STUDY ON GROWTH, FODDER YIELD AND QUALITY OF DIFFERENT BERSEEM VARIETIES (*Trifolium alexandrinum* L.) UNDER CHHATTISGARH PLAINS

M. Sc. (Ag.) Thesis

by

Jeetendra Kumar Sahu

DEPARTMENT OF AGRONOMY
COLLEGE OF AGRICULTURE
FACULTY OF AGRICULTURE
INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (C.G.)
2022

STUDY ON GROWTH, FODDER YIELD AND QUALITY OF DIFFERENT BERSEEM VARIETIES (*Trifolium alexandrinum* L.) UNDER CHHATTISGARH PLAINS

Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

by

Jeetendra Kumar Sahu

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Master of Science

in

Agriculture

(Agronomy)

U.E. ID. NO 20200211 ID No.20200211

AUGUST, 2022

CERTIFICATE – I

This is to certify that the thesis entitled **"Study on growth, fodder yield and quality of different berseem varieties (*Trifolium alexandrinum* L.) under Chhattisgarh plains"** submitted in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Jeetendra Kumar Sahu** under my guidance and supervision. The subject of the thesis has been approved by Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

Date: 18/08/22

Chairman

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman (Dr. S.K. Jha) _____

Member (Dr. Sunil Kumar) _____

Member (Dr. Sunil Kumar Verma) _____

Member (Dr. R.R. Saxena) _____

Member (Dr. S.K. Dwivedi) _____

CERTIFICATE-II

This is to certify that the thesis entitled **"Study on growth, fodder yield and quality of different berseem varieties (*Trifolium alexandrinum* L.) under Chhattisgarh plains"** submitted by **Jeetendra Kumar Sahu** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfillment of the requirements for the degree of **Master of science in Agriculture** in the **Department of Agronomy** has been approved by the external evaluator and Student's Advisory Committee after oral examination **under the chairmanship of Head of the Department.**

Signature of Head of the Department

(Dr. M.C. Bhambri)

Date: 07/09/22

Major Advisor _____

Dean/Faculty Dean _____

Approved/Not approved _____

Director of Instructions _____

ACKNOWLEDGEMENT

Education plays a dynamic role in overall progress of any person and teacher plays the major fundamental role in conveying education. I consider it my privilege and take this precious opportunity to express my humble, heartfelt and deepest sense of gratitude and admiration to those who helped me to make completion of my research work possible. My thesis work is not just only mine but the result of persistent support from many friends and dignitaries who guided me and channelled confidence and strength in me throughout the research work. I consider myself fortunate to have encountered such supportive and kind people along the way, which appeared indirectly or directly on the frame to help me complete my work while providing a knowledgeable and healthy environment to work efficiently and smoothly.

First of all, I am deeply grateful to my Major Advisor, ***Dr. S.K. Jha*** *Senior Scientist, Department of Agronomy, IGKV, Raipur for him constant support during the course of my research work. Despite the heavy schedule of the sensitive work he has to perform, him enduring interest, kind attitude, scholastic guidance, inspiring suggestions and constructive criticism coupled with kindness and patience supported me to achieve the desired destination during the entire move. I could not have asked for or imagined having any better mentor and advisor for my master's study than him.*

I would like to express, with immense pleasure, my heartfelt gratitude and respect to the members of my advisory committee, ***Dr. Sunil Kumar*** *Senior Scientist, Department of Agronomy,* ***Dr. Sunil Kumar Verma****, Asst. Professor, Department of Plant biotechnology* ***Dr. R.R. Saxena****, Associate Director Research and Professor, Department of Agricultural Statistics and Social Sciences,* ***Dr. S.K. Dwivedi,*** *Senior Scientist Department of Agronomy for their graceful guidance, encouragement and insightful comments during the course of study and period of this research work.*

I wish to record my grateful thanks to ***Dr. Girish Chandel*** *Hon'ble Vice Chancellor and* ***Dr. K.L. Nandeha****, Dean, College of Agriculture, IGKV, Raipur for providing necessary facilities, technical and administrative support for conduction of my research work. I would like to express my sincere gratitude to* ***Dr. M.C. Bhambri****, Professor and Head, Department of Agronomy for his kind support and guidance during the study.*

I am grateful to ***Dr. N.K. Choubey****, Professor,* ***Dr. S.N. Khajanji****, Professor,* ***Dr. A.K. Verma****, Senior Scientist,* ***Dr. H.L. Sonboir*** *Senior Scientist,* ***Dr. Shrikant Chitale****, Senior Scientist,* ***Dr. G.P. Banjara****, Senior Scientist and* ***Dr. D.K. Chandrakar****, Senior Scientist,* ***Dr. Ambika Tondon****, Senior Scientist and* ***Dr.***

Nitish Tiwari *Scientist Department of Agronomy for their kind cooperation throughout my study period.*

I extend my thanks to other non-teaching staff of Department of Agronomy for their timely cooperation. I would also like to thank the members of the Nehru Library for giving me their kind help during the study.

My vocabulary may fall short of words to express my irrepressible feelings and heartiest gratitude to the biggest assets of my life, my family. I am thankful to my father ***Mr. G.R. Sahu****, my mother* ***Mrs. Kumari Sahu****, my wife* ***Mrs. Shalini Sahu*** *obstinate sacrifice, pampered support and sincere blessings which have been the vital source of inspiration.*

I wish to express cordial and honest thanks to my friend for their kind support and encouragement during my study. There are many friends and well-wishers who helped me in various ways. Amongst them, my special thanks to ***Krishna, Aman, Pradeep*** *and* ***Tukesh****. I would like to convey my cordial thanks to all those who helped me directly or indirectly to fulfil my dream.*

Above all, I bow down, humbly and wholeheartedly, before Almighty and omnipresent God for sprinkling his unprecedented blessings upon me to reach the acme of success and for always giving me the required strength to face the life's unpredictable ups and downs and enabling my growth towards a better tomorrow.

Jeetendra Kumar Sahu

Department of Agronomy,
College of Agriculture,
IGKV, Raipur (C.G.)

Date: 18/08/22

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

Abbreviations	Description	Abbreviations	Description
%	Percentage	L	Litre
@	At the rate of	M	Metre
B:C ratio	Benefit cost ratio	m^2	Square metre
^oC	Degree Celsius	cm^2	Square centimetre
CD	Critical difference	m^{-2}	Per metre square
cm	Centimetre	Max	Maximum
DAS	Days After Sowing	Min	Minimum
df	Degrees of freedom	Mm	Mili metre
et al.	And others/co-workers	MSS	Mean sum of square
kmph	Kilometre per hour	S	Significant
Fig.	Figure	$plant^{-1}$	Per plant
g	Gram	Q	Quintal
$g\ day^{-1}\ plant^{-1}$	Gram per day per plant	RH	Relative humidity
ha	Hectare	Rs.	Rupees
ha^{-1}	Per hectare	kg	Kilogram
HI	Harvest index	SS	Sum of square
Hr	Hour	S. No.	Serial number
K	Potassium	T	Tonne
LAI	Leaf area index	*viz.*	Namely
CGR	Crop Growth Rate	NS	Non significant
RGR	Relative Growth Rate	SEm±	Standard error of mean

THESIS ABSTRACT

a)	Title of the Thesis	:	**"Study on growth, fodder yield and quality of different berseem varieties (*Trifolium alexandrinum* L.) under Chhattisgarh plains."**
b)	Full Name of the Student	:	Jeetendra Kumar Sahu
c)	Major Subject	:	Agronomy
d)	Name and Address of the Major Advisor	:	Dr. S.K. Jha (Senior Scientist) Department of Agronomy, IGKV, Raipur-492012 (C.G.)
e)	Degree to be Awarded	:	M.Sc. (Ag.)

Signature of Student

Signature of Major Advisor

Signature of Head of the Department

Date: 18/08/22

ABSTRACT

The present investigation entitled "Study on growth, fodder yield and quality of different berseem varieties (*Trifolium alexandrinum* L.) under Chhattisgarh plains." was carried out during *Rabi* 2021 at Instructional- cum-Research Farm, I.G.K.V., Raipur, Chhattisgarh. The experiment was conducted in Randomized Block Design with three replications. Twelve different berseem varieties namely Wardan, Bundel Berseem– 2, Bundel Berseem– 3, Jawahar Berseem- 1, Jawahar Berseem- 5, Jawahar Berseem- 9, Hisar Berseem–1, Hisar Berseem- 2, Berseem Ludhiyana- 10, Berseem Ludhiyana- 42, Berseem Ludhiyana- 43 and Berseem Ludhiyana- 44 were studied for higher quality fodder yield, and economics. Total four cuts were taken during study, first cut was taken at 60 days after sowing and subsequent cuts were done at 30 days interval. The result of experiment on response to different varieties revealed that all growth

xii

parameters like plant height, number of trifoliate leaves, number of shoots, fresh weight, dry weight, leaf and stem fresh and dry weight variety BB-3 was recorded maximum value. Maximum crop growth rate, relative growth rate was recorded by BB-3 during total crop period. Maximum LPR (leaf production rate) was recorded in variety JB-9 followed by BB-3 and JB-1 and BB-2 varieties.

Variety BB-3 was recorded significantly maximum green fodder yield (530.00 q ha^{-1}), dry fodder yield (95.80 q ha^{-1}), productivity of green and dry fodder (3.53 q ha^{-1} day^{-1} and 0.64 q ha^{-1} day^{-1}), which was found at par with varieties JB-9, JB-1 and BB-2 (524, 498 and 497q ha^{-1} green fodder yield respectively).

Variety BB-3 recorded significantly maximum total crude protein yield (18.91 q ha^{-1}), crude protein content (19.41, 23.35, 18.25 and 17.95 at first, second, third and fourth cut respectively) and dry matter content (11.13, 14.97, 20.53 and 31.00 per-cent at first, second, third and fourth cut) which was found at par with varieties JB- 9, BB- 2 and JB- 1.

Variety BB-3 was recorded significantly maximum N uptake (302.6 kg ha^{-1}), P uptake (9.31 kg ha^{-1}) and K uptake (150.7 kg ha^{-1}). Whereas, minimum NPK uptake was recorded with variety HB- 2 (188.1, 6.4 and 104.28 respectively).

Economics of berseem varieties shows that variety BB-3 recorded maximum gross monetary returns (1, 24,355 Rs ha^{-1}), net monetary returns (87,928 Rs ha^{-1}) and B: C ratio (2.97) followed by varieties JB-9, JB-1 and BB-2 (Rs 86,589, 80,044 and 79,797 ha^{-1} net monetary returns respectively).

