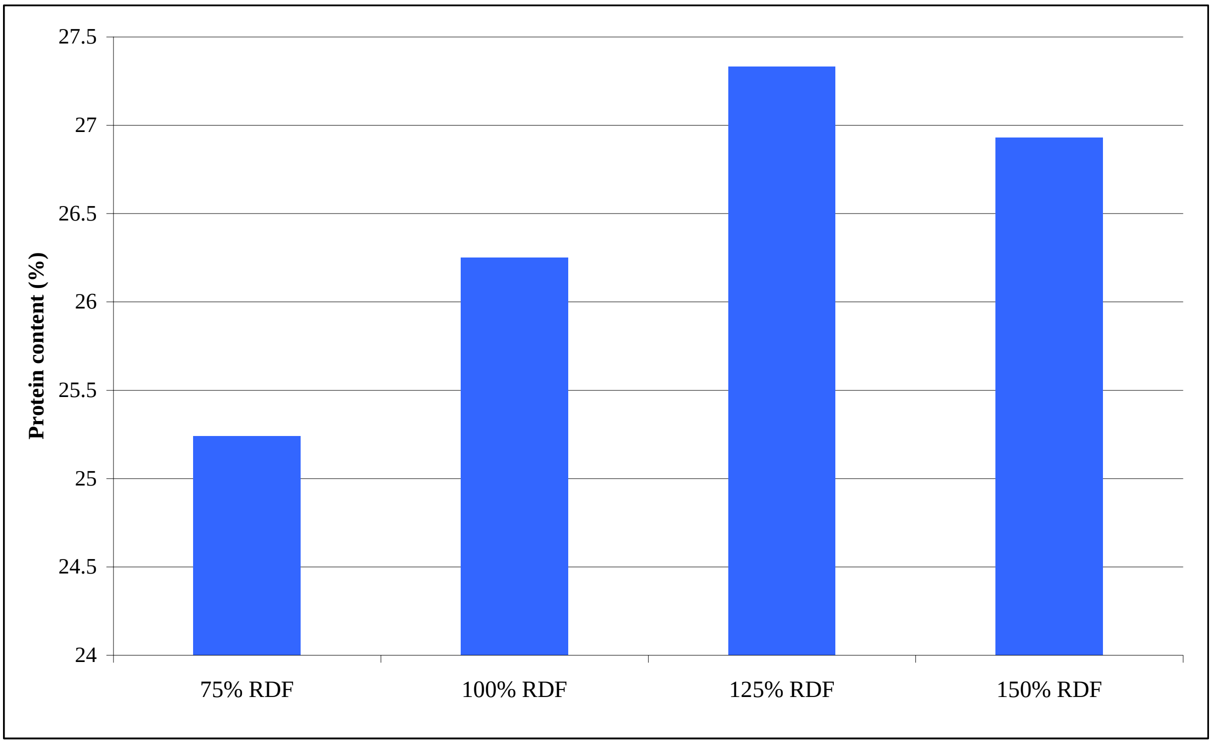


Fertilizer Levels

Fig. 4.7: Seed yield (q ha^{-1}), Stover yield (q ha^{-1}), Biological yield (q ha^{-1}) and Harvest index (%) of lentil after harvest as influenced by different treatments