शोधग्रंथ सारांश

अ) शोधग्रंथ का शीर्षक	:	**"छत्तीसगढ के मैदानी भाग हेतु विभिन्न बरसीम किस्मों (*ट्राइफोलियम अलेक्जेंड्रिनम* एल.) की वृध्दि, चारा उपज और गुणवत्ता पर अध्ययन।"**
ब) छात्र का नाम	:	जितेन्द्र कुमार साहू
स) प्रमुख विषय	:	सस्य विज्ञान
द) प्रमुख सलाहकार का नाम एवं पता	:	डॉ. एस. के. झा (वरिष्ठ वैज्ञानिक) सस्य विज्ञान विभाग इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर–492012 (छ.ग.)
ई) प्रदान की जाने वाली उपाधि	:	कृषि स्नातकोत्तर

छात्र के हस्ताक्षर

प्रमुख सलाहकार के हस्ताक्षर

दिनांकः 18/08/22

विभागाध्यक्ष के हस्ताक्षर

सारांश

वर्तमान जांच शीर्षक "छत्तीसगढ के मैदानी भाग हेतु विभिन्न बरसीम किस्मों (*ट्राइफोलियम अलेक्जेंड्रिनम* एल.) की वृध्दि, चारा उपज और गुणवत्ता पर अध्ययन" रबी वर्ष 2021 के दौरान इंस्ट्रक्शनल–कम–रिसर्च फार्म, इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर, छत्तीसगढ़ में किया गया था। प्रयोग तीन प्रतिकृति के साथ यादृच्छिक ब्लाक डिजाइन में आयोजित किया गया था। बरसीम की बारह अलग–अलग किस्में वरदान, बुंदेल बरसीम– 2, बुंदेल बरसीम– 3, जवाहर बरसीम–1, जवाहर बरसीम– 5, जवाहर बरसीम– 9, हिसार बरसीम– 1, हिसार बरसीम– 2, बरसीम लुधियाना– 10, बरसीम लुधियाना– 42, बरसीम लुधियाना– 43 और बरसीम लुधियाना– 44 का अध्ययन उच्च गुणवत्ता वाले चारा उपज, चारा गुणवत्ता एवं अर्थशास्त्र के लिए किया गया था।

अध्ययन के दौरान कुल चार कटाई की गई, पहली कटाई बुवाई के 60 दिनों के बाद मे की गई और बाद की कटाई 30 दिनों के अंतराल पर की गई। विभिन्न किस्मों की प्रतिक्रिया पर प्रयोग के परिणाम से पता चला कि सभी वृद्धि मानकों जैसे, पौधे की ऊंचाई,

xiv

तीन पत्तियों की संख्या, शूट की संख्या, पौधे का ताजा एवं सूखा वजन, पत्ते और तने का ताजा और सूखा वजन किस्म बुंदेल बरसीम–3 द्वारा अधिकतम दर्ज किया गया। कुल फसल अवधि के दौरान अधिकतम फसल वृद्धि दर, सापेक्ष वृद्धि दर बुंदेल बरसीम– 3 के द्वारा दर्ज की गई। अधिकतम एल. पी. आर. (पत्ती उत्पादन दर) जवाहर बरसीम– 9 किस्म में दर्ज की गई, इसके बाद बुंदेल बरसीम– 3, जवाहर बरसीम –1 और बुंदेल बरसीम –2 किस्मों का स्थान रहा।

बरसीम की किस्म बुंदेल बरसीम– 3 में हरे चारे की अधिकतम उपज (530 क्वि. प्रति हे.), सूखे चारे की उपज (95.8 क्वि. प्रति हे.), हरे और सूखे चारे की उत्पादकता (3.53 क्वि. प्रति हे. प्रति दिन और 0.64 क्वि. प्रति हे. प्रति दिन) दर्ज की गई, जो कि जवाहर बरसीम– 9, जवाहर बरसीम– 1 और बुंदेल बरसीम– 2 (क्रमशः 524, 498 और 497 क्वि. प्रति हे. हरा चारा उपज) किस्मों के बराबर पाया गया।

किस्म बुंदेल बरसीम– 3 में क्रूड प्रोटीन की अधिकतम उपज (18.91 क्वि. प्रति हे.), क्रूड प्रोटीन की मात्रा (19.41, 23.35, 18.25 और 17.95 प्रतिशत क्रमशः पहले, दूसरे, तीसरे और चौथे कटाई पर) और शुष्क पदार्थ (11.13, 14.97, 20.53 और 31.00 प्रतिशत क्रमशःपहले, दूसरे, तीसरे और चौथे कटाई पर) दर्ज की गई, जो कि बरसीम के अन्य किस्मों जैसे जवाहर बरसीम– 9, जवाहर बरसीम– 1 और बुंदेल बरसीम– 2 के बराबर पाया गया।

किस्म बुंदेल बरसीम–3 मे अधिकतम नत्रजन अंतर्ग्रहण (302.6 किग्रा प्रति हेक्टेयर), स्फूर अंतर्ग्रहण (9.31 किग्रा प्रति हेक्टेयर) और पोटैषियम अंतर्ग्रहण (150.7 किग्रा प्रति हेक्टेयर) दर्ज किया गया। जबकि, किस्म हिसार बरसीम– 2 मे (क्रमशः 188.1, 6.4 और 104.28 किग्रा प्रति हेक्टेयर) के साथ न्यूनतम एन. पी. के. अंतर्ग्रहण दर्ज किया गया।

बरसीम किस्मों के अर्थशास्त्र से पता चलता है कि किस्म बुंदेल बरसीम– 3 द्वारा अधिकतम सकल मौद्रिक आय (1, 24,355 रुपये प्रति हेक्टेयर), शुद्ध मौद्रिक आय (87,928 रुपये प्रति हेक्टेयर) और आयः व्यय अनुपात (2.97) प्राप्त हुआ जिसके बाद बरसीम के अन्य किस्मों जैसे जवाहर बरसीम– 9, जवाहर बरसीम– 1 और बुंदेल बरसीम– 2 (क्रमशः 86,589, 80,044 और 79,797 रुपये प्रति हेक्टेयर शुद्ध मौद्रिक आय) के द्वारा दर्ज किया गया।

CHAPTER - I
INTRODUCTION

Berseem (*Trifolium alexandrinum* L.) is an annual leguminous fodder crop and has been rightly described as the king of fodders. It is highly esteemed fodder which has a special place in animal husbandry programmes throughout the country. It is one of the most suitable fodder crops for areas below 1700 m altitude with irrigation facilities. It remains soft and succulent at all stages of growth. It can be grown without irrigation in areas with high water table and under water- logged conditions.

Berseem requires a cool and moderately cold climate for its normal growth. Berseem grows in areas where average rainfall ranges between 300- 750 mm. It cannot be grown in damp and heavy rainfall areas. It needs temperature around 13-15.5 ^{0}C for germination and establishment. The crop growth is very fast at temperature 18-21 ^{0}C. Frost period during winter checks the growth of crop. If the winter temperature falls to 6-8 ^{0}C the crop growth is severely affected. Frost period during winter makes the crop dormant and no regernation is recorded. Similarly when temperature goes around 32-35 ^{0}C re-growths after cut may not be possible. In North India, mid-October is the best time for sowing. In Eastern India it may be sown in November. The onset of winter is to be considered as the best time for berseem seed sowing as optimum temperature for berseem germination is 20 ^{0}C. Timely sowing helps in taking excess cuts for green fodder and extends the period of fodder availability (Vijay, D., *et.al*. 2017).

Berseem forms a major part of the animal diet from November to April in the central and northern- western parts of India. Owing to its high demand in milkshed areas and it has wider adaptability, high regeneration capacity, quick growth, high out turn of green fodder, high palatability, easy digestibility and easy cultivation practices the economic return of this crop are more than other fodder crops.

Among the berseem growing countries, India is having highest area under berseem with around 2 million ha followed by Egypt (1.1 million ha) and Pakistan

(0.71 million ha) (Muhammad *et al*., 2014). Seed quality is a problem in most of the countries particularly where farmers are not much aware of the quality ensuring laws. Egypt is the major exporter of berseem seed in the world meeting the stringent quality standards of Europe. In India, mainly in four states Uttar Pradesh, Madhya Pradesh, Punjab and Haryana produces berseem to the maximum extent.

Berseem is a fast growing annual crop with 30-60 cm plant height. The stem is hollow and succulent. Both basal and stem branching is observed. Roots do not extend beyond two feet in general and contains nodules. It is sparingly hairy and commonly possesses trifoliate petiolate leaves. Leaves are membranous, oblong-elliptical to oblong- lanceolate and are arranged alternately except the uppermost leaf. Berseem varieties grown in India are cut multiple times and provides highly palatable, succulent and nutritious green fodder up to 70- 75 t ha^{-1} in 4 to 5 cuttings for longer duration from November to May. The crop is ready in 55-60 days after sowing for the first cutting. Subsequent cuttings are taken at 30 days interval during winter and spring. The additional advantage of berseem cultivation is its ability to substantial improvement in soil fertility through biological nitrogen fixation.

It is the main forage legume and it is cultivated in Syria and Persia, where it forms the principal green forage for horses, donkeys and camels. It was introduced into India in 1904. Berseem is now a prominent fodder legume in irrigated areas of the Punjab, Delhi, Rajasthan and Uttar Pradesh and other parts of Western and Northern India. It is widely grown both for fodder and green manure.

The berseem fodder is highly palatable due to its succulence and is also highly nutritious having 20% crude protein and 62% total digestible nutrients, 35-38% acid detergent fiber, 24- 25% cellulose and 7- 10% hemicelluloses which increases the milching capacity of livestock. It behaves as a most potent milk multiplier in the lactating buffaloes, Sahiwal cows and crossbred cattle as compared to other forage crops. Besides, berseem has got soil building characteristics also which improves the physical, chemical and biological properties of the soil resulting in better growth and yield of crops in rotation. Thus, the crop is very important from the view point of conservation farming and imparts

sustainability to soil productivity and crop production system as a whole. It is also commonly grown in mixtures with *Brassica* and sometimes with oat to have bulk of green fodder in early cuts. Most of times, farmers are interested for taking berseem as a forage crop but not for seed purpose mainly to have quality fodder in lean period of winter season in North India. Berseem is one of the fast growing and high quality leguminous forage crop that is fed to the animals as green chopped forage. The yield and quality of berseem is low due to many environmental factors and certain management constrains. The difficulty in producing high seed yield in forages is due to the failure of seed setting in flowers. Disease and insect can be incriminated in some cases, whereas in others, lack of pollination, soil fertility may be involved. The successful production of seed along with fodder production is highly influenced by applied nutrients. Local production of clover's seed seems to be neglected by farmers, government organizations and private companies. Berseem being a legume is having a high nitrogen fixing ability resulting in improvement of soil fertility. Recent studies show that berseem can be used for phytoremediation of heavy metals *viz*., Cd, Pb, Cu and Zn due to its multi-cut nature, short life cycle and production of considerable biomass (Ali *et al*., 2012).

The growth period is varied among different berseem growing states with slight shift towards summer in Punjab compared to Madhya Pradesh. The productivity of green fodder and seed production varied among different production places. This variation also results from the suitability of varieties grown and their potential. The 16 berseem varieties were released by 5 institutes in the country of which one variety each was released by IARI, New Delhi and GBPUAT, Pantnagar during 1975 and 1993, respectively. The main berseem variety developing institutes are PAU, Ludhiana (BL-1, BL-22, BL-10, BL-42, BL-43 and BL- 44) JNKVV, Jabalpur (JB-1, JB-5, JB-9); CCS HAU, Hisar (HB-1, HB-2) and IGFRI, Jhansi (WARDAN, BB-2, BB-3). All the varieties released till date are of Mescavi type with multicut nature. The varieties mescavi and Wardan are suitable to grow in all berseem growing regions of India and among them Wardan is the national check for releasing new varieties. Remaining varieties are released for specific zones and are most suitable for irrigated tracts of those regions only. The green fodder yield potential of released varieties ranged from 62

t ha^{-1} to 105 t ha^{-1} and dry fodder yield from 9 t ha^{-1} to 18.8 t ha^{-1} with seed yield potential from 0.3 t ha^{-1} to 0.78 t ha^{-1}. The new varieties released are being tested for disease and pest resistance as special characters. Based on the region of cultivation the maturity date varies. Some late varieties were released to supply green fodder up to June.

Livestock is symbolic to wealth and power across civilizations for centuries. India is blessed with diversified type of livestock. Its livestock sector is one of the largest in the world. It has 56.7% of world's buffaloes, 12.5% cattle, 20.4% small ruminants, 2.4% camel, 1.4% equine, 1.5% pigs and 3.1% poultry. Agriculture is the back bone of Indian economy and livestock sector is an integral part of agriculture. Livestock sector accounts for 25.6 % of the agricultural GDP and about 4.11 % of total GDP. According to 20^{th} livestock census (2019) livestock population of about 193.46 million cattle, 109.85 million buffaloes, 74.26 million sheep, 148.88 million goat, 9.06 million pigs, 0.25 million camels and 1 million including other livestock. Using these resources, India ranked first with 22 per cent of global milk production.

Chhattisgarh is very rich in its livestock wealth with 1.27 million , Cattle population is the highest with 9.98 million , followed by goats 4.0 million , buffaloes 1.17 million sheep 0.18 million and pigs being the 0.52 million and including 0.0008 million other animal . In spite of having huge livestock population, the milk productivity is very low as compared to the world average and much below than the developed countries. One of the major limitations to efficient livestock population in the country is the lack of adequate level of quality forage. The importance of livestock in Indian agriculture is well recognized. Livestock not only provides food security through supply of milk, meat and self-employment of both men and women but also plays an important role for poverty alleviation of smallholder livestock farmers. The livestock are less affected by the climate change and its growth is also higher than agriculture. In 11^{th} plan the average growth of livestock sector was 4.1 while it was 3.6 for agriculture as a whole. The growth in livestock sector is also demand-driven, inclusive and pro-poor. Incidence of rural poverty is less in states where livestock accounts for a sizeable share of agricultural income as well as employment. In India, livestock production system

is primarily characterized by low input as well as low output. The livestock population is increasing and accordingly its feed requirements are also increasing. There is urgent need to meet the demand of increasing number of livestock and also enhance their productivity for which availability of feed resources have to be increased. Almost all the grasslands and grazing areas are devoid of quality legumes in enough quantity. To compensate low productivity farmers generally maintain more number of animals which obviously increase the pressure on limited fodder resources. Fodder scarcity makes dairying uneconomical and unattractive as an income generation activity among the poor farmers of the country. Looking at the vast gap between the demand and supply position, it becomes necessary to put adequate efforts to transfer the potential technologies developed by various research organization in the country to farmer's field in order to increase the economically attractive, milk production and productivity has to be enhanced. This is possible only by making available good quality feed and fodder in adequate quantity. Fodder crops are the cheapest source of feed for livestock. As the distribution pattern of livestock ownership is different among landless labourers and marginal farmers, the progress in this sector will result in a balanced development of the rural economy. On the other side, there is emerging emphasis on intensive and diversified cropping systems, transformation of sustenance farming into market oriented contract farming, emergence of corporate world in input supply and output procurement, processing and marketing through organized retail chains, linking production to consumption under changing food habits towards livestock products, quality consciousness and standards.

The cropping intensity of the Chhattisgarh state is quite low as farmers generally take mono-crop of paddy. Introduction of berseem on such lands will not only provide quality fodder to the animals but also improve the fertility status of the soil besides raising the cropping intensity of the region.

On all India bases, an overall deficit of 11.24% in green fodder availability was estimated. Total green fodder availability was estimated to be 734.2 mt. against requirement of 827.19 mt. Similarly for dry fodder availability was estimated to be 326.4mt against requirement of 426.1 mt., thereby making an overall deficit of 23.4%. For concentrate, our study indicated requirement of 85.78

million tons at national level, however, the estimated annual availability of total concentrate feed is only 61 million tons (Anonymous, 2018) which makes a deficit of approximately 24.78 million tons or 28.9% of the demand.

As berseem is the emerging crop in Chhattisgarh and it can be grow from November to mid April with 4 to 5 cut for the selection of high yielding variety , in the state study in different variety are needed to selection the high yielding variety for farmers recommendation.

Hence, the present investigation is planned to study the – **"Study on growth, fodder yield and quality of different berseem varieties (*Trifolium alexandrinum* L.) under Chhattisgarh plains"** and is proposed to be undertaken during the *Rabi* 2021 at Instructional cum Research Farm IGKV, Raipur (C.G) with the following objectives:-

1. To study the suitable high fodder yielding varieties of berseem for Chhattisgarh plains.
2. To evaluate the different quality parameters of berseem varieties.
3. To work out the economics of berseem varieties.

CHAPTER - II

REVIEW OF LITERATURE

The present investigation entitled **"Study on growth, fodder yield and quality of different berseem varieties (*Trifolium alexandrinum* L.) under Chhattisgarh plains"** deals with a review of literature on the various researches conducted in the country and abroad with more emphasis placed on the work done in recent years. The literature on the aspects is reviewed under following heads:

2.1 Effect on variety

2.2 Effect on nutrient uptake

2.3 Effect on green forage and yield

2.4 Effect on quality

2.5 Effect on economics

2.1 Effect on Variety

Singh and Dixit (1990) conducted field experiment at Indian Grassland and Fodder Research Institute, Jhansi (Uttar Pradesh) and observed that application of 100 % RDF to Wardan produced 60.04 to 70.30 t fresh fodder yield and 10.32 to 13.31 t dry matter ha^{-1} compared with 56.45 to 69.55 and 9.84 to 13.52 t, respectively for standard cv. Mescavi in five zone of India.

Dinesh Nargesh (2012) Department of Soil Science & Agricultural Chemistry, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya College of Agriculture, Gwalior (M.P.) was an experiment conducted and conclude that In respect of total forage yield (green fodder yield), variety Wardhan recorded significantly higher (556.67 q ha^{-1}) as compared to variety Bundelkhand berseem-3, which produce 493.19 q ha^{-1} green fodder yield. The variety Wardhan recorded 454.19 and 3690.8 kg ha^{-1} seed and straw yield of berseem which was 20.67 and 6.47 percent significantly higher over to variety Bundelkhand berseem-3.

Singh *et.al* (2016) recorded highest total green fodder yield (71.19 t ha^{-1}) was also recorded in JB-04-21 which was significantly superior over Wardan

except other genotypes. Highest total dry matter yield (10.05 t ha^{-1}) was recorded in BB-2 which was significantly superior to Wardan and JB-04-23.

Abd El-Naby *et al.* (2016)) was conduct a field trial at SIDS research station in (2012/13 and 2013/14) seasons and recorded Khadarawy genotype was the produce highest forage yield 9.97 t ha^{-1} among the variety Narmer, New Narmer (N), Hatour ,New Hatour (H), composite (H+N), Big floret, Sakha-4, Helaly, Giza-6, Serw-1 and Gemmiza.

Kumawat *et al.* (2017) a field experiment was conducted at agricultural research station, SKRAU, Bikaner on *Rabi* season of 2016-17 found that AVTB 2-3 was recorded Significantly higher plant height (49.33 cm), green fodder yield (153.2 q ha^{-1}) and dry matter yield (28 q ha^{-1}) among the variety AVTB2-1, AVTB2-2, AVTB2-4 and AVTB2-5.

Badawy *et al* (2018) the results from the combined analysis of two seasons showed that Helaly variety recorded the highest of total fresh yield, total dry yield, mean plant height and mean number of stems (0.25m^{-2}) whereas (107.39 kg $plot^{-1}$, 2.87 kg $plot^{-1}$, 74.2cm. and 251.56). Helaly cultivar was the best commercial in this study.

Devi and satpal (2019) was conducted field experiment at Forage Section Research Farm, Department of Genetics and Plant breeding, CCS Haryana Agricultural University, Hisar (Haryana) during winter season (*Rabi*) of 2017-18 and found highest total green fodder and dry matter yield (687 and 93 q ha^{-1}, respectively) were recorded in variety JB-05-9 which was at par with all berseem varieties (Wardan, Mescavi and Bundel Berseem-2). The maximum crude protein yield (19.98 q ha^{-1}) was recorded with JB-05-9 which was on a par with all the genotypes except Bundel Berseem-2.

Dahiya *et al* (2019) reported variety Mescavi (Pusa) was found to be superior in every aspect and gave the higher green fodder yield of 151.25 q ha^{-1} over local variety (Bhart Kaveri) of berseem (144. q ha^{-1}).

Singh *et al.* (2020) was recorded higher green fodder and dry matter yield and varieties HB-2 (55.91 t ha^{-1} and 10.16 t ha^{-1}) and BL-42 (55.33 t ha^{-1} and 10.73

t ha^{-1}) statistically at par with each other and significantly higher than Wardan (national check) variety BB-3, BB-2, BL-10 and exotic berseem Mescavi. Berseem variety HB-2 recorded higher crude protein yield (1.82 t ha^{-1}) than Wardan (NC) and exotic variety Miskawi, BB- 3, BB- 2, BL- 1, BL- 10, BL- 42, JB- 1 and JB- 5. Crude protein (CP) content was recorded significantly higher for HB-2 (17.93 %) as compared to Wardan, BB- 3, BB- 2, BL- 1, BL- 42, JB- 1 and Miskawi. Lowest crude content was recorded for BB- 3 (15.80 %).

Tufail *et al* (2020) recorded Maximum cumulative fresh forage (89.7 t ha^{-1}) and dry matter (13.4 t ha^{-1}) yields were obtained with Agaitti Berseem-2002 when harvesting occurred five times over the season. Agaitti Berseem-2002 also produced forage with the higher crude protein content (27%), DM digestibility (69%), digestible organic matter (DM basis; 65%) and metabolizable energy content (10%) compared to the local landraces (LBF1 and LBM1).

Cheptoo *et al.* (2020) was conducted an experiment during two successive winter seasons (2018/19 and 2019/20) and found that total dry yield of the two seasons, variety khadrawy was the best producing 26.52 and 32.18 ton $acre^{-1}$ in the first and second seasons, respectively among the variety Hartuor, Narmar, Sinai 2, Giza 6, Helaly, Gemiza, Serw1, Sakha 4 and Meskawi.

Mofeeda , A. *et al.* (2020) conducted an experiment in the research station at Nubaria region, Al-Behira government across the two growing seasons 2015/2016 and 2016/2017 and recorded variety Helaly and Pop.4 were the tallest in average of plant height 73.19 cm, Helaly recorded the highest fresh and dry yield (71.065, 9.783 kg $plot^{-1}$) among the variety Pop.1,Pop.2 , Pop.3, Serw3, Pop.6 , Pop.10 , Pop.46 , Sakha 4 , Serw 1 , Gemmiza 1 and Giza 6. Variety Helaly was the highest one for fresh leaf: stem ratio is 57.2.

Kumar *et al.* (2021) conducted an experiment during *Rabi* season, 2019-20 at Forage Research Farm, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar (Haryana) and recorded average plant height (cm) found highest with entry JHB-17-1(57.4 cm). Furthermore, leaf stem ratio was observed highest (0.82) with entry JHB-17-1 which was significantly higher than variety JHB-17-2, BB-2 (ZC), PC-91 and Wardan (NC). The average

numbers of tillers per meter row length were also recorded maximum (108.4) with JHB-17-1 which was significantly higher than all other variety.

Gondal *et al.* (2021) was found highest number of tillers variety Agaiti berseem (388 m^{-2}) followed by Super late with 373 tillers m^{-2} and Punjab Berseem with least number of tillers (366 tillers m^{-2} and the highest fresh fodder yield (143.69 t ha^{-1}) was obtained from Super late variety.