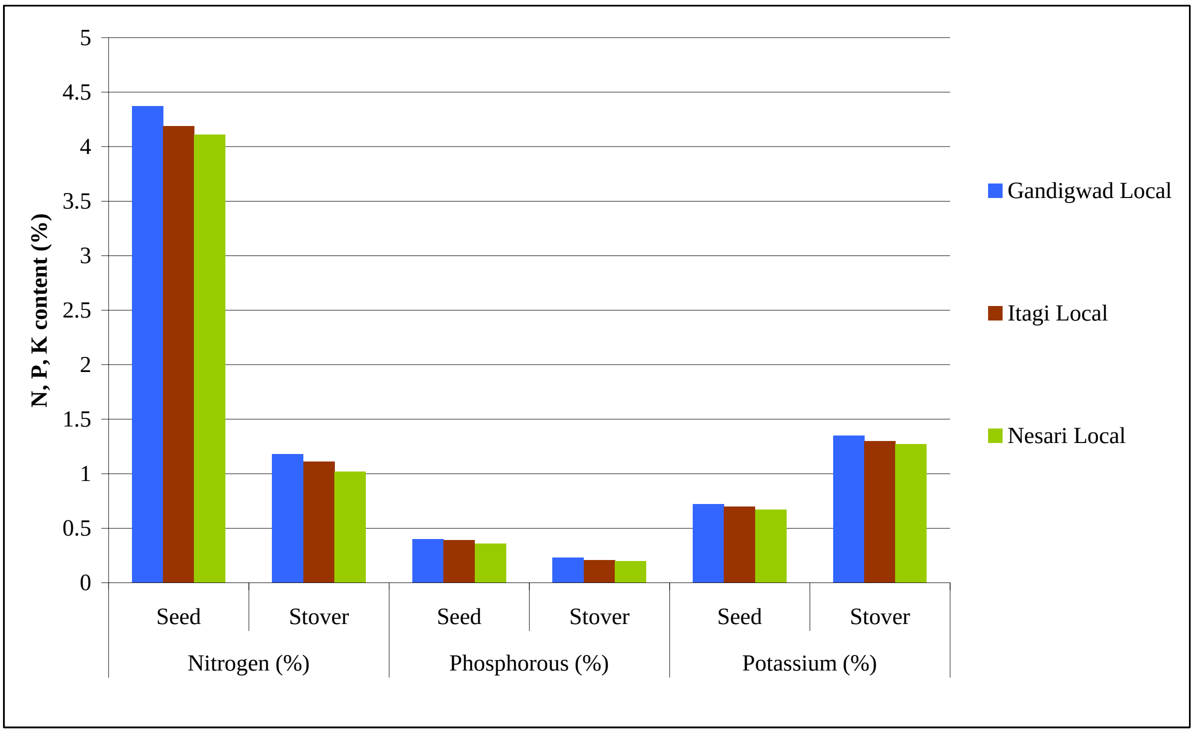


Lentil Genotypes

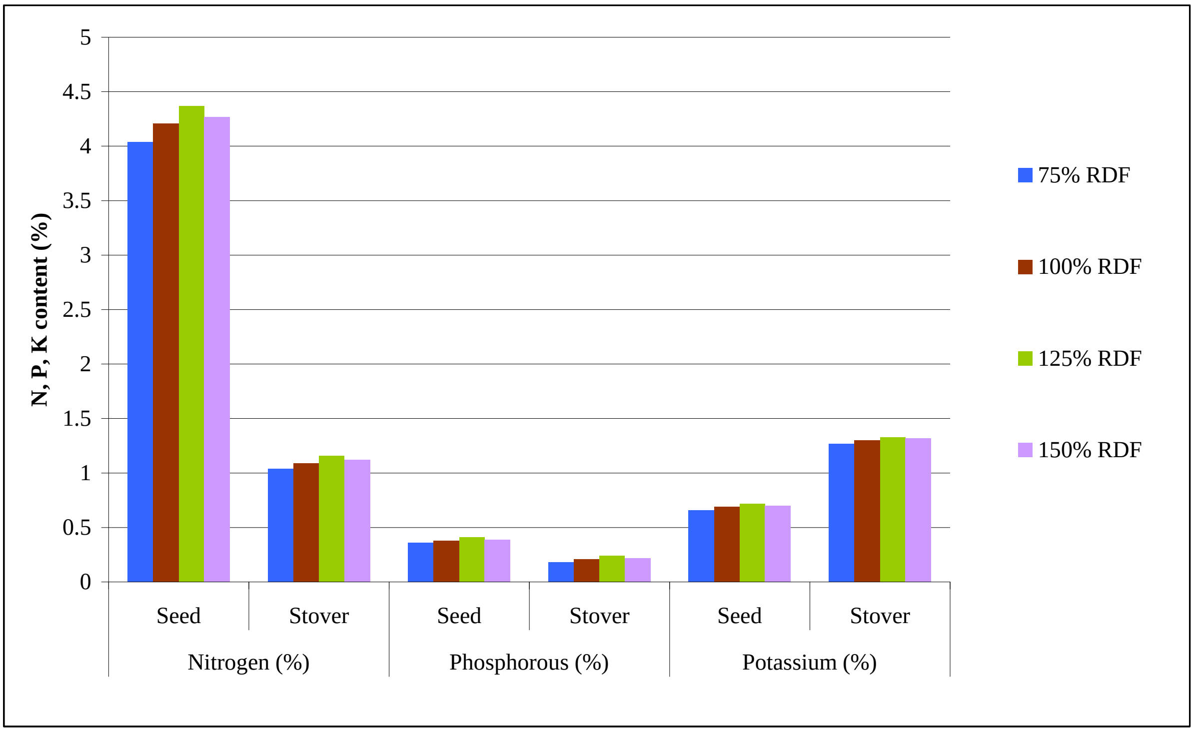


Fertilizer Levels

Fig. 4.8: Protein content (%) of lentil as influenced by different treatments after harvest