2.2 Effect on nutrient uptake

Rana *et al*. (1992) conducted field experiment at Haryana Agricultural University, Hisar (Haryana) and revealed that the application of 80 kg P_2O_5 ha^{-1} gave significantly higher berseem forage as well seed yields over control and 40 kg P_2O_5 ha^{-1}.

Sheoran *et al*. (1992) conducted field experiment at Haryana Agricultural University, Hisar (Haryana) during *rabi* season of 1989-90 and 1990-91 and observed that forage and seed yields were increased significantly upto 120 kg P_2O_5 ha^{-1}, whereas, during next year yield were increased significantly only upto 80 kg P_2O_5 ha^{-1}.

Munde and Shelke (1993) conducted field experiment at Marathwada Agricultural University, Parbhani(Marathwada) to study the effects of irrigation schedules and phosphorus levels on uptake and crude protein content and found that phosphorus fertilization @ 80 kg P_2O_5 h^{-1} improved the uptake of N.

Sood *et al.* (1994) conducted field experiment at Himachal Pradesh Krishi Vishwavidyalaya, Palampur (Himachal Pradesh) during *Rabi* season of 1989-90 and 1990-91 and found that 75 kg P_2O_5 ha^{-1} was found to be the best dose of phosphorus and leaving the crop for seed production after taking two cuts of green fodder was proved to be the best cutting frequency from seed yield and total forage production point of view.

Sood and Kumar (1994) conducted field experiment at Himachal Pradesh Krishi Vishvavidyalaya, Palampur and shown that application of N and P fertilizer increased N and P concentrations and their uptake and increased K uptake but had less effect on K concentration of the plant.

Agarwal *et al*. (1995) conducted field experiment at College of Agriculture, Gwalior (Madhya Pradesh) and shown that protein P and S contents were significantly higher in cv. BL- 2 than Wardan at the initial growth stage but significantly higher in Wardan in later growth stages and increased with increase in S rates when 80 kg P_2O_5 ha^{-1} was applied.

Hamdard *et al*. (1995) conducted field experiment at Ayub Agricultural Research Institute, Faisalabad (Pakistan) and observed that NPK fertilizer decreased the moisture content, crude fiber and nitrogen free extract of the fodder dry matter and increased crude protein, mineral content and ether extract. K had no positive effect on crude protein content. The optimum response in terms of dry matter, crude protein and digestible crude protein yields was obtained with 22.5 kg N + 112 kg P_2O_5 ha^{-1}.

Jadhav *et al*. (1995) conducted field experiment at Punjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) and reported that green fodder yield, number of nodules and crude protein content increased with P_2O_5 application.

Mendhe *et al*. (1995) conducted field experiment at Nagpur Veterinary College, Nagpur (Maharashtra) and observed that application of 115 kg P_2O_5 ha^{-1} was adequate to produce higher tonnage of green fodder.

Sinha and Rai (1995) conducted field experiment at IARI, New Delhi during *Rabi* season of 1991-93 and reported that fodder yield increased up to 60 kg N + 150 kg P_2O_5 ha^{-1}.

Sharma and Paradkar (1995) conducted field experiment at Zonal Agricultural Research Station, Chhindwara (Madhya Pradesh) and observed that forage yield increased with rate of N application. Application of 225 g simazine at 60 DAS gave the highest forage yield.

Moawad *et al*. (1996) conducted field experiment at National Research Centre, Cairo (Egypt) and concluded that rock phosphate fertilization, Rhizobium and Mycorrhizae inoculation were practiced the highest green fodder yield, nodulation along with N and P content of plant were obtained at the second and third cuts.

Singh *et al*. (1996) conducted field experiment at Punjab Agricultural University, Ludhiana (Punjab) and reported that the response of berseem to 100 kg P_2O_5 ha^{-1} was curvilinear and decreased with increase in FYM rates. Crops showed significant response up to 75 kg P_2O_5 ha^{-1} without FYM and up to 50 kg P_2O_5 ha^{-1} with 7.5 to 15 t FYM.

Mani and Singh (1997) conducted field experiment at Narendra Deva University of Agriculture and Technology, Faizabad (Uttar Pradesh) and shown that plant height, number of shoots $plant^{-1}$, number of nodule $plants^{-1}$, root dry weight $plant^{-1}$, N and P uptake and yield of green forage, dry matter and crude protein increased significantly as P application rate increased to 35.2 kg ha^{-1}.

Patel (1997) conducted field experiment at College of Veterinary Sciences, Anjora (Madhya Pradesh) and shown that berseem grown in rows 30 cm apart with 25 kg K_2O ha^{-1}, the fodder dry matter yield increased up to 30 kg N ha^{-1} and up to 90 kg P_2O_5 ha^{-1}. Further Patel (1998) conducted field experiment and found that berseem green fodder yield was 25.6, 39.0, 42.2 and 43.1 t ha^{-1} with 0, 15, 30 and 45 kg N ha^{-1}, respectively. P fertilizer rates of 0, 30, 60 and 90 kg P_2O_5 ha^{-1} produced green fodder yield of 33.0, 36.4, 39.1 and 41.5 t ha^{-1}, respectively.

Singh and Prasad (1997) conducted field experiment at Ranchi Veterinary College, Ranchi (Jharkhand) and cv. Wardan were given 0, 13.2, 26.4 or 39.6 kg P_2O_5 ha^{-1}. Green forage and dry matter yields were not significantly different between legume cultivars, but increased with increasing P rate.

Choubey and Bhagat (1998) conducted field trial at Birsa Agricultural University, Ranchi (Bihar) and revealed that green forage and dry matter yield of berseem were increased by lime and by 60 kg P_2O_5 ha^{-1}.

Mandal and Chakraborty (1998) conducted field trial at Institute of Agriculture, Visva Bharate, Sriniketan (West Bental) and reported that the maximum P rate (80 kg ha^{-1}) were the most effective for increasing plant height, growth, root nodules dry weight and fresh fodder yield with the best source whey treated rock phosphate followed by super phosphate. Further shown that dry matter content and uptake of N, P and K were increased with increasing P rate from 0 to 150 kg P_2O_5 ha^{-1}.

Sharma *et al*. (1998) conducted field experiment at RAU Agriculture Research Station, Durgapura, Jaipur (Rajasthan) and shown that berseem produced mean green forage yield (total of 5 cuts) of 85.4 and 93.0 t ha^{-1} with 0 and 30 t FYM ha^{-1}, 86.7 and 91.8 t with 0 and 20 kg N and 82.6, 90.1 and 95.0 t with 0, 45 and 90 kg P_2O_5 ha^{-1}, respectively.

Rao *et al*. (1999) conducted field experiment at Indian Institute of Soil Science, Bhopal (Madhya Pradesh) and showed that significant increase in crop

Yield up to150 K_2O ha^{-1} in the first harvest. In the second harvest, a significant response was obtained up to 150 kg K_2O ha^{-1} in berseem crop.

Sardana *et al*. (2001) conducted field experiment at Haryana Agriculture University, Hissar (Haryana) and found that rhizobium seed inoculation and application of 25 kg N ha^{-1} improved crude protein and ash content but adversely affected the acid and neutral detergent, fibre contents and nitrogen free extract value of both in fodder and straw. Application of 80 kg P_2O_5 significantly increased the ether extract, crude fibre, ash, hemicellulose and protein content of fodder cuttings.

Sohail Ahmad *et al.* (2001) investigated the effect of five agronomic treatments: control, T1; seed scarification, T2; P fertilizer application, T3; *Rhizobium* inoculation, T4; and P fertilizer application + *Rhizobium* inoculation, T5, on the yield and nutritive value of barseem fodder (*Trifolium alexandrinum L.*) Fodder DM yield (DMY) was significantly affected by treatments and cuts and was 7.6, 9.1, 9.3, 9.4 and 9.8 t ha^{-1} with T1, T2, T3, T4 and T5, respectively. All treatments were effective in increasing the DMY over the control, with a maximum yield recorded from treatments T4 and T5. Fodder nitrogen contents significantly varied due to treatments and cuts and the mean values were 3.01, 2.80, 2.90, 2.91 and 2.94 with treatments T1, T2, T3, T4 and T5, respectively. Fodder nitrogen contents remained higher up to the third cut (2.85-3.14 g 100 g^{-1} dry matter) and declined at the fourth and fifth cuts (2.61-2.85 g 100 g^{-1} dry matter). Berseem *in vitro* dry matter digestibility (IVDMD) was affected by treatments and cuts. A significant interaction of treatments x cuts revealed that treatments affected IVDMD only at the first and third cuts. IVDMD decreased with the advancement

of cuts in all treatments and declined from 72.8% in the first cut to 59.8% in the fifth cut. P application did not improve fodder P contents and averaged 0.21 g 100 g^{-1} dry matter.

Malik *et al*. (2002) conducted field experiment at Egypt-finland Agricultural Research Project, Ismailia (Egypt) and shown that foliar mineral fertilized berseem treatments 0.75 per cent 19:19:19 and 1 per cent 19:19:19 significantly increased forage dry matter, digestible crude protein and total digestible nutrients yield were higher than those of control treatment.

Bhilare and Desale (2003) conducted field experiment at Forage Crops Research Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) during *Rabi* seasons of 1994- 95 to 1996-97 and reported that the application of 100 % of recommended NPK recorded maximum and significantly higher green foliage, dry matter and crude protein yield on the other hand significantly higher yields of green forage and dry matter were obtained with the application of 20 kg S ha^{-1}.

Tiwana and Puri (2003) conducted field experiment at Punjab Agricultural University, Ludhiana (Punjab) and reported that 100 per cent RDF produced significantly higher green fodder and dry matter yield of berseem over 50 per cent RDF but was at par with 75 per cent RDF.

Sharma and Sharma (2004) revealed that the application of N & P significantly increased green fodder yield of berseem over N alone by 60-98 q ha^{-1}, dry matter yield by 7-12 q ha^{-1}, N uptake by 15-45 kg ha^{-1}, P uptake by 7-9 kg ha^{-1}, K uptake by 13-20 kg ha^{-1}, whereas application of N K registered an increase of 66-70 q ha^{-1} in green fodder yield, 8.0-8.4 q ha^{-1} in dry matter yield, 14-35 kg ha^{-1} in N uptake, 5.3-5.6 kg ha^{-1} in P uptake, 10-11 kg ha^{-1} in K uptake, over N alone. whereas NPK+ FYM combination resulted an increase of 21-32 q ha^{-1} in green fodder yield, 3-4 q ha^{-1} in dry matter yield, 8-14 kg ha^{-1} in N uptake, 7-9 kg ha^{-1} in P uptake, 27-31 kg ha^{-1} in K uptake over NPK combination.

Kumar *et al*., (2007) reported that berseem crop responded well to application of manures, fertilizers and bio fertilizers. The growth parameters were significantly higher when the crop fertilized with 50 % N through FYM and 50 % NPK through inorganic fertilizers, however the L: S Ratio and root nodules were

significantly higher with T2 (100 % NPK inorganic) and T6 (25 % N through FYM + 50 % NPK inorganic fertilizers + *Rhizobium* application.

Tomar (2009) conducted an experiment during the winter seasons of 2001 and 2002 to assess the influence of phosphorus and farmyard manure on the nutrient content and uptake by berseem. Basal application of P at 80 kg P_2O_5 ha^{-1} to berseem increased the N and P content in green fodder during all the cuts, seed and straw yield during both the year. Incorporation of 10 t FYM brought about a significant improvement in nitrogen and phosphorus contents in green fodder, seed and straw yields and their uptake through respective produce of berseem.