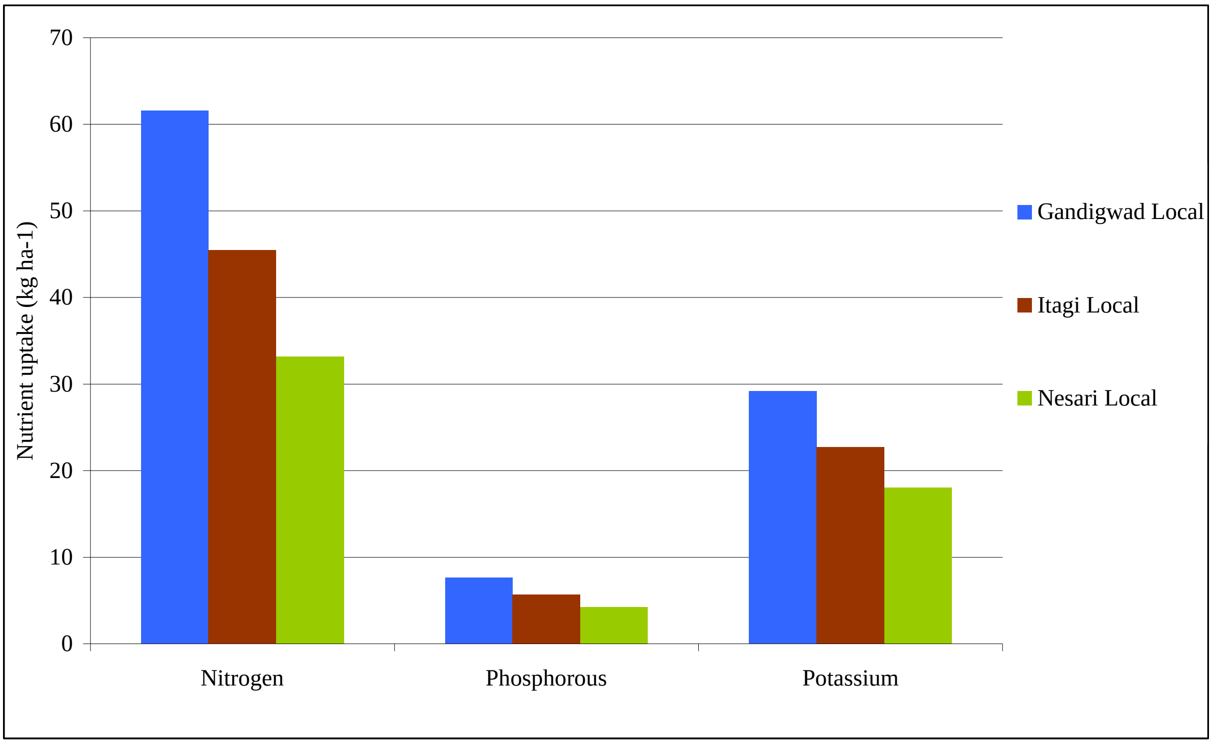


Lentil Genotypes

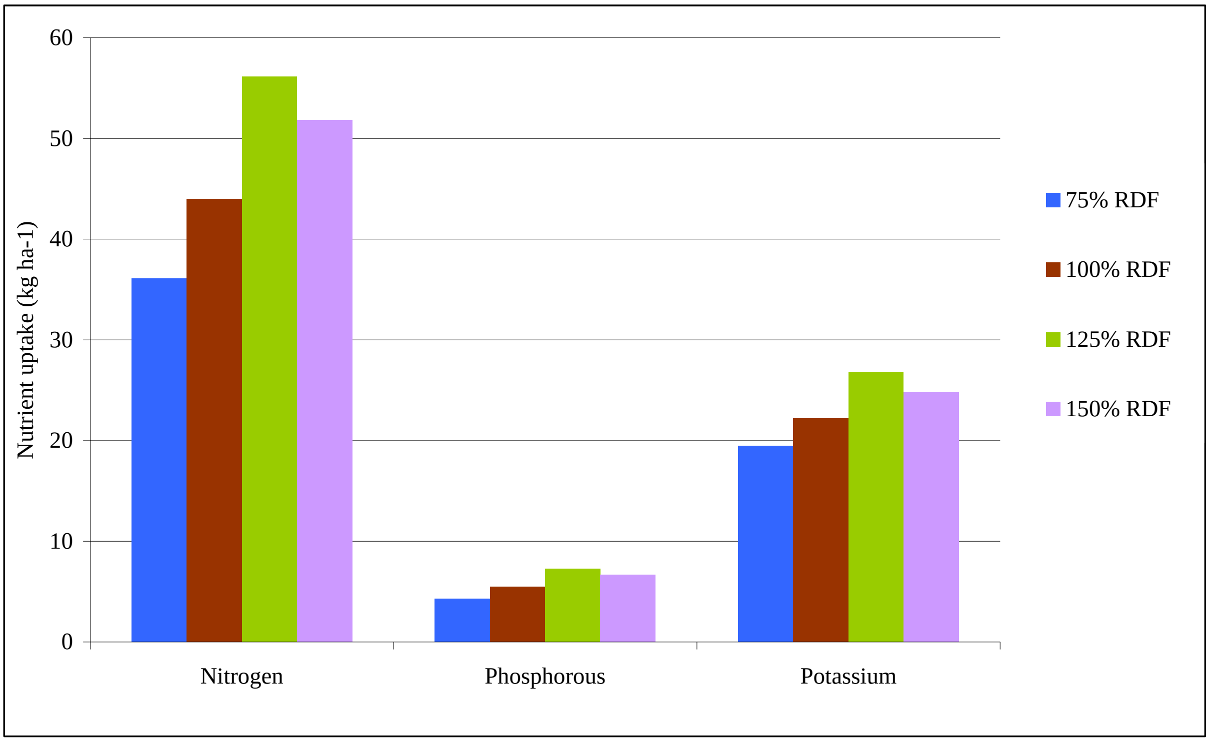


Fertilizer Levels

Fig. 4.9: N, P and K content of lentil as influenced by different treatments after harvest

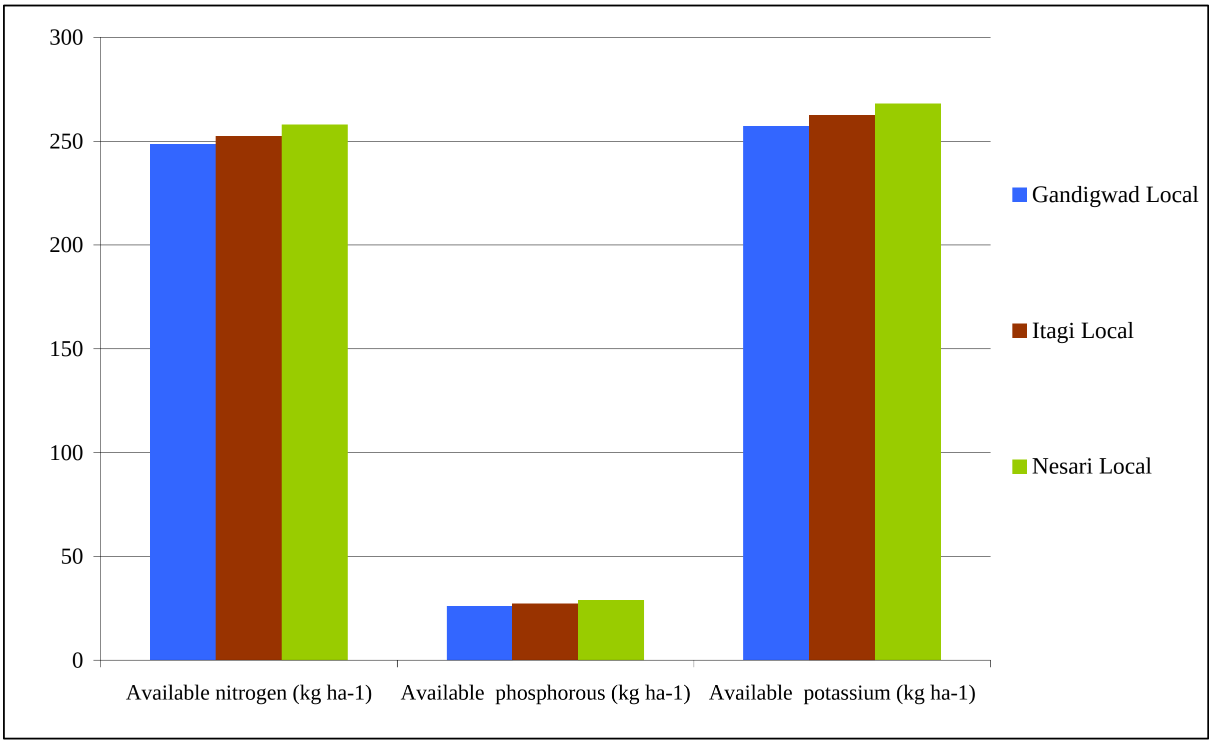


Lentil Genotypes

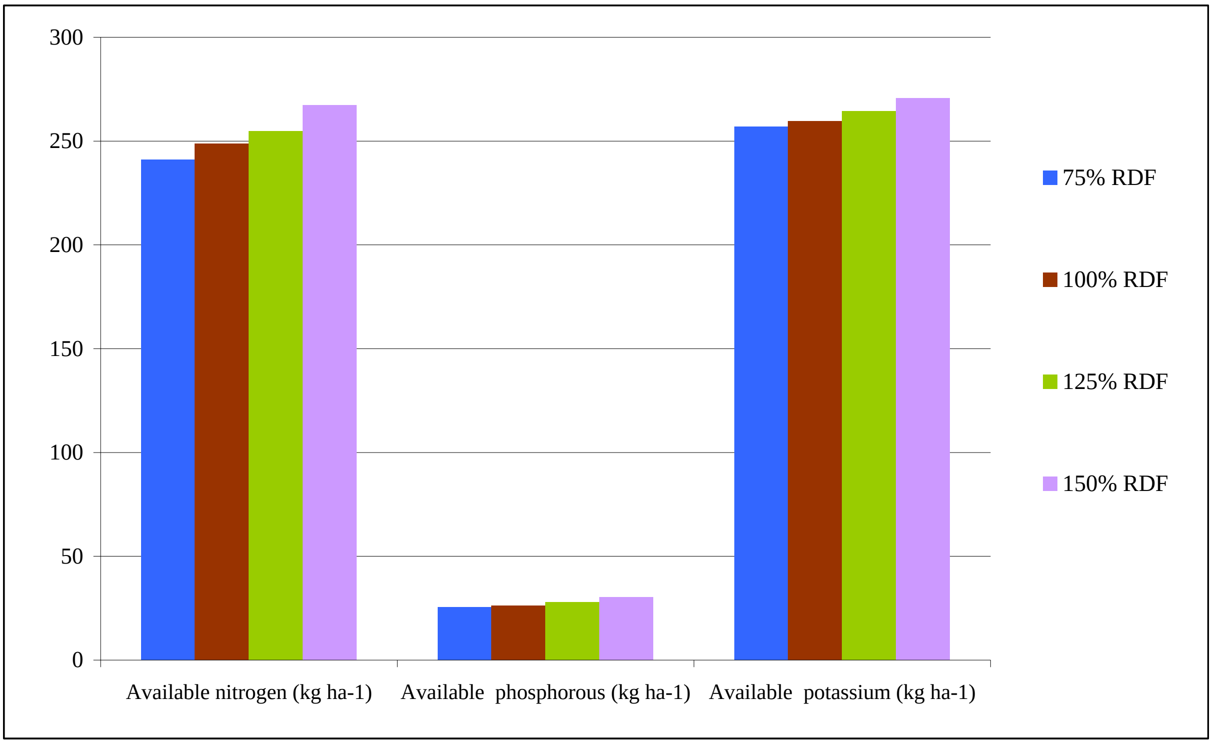


Fertilizer Levels

Fig. 4.10: Mean total uptake of N, P and K kg ha^{-1} by lentil as influenced by different treatments