Soleymani *et al.* (2011) conducted an experiment in 2010, at Research Farm, Faculty of Agriculture, Islamic Azad University, Khorasgan Branch (Isfahan) with three cultivars of berseem clover as cover crops with different levels of nitrogen starter fertilizer. Cultivars were Karaj, Sacromont and Multicut, and nitrogen levels were 0, 40 and 60 kg ha^{-1}. The nitrogen fertilizer was provided from urea source (46% pure N). The effect of nitrogen was significant on potassium, and organic matter percentage and Fe and Mn content. Application of N 40 kg ha^{-1} was necessary. The maximum Mn and P percentages were also obtained by application of N 60 kg ha^{-1}. Sacromont had the highest contents of phosphorus, potassium and organic matter. Nitrogen application management and appropriate cultivar appeared to be important parameters for obtaining high forage quality yields and high nutritive value for each cultivars of berseem clover in semi arid regions.

Saeed *et al.* (2011) was conducted an experiment the Research Farm of Khyber Pakhtunkhwa, Agricultural University Peshawar, Pakistan during the cropping season of 2004 to 2005 and recorded that maximum forage yield under (6077 kg ha^{-1}) and dry forage yield (156.83 kg ha^{-1}) with the application of 60 kg P ha^{-1} x 30 kg K ha^{-1} levels.

Chintapalli *et al.* (2012) was found maximum mean plant height (13.1 cm) and fresh forage yield (16780 kg ha^{-1}) in plots treated with FYM + Rhizobium + PSB + *Azotobacter.*

Basanthi *et al. (*2012b) reported that application of farm yard manure + Rhizobium + phosphate solubilizing bacteria + Azospirillium resulted in maximum plant height (13.1

cm at 35 DAS), fresh forage yield (16780 kg ha^{-1}), maximum length of head (2.7 cm), maximum number of flowers per head (83 flowers $head^{-1}$) and maximum seed yield (387.2 kg ha^{-1}).

Dinesh Nargesh (2012) reported that total forage yield, treatment N-90kg, P-80kg also produced maximum green fodder yield (569.72 q ha^{-1}) which was significantly higher over N-30kg, P-40kg and vermicompost @ 4 t ha^{-1}.

Jan, B. *et al.* (2014) an experiment was conducted and found that Berseem crop uptake maximum plant N of 173 kg ha^{-1} and Maximum P 17.47 kg ha^{-1}

El-Karamany, *et al.* (2014) an experiment were conducted during winter season of 2012/2013 and 2013/2014 at research and production station of National Research Centre, Al Nubaria district, Al Behaira Governorate, Egypt and found that treatments of 60 kg ha^{-1} N-fertilizer produced the best forage yield 20.48 ton ha^{-1}.

Valiki *et al.* (2015) A field experiment was carried out in 2012 at agriculture research field of Qaemshahr, Iran, and found that the highest plant height with 177.83 cm, leaf fresh weight with 117.75 gm^{-2} , shoot fresh weight with 385.5 g m^{-2} and forage fresh yield with 500.33 g m^{-2} was applied by of 50 kg ha^{-1} pure nitrogen.

Singh *et al.* (2016) recorded berseem responded to phosphorus fertilization up to 100 kg P_2O_5 ha^{-1}. Application of 100 kg P_2O_5 ha^{-1} brought out an increase of 21.8 and 9.0 percent in green fodder, and 28.4 and 12.1 percent in dry matter over 60 and 80 kg P_2O_5 ha^{-1}, respectively.

Roy *et al*. (2016) conducted A field experiment during *Rabi* season for two consecutive years of 2013-14 and 2014-15 and found higher yields of better quality green forage of berseem (32.18 t ha^{-1}))were obtained in inoculation with PSB with phosphorus application of 80 kg P_2O_5 ha^{-1}.

Kumar *et al.* (2017) was reported berseem should be fertilized with 10 t ha^{-1} FYM + 30 kg sulphur + 4 kg boron + 1 kg molybdenum ha^{-1} in place of chemical fertilizer for higher productivity and quality of berseem herbage. Application of 20 kg N + 60 kg P + mixture of *Rhizobium trifolii* and phosphate solubilizing bacteria (PSB) recorded highest green fodder (65.45 t ha^{-1}), dry matter yield (16.98 t ha^{-1}) and protein content (19.7%) of berseem.

Pal *et al.* (2017) reported that application of 10 t ha^{-1} FYM along with sulphur, boron and molybdenum had higher plant height, leaf : shoot ratio, green and dry forage yield and also crude protein production of berseem than application of both treatments either 100 per cent RDF (inorganic source) or RDF + FYM @ 5 t ha^{-1} + S + Mo + B and recommended that the berseem should be fertilized with 10 t ha^{-1} FYM + 30 kg sulphur + 4 kg boron + 1 kg molybdenum ha^{-1} in place of chemical fertilizer for higher productivity and quality of berseem herbage.

Kumawat *et al.* (2017) was found maximum dry matter yield of berseem is 28 q ha^{-1} with application of 60 kg P ha^{-1}; while maximum GFY (143 qha^{-1}) was found at 80 kg P_2O_5 ha^{-1} dose.

Nand *et al.* (2018) an experiment was conducted during winter season of 2016-17 on Berseem (cv. Mescavi) and to be recorded the maximum plant height (46.9 cm) and fresh weight of leaf (58.4 g m^{-2}) at different cutting stages with the application of 100% RDF (20 kg N + 80 kg P_2O_5 ha^{-1}).

Leghari *et al.* (2018) was found the combination of 70:100:30 kg NPK ha^{-1} also produced good performance with a better plant height 71.1 cm, leaves plant $^{-1}$- 87.0, branches $plant^{-1}$ - 30.0, plant weight 15.3 gm and fodder yield 58.60 t ha^{-1}.

Shahrajabian *et al.* (2019) reported that increasing the nitrogen fertilizer application rate from 10 to 70 kg N ha^{-1} resulted in numerically increased plant height, total fresh and dry yield. Maximum nitrate, protein, potassium, organic matter, ash and Zn levels were obtained in an application of 70 kg N ha^{-1}.

Devi and satpal (2019) recorded all the growth parameters, green fodder as well as dry matter yield and average crude protein content and yield increased with increasing levels of phosphorus. Highest green fodder yield, dry matter yield,

average number of tillers per square foot and plant height were recorded with application of 100 kg P_2O_5 ha^{-1} which was at par with 80 kg P_2O_5 ha^{-1} but significantly superior to 60 kg P_2O_5 ha^{-1}.The quality of berseem fodder in terms of crude protein content and crude protein yield increased significantly up to 100 kg P_2O_5 ha^{-1}. For ensuring maximum fodder yield, quality and economics, berseem crop can be fertilized with 100 kg P_2O_5 ha^{-1}.

Singh *et al.* (2020) recorded berseem varieties, uptake of primary nutrients N, P_2O_5 and K_2O were found non-significant, however, it ranged between 219.64-291.52, 67.28 - 80.77 and 133.76-185.54 kg ha^{-1}, respectively. Ca uptake was significantly higher for HB-2 (154.35 kg ha^{-1}) than Mescavi, BB-3, BB-2, BL-10 and JB varieties. Lowest Ca uptake was recorded for BB-3 (107.27 kg ha^{-1}). Magnesium and sulphur uptake differed non-significantly among varieties but varied between 36.60- 46.42 and 22.06 - 28.97 kg ha^{-1}, respectively Zinc uptake was found to be significantly higher for HB-2 (434.39 g ha^{-1}) but at par with BL-42 (341.82 kg ha^{-1}) and BL-1 (342.41 kg ha^{-1}) varieties. Similarly, Mn uptake was also significantly higher for HB-2 (661.70 g ha^{-1}) in comparison to Miskawi, BB-2, BB-3 and Wardan varieties.

Kumar *et al.* (2021) was observed berseem responded to phosphorus fertilization up to 100 kg P_2O_5 ha^{-1}. Application of 100 kg P_2O_5 ha^{-1} improved the yield (green fodder yield, dry matter yield and crude protein content) to maximum but it was on a par with 80 kg P_2O_5 ha^{-1}.

Akram *et al.* (2022) conducted field experiment Agricultural Research Station, Bahawalpur, Pakistan was recorded maximum fodder yield (82tons ha^{-1}) that use PK fertilizer @ 60:30kg ha^{-1} found optimal rate of application for better growth and yield of berseem crop. Further Akram *et al*. (2022) found that highest crop growth rate (5.20g m^{-2} $day^{-1)}$, Leaf Area Index (2.17), plant height (76cm), fodder yield (82tons ha^{-1}) were estimated in PK were applied @ 60:30kg ha^{-1} compared to all other fertilizer doses.

2.3 Effect on green forage and yield

Barik and Mukherjee (1990) conducted field experiment at B.C. Krishi Viswavidyalaya, Kalyani (West Bengal) and reported that sowing in late

November or in 2nd week of December produced yield of 65 and 60 t ha^{-1} yield were similar with the sowing rate of 35 kg ha^{-1} and P rate of 120 kg ha^{-1}.

Karwasra and Anil Kumar Gupta (2006) recorded significantly higher green forage yields (907.1 q ha^{-1}) compared with the yield (815.69 q ha^{-1}) obtained without application of phosphorus.

Faridullah *et al*. (2008) was recorded Maximum plant height of 79.83cm recorded in Agaiti berseem, 79.80cm in Juglote local and 71.16 cm in Pachaiti. The maximum number of tillers was obtained by Juglote local with 175 while the lowest was attained by Pachaiti with 149. The Stem thickness for all varieties ranged from 0.5cm to 0.58cm. More number of leaves was observed from Juglote local with 144.9 while minimum number of leaves was observed from Pachaiti berseem.

El kramany *et al.* (2012) was conducted two field experiment during winter seasons of 2010/2011 and 2011/2012 in The Research and Production Station of National Research Centre, , Egypt and found that maximum total forage yield 82.06 ton ha^{-1} as summation of 3 cuts 60, 90 and 120 DAS.

Jan, B., *et al.* (2014) An experiment was conducted Department of Soil and Environmental Science, University of Agriculture, Peshawar, Pakistan and found that maximum shoot dry matter yield of 4333 kg ha^{-1}.

Singh *et al.* (2016) a field experiment was conducted at CCS Haryana Agricultural University, Hisar (Haryana). The highest average number of tiller m^{-2} (849.92) and plant height (65.31 cm) were recorded in JB-04-21 which was on par with all the other genotypes except Wardan.

Pal *et al.* (2018)) was found maximum Green forage yield 2313 q ha^{-1} and Dry matter yield 366 q ha^{-1} under Conventional tillage with 3 cultivation .

Pal *et al.* (2019) conducted an experiment during two winter seasons of 2013-14 and 2014-15 at G.B. Pant University of Agriculture and Technology, Pantnagar and to be recorded maximum green forage yield 22.1 and 47.4 t ha^{-1}, Dry forage yield 3.20, and 6.13 t ha^{-1}.

Devi and satpal (2019) was recorded the green fodder yield as well as dry matter yield (687.08 and 93.28 q ha^{-1}, respectively) highest with the genotype JB-05-9, which was at par with all other genotypes like Mescavi and PC-82 except Bundel Berseem- 2.

Devi and satpal (2019) CCS Haryana Agricultural University reported that maximum average number of tillers $foot^{-2}$ (47.89) recorded in Wardan, which was at par with all the entries *viz.*, JB-05-9, Mescavi and PC- 82 except Bundel Berseem-2. However, the lowest number of tillers $foot^{-2}$ (43.61) was recorded with the genotype Bundel Berseem-2. The maximum plant height (57.96 cm) and lowest plant height (53.25 cm) was recorded with JB- 05-9 and Bundel Berseem-2 genotypes, respectively.

Singh *et al.* (2020) recorded plant height at harvest higher for BL- 1 (54.59 cm) that was significantly higher than national check variety Wardan, BB-3, BB-2, JB- 1 and HB- 2. Lowest plant height at harvest was observed in variety Wardan (49.72 cm). Significantly higher dry matter (DM) content was recorded for variety BB- 2 (21.73 %) while lowest DM content was recorded for JB-1 (17.79 %). DM content in variety BB-2 was found to be significantly higher than BL- 42, JB- 1, JB-5 and HB-2.

Gondal *et al.* (2021) conducted a field experiment at Fodder Research Institute, Sargodha, Pakistan reported that variety super late given highest fodder yield 143.69 q ha^{-1} to other variety (Agaiti and Punjab berseem).

Kumar *et al.* (2021) was found total green fodder (582.6 q ha^{-1}) and dry matter (80.5 q ha^{-1}) maximum in JHB-17-1 which was significantly higher than variety JHB-17-2, BB-2 (ZC), PC-91 and Wardan (NC). The per day productivity of green (3.86 q $ha^{-1}day^{-1}$) and dry fodder (0.53 q ha^{-1} day^{-1}) were recorded highest with entry JHB-17-1 which was significantly higher than all other variety.

2.4 Effect on quality

Munde and Shelke (1993) conducted field experiment at Marathwada Agriculture University, Parbhani (Maharashtra) and reported that an increase of green forage to the tune of 6.65 and 10.20 per cent, dry matter 8.46 and 14.77 per

cent and crude protein yield 8.97 and 16.47 per cent were observed by application of 75 and 100 per cent recommended dose of NPK over 50 per cent recommended dose.

Tiwana and Puri (2003) conducted field trial at Punjab Agricultural University, Ludhiana (Punjab) to see the response of berseem to sulphur under different fertilizer levels and reported that the crude protein content in berseem increased from 18.1 to 22.3 per cent with recommended dose of fertilizer.

Gaikwad (2009) was reported maximum crude protein yield was recorded in 75 per cent Recommended dose of fertilizer + two foliar sprays, followed by 50 per cent recommended dose of fertilizer + two foliar sprays Of 1 per cent 19:19:19 water soluble fertilizer, first 10 days After first cut and second 10 days after second cut.

El kramany *et al.* (2012) was conducted two field experiments during winter seasons of 2010/2011 and 2011/2012 and observed that maximum Protein content of berseem is 15.85%.

Dinesh Nargesh (2012) reported Application of higher levels of N-P levels (N90 kg, P80kg) showed significantly higher nutrient (N and P)and protein content in green fodder which was significantly superior over N30 kg, P40kg but statistically at par with vermicompost @ 4 t ha^{-1} 1 and N60 kg, P60kg treatments.

El-Karamany, M.F. *et al.* (2014) an experiment were conducted and found that maximum Protein content (%) in 15% at 60 DAS and 15.53% at 100 DAS.

Salama, H.S.A. *et al.* (2015) conducted an experiment during winter season of two successive years (2012 and 2013) in the station of SEKEM organic farm, Egypt and found that maximum Crude Protein (CP) Content 199.05g kg^{-1} in the berseem crop.

Singh *et.al* (2016) recorded highest total crude protein yield (17.2 q ha^{-1}) and total digestible dry matter yield (68.8 q ha^{-1}) were recorded in BB-2 which were significantly superior over JB-04-23. Significantly highest crude protein content (18.12%), IVDMD (70.07%), total crude protein yield (18.56 q ha^{-1}) and total digestible dry matter yield (72.91 q ha^{-1}) were also recorded with the

application of 100 kg P_2O_5 ha^{-1}. It was observed that with the increasing level of phosphorus, the content of structural carbohydrates decreased. At 60 kg ha^{-1}, highest level of NDF, ADF, hemicellulose, cellulose and lignin were observed.

Abd El-Naby *et al.* (2016) was recorded maximum content of Crude Protien is 18.91%, maximum crude fiber (CF) content 26.05%, crude protein yield (CPY) 1.84 t fad^{-1}.

Shrivastava *et al.* (2017) conducted an experiment during *Rabi* season of 2017-18 at experimental block of Murjhad farm, College of Agriculture, Balaghat, Madhya Pradesh, India to evaluate crude protein content, dry matter digestibility and crude protein yield was highest in berseem than other crops. Crude protein yield was increased 19.53, 52.23 and 28.71 % at 3^{rd} cutting and 15.32, 50.54 and 24.19 % at 4th cutting in berseem crop over makkhan grass, oat and local rye grass, respectively.

Kumawat *et al.* (2017) was found Maximum crude protein content on berseem variety AVTB 2-3 (17.63%) and crude protein yield (4.95 q ha^{-1}) among the variety AVTB2-1, AVTB2-2, AVTB2- 4 and AVTB2-5.

Roy *et al*. (2016) conducted A field experiment during *Rabi* season for two consecutive years of 2013-14 and 2014-15 and recorded maximum dry matter (DM)12.32%, Crude Protein (CP) 19.33% , CP yield 0.769 t ha^{-1}.

Pal *et al.* (2018) conducted an experiment during 2009-10 and 2010-11 at Instructional Dairy Farm, G.B. Pant University of Agriculture & Technology, Pantnagar and found maximum crude protein production 31.7 q ha^{-1} $year^{-1}$.

Pal *et al.* (2019) conducted an experiment during two winter seasons of 2013-14 and 2014-15 at G.B. Pant University of Agriculture and Technology, Pantnagar and to be recorded maximum Crude protein yield 0.63 and 1.20 t ha^{-1}.

Celal Yücel (2019) Department of Field Crops, Faculty of Agriculture, University of Sirnak, Turkey reported that In the first and second year of the experiments, green herbage (GH) yields varied respectively between 53.3-79.7 and between 22.7-32.3 t ha^{-1}; dry matter (DM) yields varied respectively between 7.26-12.02 and 5.16-7.42 t ha^{-1}; crude protein (CP) ratios varied respectively between

11.37-15.39 and between 15.22-18.88%; digestible dry matter (DDM) ratios varied respectively between 61.10-68.08 and between 56.84-67.70%, acid detergent fiber (ADF) ratios varied respectively between 27.22- 41.45 and between 23.07-31.41%; relative feed values (RFV) varied respectively between 99.3-155.0 and between 146.5-190.5. In both years, genotypes 3, 8, 15, 16, 17 and 18 had greater DM yields than the standard cultivar and the other genotypes. These genotypes were also prominent for herbage quality attributes. Genotype 18 was registered under the name of "DERYA" in 2015 and the other promising genotypes are still being used in on-going breeding studies.

Devi and Satpal (2019) the maximum crude protein yield (19.98 q ha^{-1}) was recorded with JB-05-9 which was on a par with all the variety Wardan, Mescavi, PC- 82 and Bundel Berseem-2.

Mofeeda A. *et al.* (2020) was found that The genotype Pop.46 had maximum values of crude protein content is 16.92 % across all genotypes Pop.1,Pop.2, Pop.3, Serw3, Pop.6, Pop.10, Helaly, Sakha 4, Serw 1, Gemmiza 1 and Giza 6.Variety (16.92 and 11.80%).

Singh *et al*. (2020) recorded crude protein (CP) content significantly higher for HB-2 (17.93 %) as compared to Wardan, BB-3, BB-2, BL- 1, BL-42, JB-1 and Mescavi. Lowest crude protein content was recorded for BB-3 (15.80 %). Crude fiber (CF) content was found significantly higher in BL-1 (23.30 %) as compared to Wardan (20.17 %), BB-3 (20.38 %), BB-2 (20.70 %) and JB-5 (20.26 %) varieties. Lowest CF fraction was recorded in national check variety Wardan (20.17%). Miskawi (2.15 %) recorded higher crude fat content but statistically at par with JB-5 (2.04), BB-3 (1.94), Wardan (1.92) and BL-1 (1.89) varieties and significantly higher in comparison to many notified varieties *viz*. BB-2 (1.60 %), BL-10 (1.74 %), BL-42 (1.87 %), JB-1 (1.58 %) and HB-2 (1.83 %).

Kumar *et al.* (2021) was recorded maximum crude protein content (20.78%) in variety Bundel Berseem-2 which was significantly higher than PC-91 and Wardan, whereas crude protein yield (16.72 q ha^{-1}) was significantly higher with JHB- 17-1 than. variety JHB-17-2, BB-2 (ZC), PC-91 and Wardan (NC).

Gondal *et al.* (2021) was recorded highest crude protein yield (2.913 t ha^{-1}) observed when Pendimethalin was applied 4 DBS, followed by application of Pendimethalin 2 DBS (2.813 t ha^{-1}).

2.5 Effect on economics

Yadav *et al.* (1988) conducted field trial at Indian Grassland and Fodder Research Institute, Jhansi (Uttar Pradesh) and found that the production cost of berseem fodder in farmers field was Rs. 2242.80 ha^{-1} and Rs. 37.00 $tonne^{-1}$.

Singh *et al.* (2002) conducted field experiment at National Dairy Research Institute, Karnal (Haryana) and found that average cost of production (Rs q^{-1}) of green fodder, dry matter, total digestible nutrients and crude protein were 12.12, 90.70, 165.88 and 466.93, respectively.

Jain and Poonia (2002) conducted field experiment at Agricultural Research Station, Rajasthan Agricultural University, Navgaon (Rajasthan) and revealed that the highest berseem fodder productivity (65.4 t ha^{-1}) and gross monetary returns (Rs. 41200 ha^{-1}) was recorded when berseem was sown on 23rd October.

Gaikwad (2009) reported that maximum net monetary returns and benefit: cost ratio were Recorded with the application of 75 % of RDF + two foliar Sprays of 1 per cent 19:19:19 water soluble fertilizer, first 10 Days after first cut and second 10 days after second cut (Rs. 31676 ha^{-1} and 2.32, respectively).

Singh *et al.* (2016) recorded among genotypes, the maximum gross returns (Rs. 88984 ha^{-1}), net return (Rs. 32537 ha^{-1}) and B: C ratio (1.58) was fetched with JB-04-21 closely followed by BB-2. Among different P levels, maximum gross returns (Rs.91849 ha^{-1}), net return (Rs. 34,451 ha^{-1}) and B: C ratio (1.60) was fetched with the application of 100 kg P_2O_5 ha^{-1} and it was superior to lower doses.

Leghari et *al.* (2018) was found high net profit $1910.8 ha^{-1} were obtained from 70:100:30 kg NPK ha^{-1} + 12 irrigations.

Kumawat *et al.* (2017) conducted a field experiment at agricultural research station, skrau, bikaner on *Rabi* season of 2016-17 and found that maximum net

return on variety AVTB 2-3 (7644 Rs.ha^{-1}) and B:C ratio was (0.33).

Pal *et al.* (2018) conducted an experiment during 2009-10 and 2010-11 and found maximum Net return 90237 Rs ha^{-1} with B: C ratio 2.6 under Conventional tillage with 3 cultivations.

Pal *et al.* (2019) was recorded maximum Gross returns 45160 Rs ha^{-1} Net returns 31760 Rs ha^{-1} and B:C ratio 2.37 for first year and Gross returns 108460 Rs ha^{-1} Net returns 93460 Rs ha^{-1} and B:C ratio 6.23 for second year.

Devi and satpal (2019) recorded amongst genotypes, the maximum gross returns (Rs. 85,885 ha^{-1}), net return (Rs. 23,160 ha^{-1}) and B: C (1.37) was fetched with JB- 05-9.