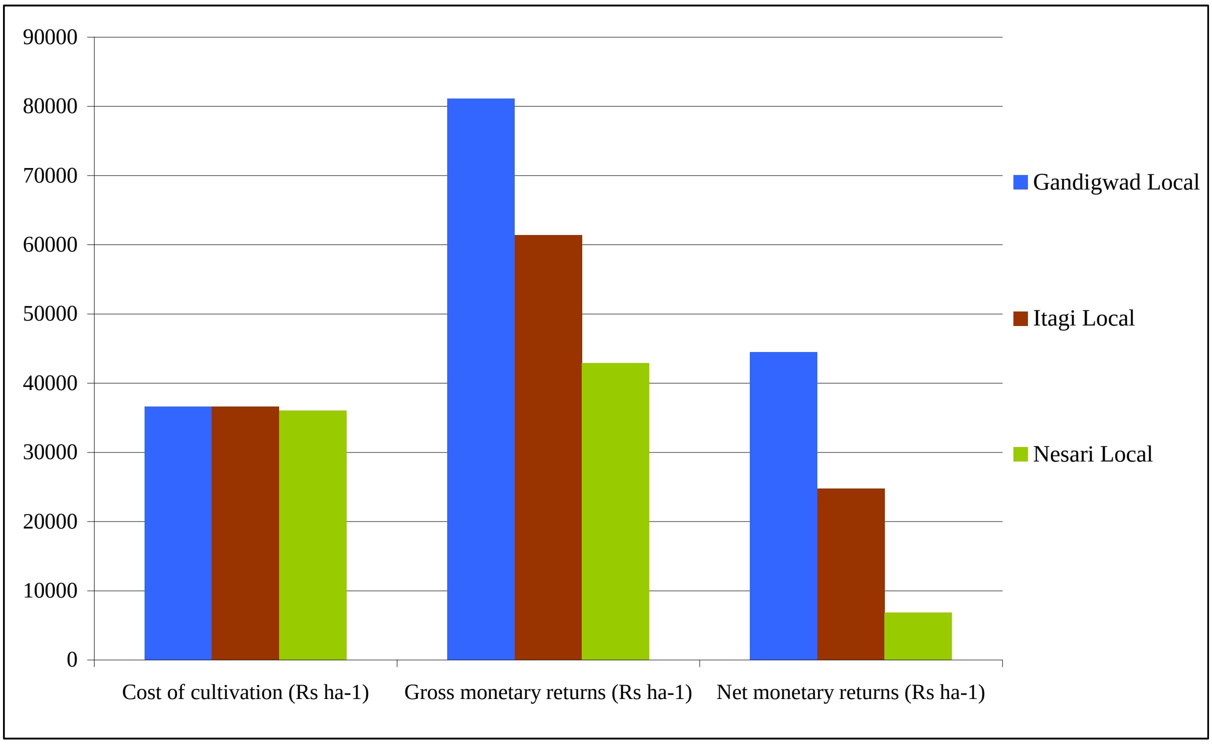


Lentil Genotypes

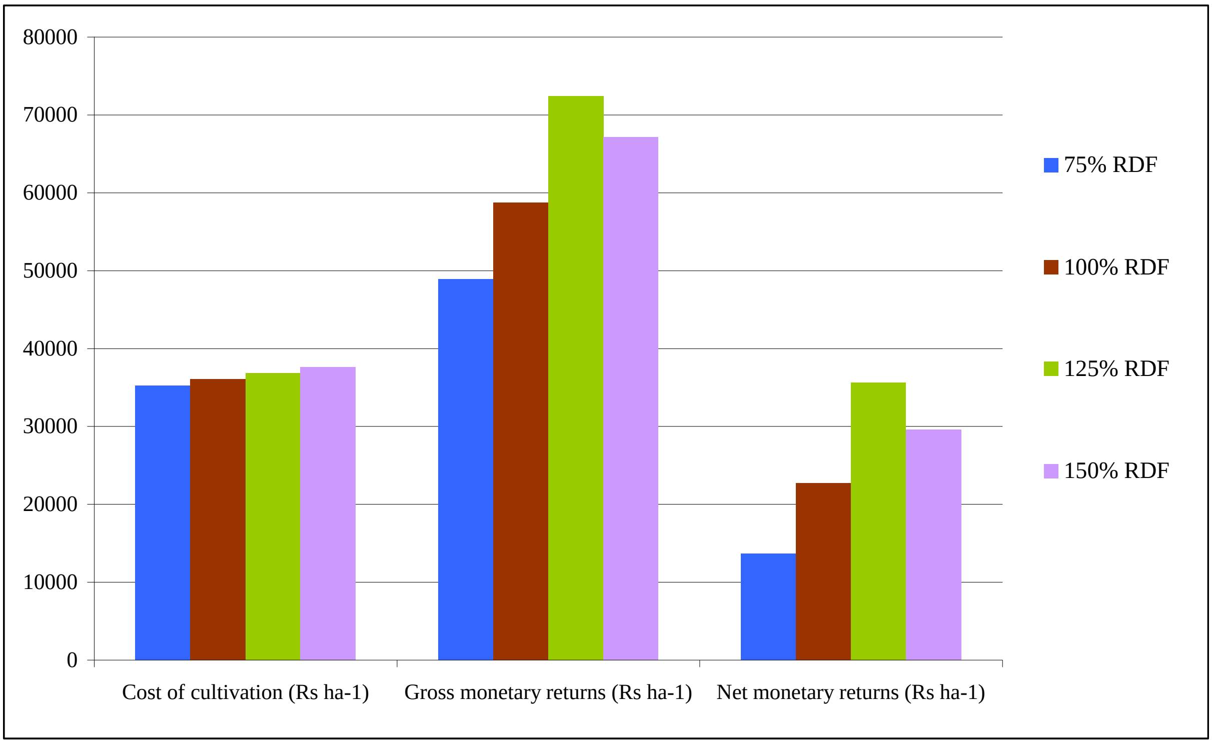


Fertilizer Levels

Fig. 4.11: Available nitrogen, phosphorus and potassium kg ha^{-1} in soil of lentil after harvest as influenced by different treatments



Lentil Genotypes



Fertilizer Levels

Fig. 4.12: Cost ofcultivation, Gross monetary returns and Net monetary returns as influenced by different treatments