Kumar *et al.*(2021) reported the maximum gross returns (Rs. 116527 ha^{-1}), net return (Rs. 51387 ha^{-1}) and B:C ratio (1.79) was found with variety JHB-17 1 among different phosphorus levels, maximum B: C ratio (1.70) was fetched with 100 kg P_2O_5 ha^{-1} followed by 80 kg P_2O_5 ha^{-1}.

Gondal *et al.* (2021) conducted an experiment Soil and Water Conservation Research Institute Chakwal, Pakistan and found highest gross income (Rs. 407362 ha^{-1}), net income (Rs. 192196 ha^{-1}) and B: C (1.89) from the treatment of Pendimethalin 4 DBS.

Gondal *et al.* (2021) recorded that berseem crop sown under broadcast sowing gave maximum net return of Rs. 283,250 ha^{-1} and Benefit: cast ratio is 3.51.

Akram *et al*. (2022) an experiment was conducted on Agricultural Research Station, Bahawalpur, Pakistan and found that application of PK @ 60: 30kg ha^{-1} PK in berseem is a profitable for net return (247967 Rs ha^{-1}) to the farmers.

CHAPTER - III
MATERIALS AND METHODS

The present investigation entitled **"Study on growth, fodder yield and quality of different berseem varieties (*Trifolium alexandrinum* L.) under Chhattisgarh plains"** was carried out during *Rabi* season of 2021 at Instructional cum Research Farm IGKV Raipur (C. G.). The present chapter deals with a brief description of the methods followed and materials used during the period of investigation.

3.1 Location of experimental site

The experiment was laid out Instructional cum Research Farm IGKV Raipur during *Rabi* season of 2021-22 and on 836.55 m^2 area having fairly uniform topography with adequate drainage. Raipur located at between $22^0$33'N to $21^0$14'N latitude and $82^0$6'E to $81^0$38'E longitude with an altitude of 298.15 meters from mean sea level, in Chhattisgarh.

3.2 Climatic and weather condition during crop season

The weather data were taken from the meteorological observatory, located at College of Agriculture, IGKV, Raipur during the experimental period. Raipur comes under the Chhattisgarh plains- agro climatic zone, and this Region comes under sub-humid with hot summer and cold winter. In general, the average weekly temperature in the summer season goes up to 40.8^{o}C and in the winter, at least up to 8.3^{o}C. The average annual rainfall of this region is 1292 mm and most of the rainfall (85-90%) is received from monsoon (June-September). A few showers are expected during winters and occasionally during summer months. The seasonal rainfall receiving 156 mm during cop season. Evaporation during November to April ranges from 1.3 mm- 8.9 mm, weekly average Sunshine 1.3- 8.9 hours, Relative humidity varies from 13%- 93.6%, weekly average wind speed ranges between 0.76- 5.60kmph. Weekly meteorological data of temperature, rainfall and RH recorded during the experimental period from 15th November to 15th April is given through Fig. 3.1 and appendix- A.

3.3 Physio-Chemical properties of soil

The soil of the experimental plot was clayey in texture. To determine the physical and chemical properties of the soil of experimental plot, eight soil samples were collected randomly with the help soil auger from different spots at the experimental field from a depth of 0-15 cm just before preparing the field for sowing. These soil samples were thoroughly mixed to make a composite sample. This composite sample was air dried, grinded and then sieved through 2 mm sieve. After that, it was analyzed in the laboratory with their used methods for determination different physico-chemical properties which are given in the Table 3.1

Table 3.1: Chemical properties of soil of the experimental field.

S.N.	Parameters	Analysis value	Rating	Method of estimation
1.	pH (Soil: water, 1:2.5)	7.9	Alkaline	Glass electrode pH meter (Piper, 1967) (1:2.5 soil: water suspension)
2.	EC (dsm^{-1} at 25°**C**)	0.192	Normal	Sytronics electrical Conductivity meter (Jackson, 1973) 1:2.5 soil: water supernatant solubridge
3.	Available nitrogen ($kg\ ha^{-1}$)	150.5	Low	Modified kjeldal method (Jackson 1967)
4.	Available phosphorus ($kg\ ha^{-1}$)	7.41	Low	0.5N sodium bicarbonate extractable P by Olsen's method (Olsen *et al*.,1954)
5.	Available potassium ($kg\ ha^{-1}$)	319.0	High	Neutral Normal Ammonium acetate extractable k (Jackson 1967)

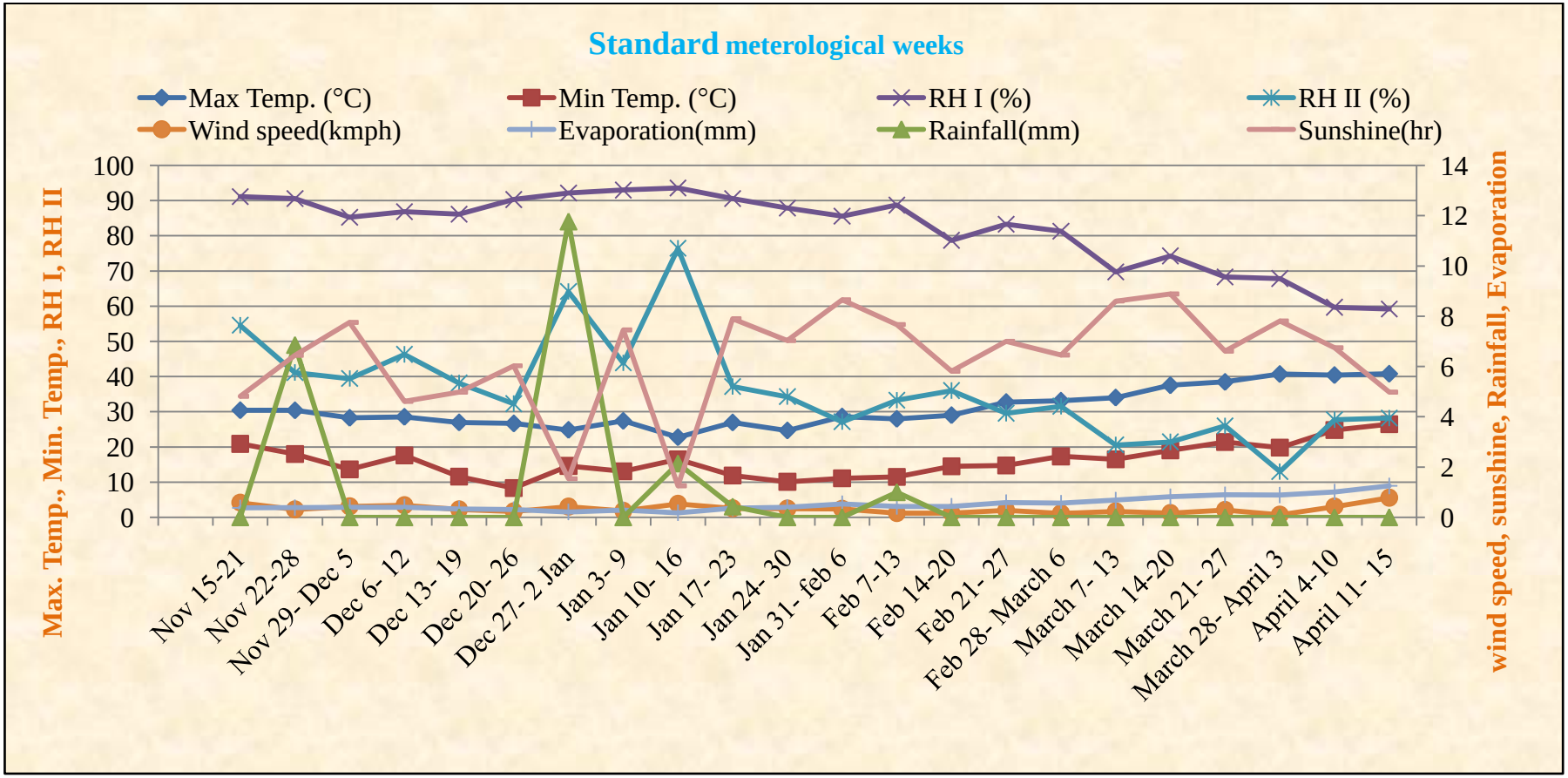

Fig. 3.1: Weekly meteorological data during crop period from 15 Nov 2021 to 15 April 2022

3.4 Cropping history of the experimental site

The experimental plot is the part of Agronomical Research Farm; where fodder crops are grown like Berseem, Pearl millet, Cow pea, Lathyrus, oats, fodder Sorghum and fodder Maize *etc*. On previous crop fodder maize was cropped during *Kharif* -2021. The cropping sequences followed past five years on the experimental plot before the research programmed given in Table 3.2.

Table 3.2: Cropping history of the experimental plot last five year.

Year	Season	
	Kharif	***Rabi***
2017-18	Fodder Maize	Fodder Oat
2018-19	Fodder Maize	Fodder Oat
2019-20	Fodder Maize	Fodder Oat
2020-21	Fodder Maize	Fodder Oat
2021-22	Fodder Maize	Berseem (Experiment)

3.5 Experimental details

Field experiment was conducted during *Rabi* season of 2021-22 at Instructional cum Research Farm, IGKV, Raipur (C.G.).

Table 3.3: Experimental details

Location	**:**	Instructional cum Research Farm IGKV Raipur (C. G.)
Season	**:**	*Rabi* -2021
Crop	**:**	Berseem (*Trifolium alexandrinum* L.)
Soil	**:**	*Vertisol*
Design	**:**	RBD
Number of replication	**:**	3
Number of treatment	**:**	12
Plot size	**:**	4.8 m x 3.5 m
Total number of plot	**:**	36
Row to row spacing	**:**	30 cm
Seed rate	**:**	25 kg ha^{-1}
Date of sowing	**:**	15/11/2021
Fertilizer	**:**	N-20 :P_2O_5 - 80:K_2O- 30 kg ha^{-1}
Cutting management	**:**	First cut 60 DAS, subsequent cut 30 days interval

3.6 Cultivar description

Wardan

This variety has been developed Indian Grassland & Fodder Research Institute, Jhansi in 1981. Average green fodder yield is 726.0 q ha^{-1}, dry matter yield-139.0 q ha^{-1}. It is recommended for Haryana, Punjab, Delhi, Uttar Pradesh, Bihar, Rajasthan, Himachal Pradesh, and Madhya Pradesh. This variety tolerant to bacterial wilt and other diseases under field conditions.

Bundel Berseem–2

This variety has been developed Indian Grassland & Fodder Research Institute, Jhansi in 1997. This variety is multicut in nature. Average green fodder yield 790.0 q ha^{-1}, dry matter yield- 110.0 q ha^{-1}. It is recommended for tropical and sub-tropical regions *i.e.* Punjab, Haryana, Uttarakhand, part of UP, MP and Maharashtra under irrigated conditions during Rabi season. Resistant to root rot, stem rot and to other major pests.

Bundel Berseem–3

This variety has been developed Indian Grassland & Fodder Research Institute, Jhansi in 2000. Average green fodder yield 560.0 q ha^{-1}, dry matter yield-90.0 q ha^{-1}. It is recommended for tropical and sub-tropical areas of Northeast zone including Eastern U.P., Bihar, Jharkhand, West Bengal, Orissa and Assam states during Rabi season. Moderately resistant to stem rot and root rot diseases and immune to downy mildew.

Jawahar Berseem - 1

This variety has been developed Jawaharlal Nehru Krishi Viswa Vidyalaya, Jabalpur (Madhya Pradesh) in 1981. Average green fodder yield870.0 q ha^{-1}, dry matter yield- 155.0 q ha^{-1}. It is recommended for Madhya Pradesh, Chhattisgarh and part of Bihar and Uttar Pradesh. This variety was High re-generation potential.

Jawahar Berseem - 5

This variety has been developed Jawaharlal Nehru Krishi Viswa Vidyalaya, Jabalpur (Madhya Pradesh) in 2004. Average green fodder yield 675.0 q ha^{-1}, dry

matter yield- 130.0 q ha^{-1}. It is recommended for Irrigated areas of MP, part of UP, Maharashtra, Gujarat and Chhattisgarh. This variety suitable for the late cutting (up to 15th April).

Hisar Berseem–1

This variety has been developed C.C.S., Haryana Agricultural University, Hisar, Haryana in 2005. Average green fodder yield 680.0 q ha^{-1}, dry matter yield- 142.0 q ha^{-1}. It is recommended for normal fertility and irrigated conditions of Haryana state. Being late in maturity, it supplies green fodder for longer period *i.e.*, up to end of June.

Hisar Berseem- 2

This variety has been developed C.C.S., Haryana Agricultural University, Hisar, Haryana in 2014. Average green fodder yield 785.0 q ha^{-1}, dry matter yield- 101.4 q ha^{-1}. It is recommended for normal fertility and irrigated conditions of Haryana state. Being late in maturity, it supplies green fodder for longer period *i.e.*, up to end of June

Berseem Ludhiyana- 10

This variety has been developed from Department of Plant Breeding, Punjab Agricultural University, Ludhiana in 1983. This variety is multicut in nature. Average green fodder yield 1050.0 q ha^{-1}, dry matter yield- 188.0 q ha^{-1}. It is recommended for sub temperate areas of the North and Central regions under irrigated conditions. It is comparatively more resistant to stem rot caused by *Sclerotinia spp*. It can supply green fodder up to 15th June

Berseem Ludhiyana- 42

This variety has been developed from Department of Plant Breeding, Punjab Agricultural University, Ludhiana in 2005. This variety is multicut in nature. Average green fodder yield 700.0 q ha^{-1}, dry matter yield- 122.0 q ha^{-1}. It is recommended for all over India under irrigated condition. It is resistant to stem rot caused by *Sclerotinia spp*.

Berseem Ludhiyana- 43

This variety has been developed from department of plant breeding, punjab agricultural university, ludhiana. The berseem variety BL-43 gives superior quality green fodder of 390 quintals per acre up to first week of june and also given higher seed yield.

Berseem Ludhiyana- 44

This variety has been developed from Department of Plant Breeding, Punjab Agricultural University, Ludhiana. Berseem variety BL 44 is a quick-growing variety with more tillers. BL- 44 out yielded the check variety BL- 43 by 5.9 per cent for green fodder yield and also possess better nutritional character.

3.7 Cultural operations

3.7.1 Land preparation

Weed free field is important for the berseem cultivation. The experimental field must be cleared from weeds after harvest of *Kharif* crop. Field was ploughed at 2 times by cultivator, and then it was leveled properly by tractor operated leveler. The irrigation channels were prepared around the plots to facilitate the irrigations. The furrow was opened manually with the help of *Kudali* to facilitate sowing of seeds and application of fertilizers.

3.7.2 Seed sowing

The sowing was done on 15th November 2021 by manual labour, opening furrow with the help of *Kudali*. 25 kg seed ha^{-1} was used for sowing and maintained 30 cm row to row spacing. After seed sowing, seeds were fully covered with soil.

3.7.3 Fertilizer application

Recommended dose of fertilizers *i.e.* 20 kg N was applied form of Urea, 80 kg P_2O_5 as SSP and 30 kg K_2O as MOP. Full dose of N, P and K was applied as basal dose.

R-I		R-II		R-III	
Wardan	HB-1	JB-5	BL-43	BL-44	JB-9
BB-2	HB-2	BL-44	BB-2	BL-43	JB-5
BB-3	BL-10	JB-9	HB-2	BL-42	JB-1
JB-1	BL-42	HB-1	Wardan	BL-10	BB-3
JB-5	BL-43	BL-42	BL-10	HB-2	BB-2
JB-9	BL-44	BB-3	JB-1	HB-1	Wardan

Season	- *Rabi*- 2021
Crop	- Berseem
Soil	- *Vertisol*
Design	- RBD
Replication	- 3
Treatment	- 12
Gross plot size	- 5m x 4m
Plot size	- 4.8 m x 3.5 m
Total number of plot	- 36
Distance between plots	- 0.75 m

Distance between Replication	- 1.0 m
Row to row spacing	- 30 cm
Seed rate	- 25 kg ha^{-1}
Date of sowing	- 15/11/2021
Fertilizer	- N: P_2O_5: K_2O 20: 80: 30 kg ha^{-1}
Cutting management	- First cut 60 DAS, subsequent cut 30 days interval

Fig. 3.2: Layout plan of experimental field

3.7.4 Irrigation

First irrigation was applied 15th November just after seed sowing to ensure proper germination and growth. Irrigation was applied just after each cutting and according to rainfall and crop requirement.

Table 3.4: Irrigation details:

S.N.	Irrigation No.	Date of irrigation	Days interval
1.	1st (After sowing)	15-11-2021	-
2.	2nd	06-12-2021	21
3.	3rd	25-12-2021	19
4.	4th	23-01-2022	29
5.	5th	08-02-2022	16
6.	6th	20-02-2022	12
7.	7th	17-03-2022	25
8.	8th	29-03-2022	12

3.7.5 Weeding

One hand weeding was done manually by labors at 25 days after sowing.

3.7.6 Harvesting

The harvesting of crop was done manually with the help of sickles at each cut *i.e.* first cut at 60 days after sowing , second cut at 30 days after first cut, for third cut management 30 days after second cut and fourth cut 30 days after third cut. The crop of net area was harvested from each plot separately. Then the fodder yield of each plot was recorded with the help of spring balance.

3.8 Crop studies

3.8.1 Growth parameter

3.8.1.1 Plant height

The height of plant was recorded from randomly in each plot and it was measured on the main shoot from the ground level to the base of well measured last leaf with the help of steel meter scale at 30, 60, 90, 120 and 150 days after sowing. This observation was recorded at just before each cut.

3.8.1.2 Number of trifoliate leaves plant $^{-1}$

The number of trifoliate leaves plant^{-1} was counted from randomly selected plant at each plot, counted just before each cut after that mean value was calculated and data expressed for plant^{-1}.

3.8.1.3 Number of shoots plant^{-1}

The number of tillers/ shoot plant^{-1} was recorded from randomly selected 5 plants at each plot just before each cut *i e* .30, 60, 90, 120 and 150 days after sowing and then mean value was calculated number of shoots plant^{-1}.

3.8.1.4 Fresh weight plant^{-1} at each cut

Fresh weight plant^{-1} at each cut was recorded randomly selected 5 plants from each plot *i.e.* 30, 60, 90, 120 and 150 days after sowing. Fresh weight plant^{-1} recorded and then means value was calculated.

3.8.1.5 Dry weight plant^{-1} at each cut

The dry weight plant^{-1} at each cut was recorded from 5 plants randomly selected from each plot *i.e.* 30, 60, 90, 120 and 150 days after sowing, and oven dried then recorded the dry weight plant-^{1}.

3.8.1.6 Leaf and stem fresh and dry weight plant $^{-1}$

Fresh and dry weight of leaf and stem each cut was randomly selected 5 plants from each plot. The leaf and the stem portions are separated and fresh weight of leaf and stem was separately recorded, after that the sample is put for oven for dried taking dry weight plant $^{-1}$.

3.8.1.7 Leaf: stem ratio

The leaf: stem ratio was recorded from 5 plants randomly selected in each plot at before each cut *i.e.* 30, 60, 90, 120 and 150 days after sowing. The leaf and stem portions were separated. Then separately recorded the dry weight of oven dried samples of leaf and stem, calculating leaf: stem ratio by dry weight of leaf was divided by the dry weight of stem.

$$\textbf{Leaf: stem ratio} = \frac{\textbf{Weight of oven dried leaves from the sample}}{\textbf{Weight of oven dried stem from the sample}}$$

3.8.2 Yield studies

3.8.2.1. Green fodder yield each cut and total

Green fodder yield (q ha^{-1}) each cut was recorded from each net plot area. It was converted into the yield in q ha^{-1} by multiplying with appropriate factor.

3.8.2.2. Dry fodder yield each cut and total

On the basis of dry matter content (%) was presence in respective varieties. The green fodder yield in q ha^{-1} was converted into dry matter yield in q ha^{-1}.

$$\text{Dry matter yield (q ha}^{-1}\text{)} = \frac{\text{Green fodder yield (q ha}^{-1}\text{)} \times \text{Dry matter content of treatment}}{100}$$

3.8.2.3. Productivity of green fodder each cut

Green fodder yield per day productivity was recorded from each plot. It was converted into the yield in q ha^{-1} of each cut by dividing with appropriate factor then divided by total number of days of crop.

$$\text{Productivity of green fodder (q ha}^{-1}\text{ day}^{-1}\text{)} = \frac{\text{Green fodder yield (q ha}^{-1}\text{)}}{\text{No. of days to harvest (day)}}$$

3.8.2.4. Productivity of dry fodder each cut

Dry fodder yield per day productivity was recorded from each plot. It was converted into the yield in q $ha^{-1}$of each cut by dividing with appropriate factor then divided by total no. of days of crop.

$$\text{Productivity of dry fodder (q ha-}^{1}\text{ day}^{-1}\text{)} = \frac{\text{Dry fodder yield (q ha}^{-1}\text{)}}{\text{No. of days to harvest (day)}}$$

3.8.3. Quality study

3.8.3.1. Crude protein yield at each cut and total

The dry matter yield in q $ha^{-1}$was converted into crude protein yield in quintal per hectare on the basis of crude protein content:

$$\text{Crude protein yield (q ha}^{-1}\text{)} = \frac{\text{Crude protein content (\%)} \times \text{Dry fodder yield (q ha}^{-1}\text{)}}{100}$$

3.8.3.2. Crude protein content at each cut

Oven dried samples of each plot was grinded into grinder to make powder and then analyze for N content (%). After this, N content (%) of produce from each plot converted into crude protein content (%) by multiplying with 6.25 factors.

$$\text{Crude protein content (\%)} = \text{N content X } 6.25$$

3.8.3.3. Dry matter content at each cut

By applying different treatments in green fodder the dry matter content was determined by taking 500 gram sample after each cut then oven dried and computed as given below:

$$\text{Dry matter content (\%)} = \frac{\text{Weight of oven dry sample} \times 100}{\text{Weight of green fodder sample}}$$

3.8.3.4. Nitrogen content

Preparation of plant samples for the determination of nutrient contents in plant samples was crashed. All the precautions were taken to avoid the contamination from other plant materials. The grinded plant materials were stored in the paper bags and used for further chemical analysis. Digestion Plant sample of 0.25 g of fine powdered was taken in 100 ml conical flask.5 ml concentrated nitric acid added to it and kept for overnight. On the next day, 10 ml of diacid mixture (HNO3 and HClO4 in 9:4) was added and digested in hot plate as described by Piper (1966). After digestion, known volume was prepared with glass distilled water and filtered. The same extract was used for the estimation of N, P, and K.

Total nitrogen in plant samples was determined using the nitrogen determination method used by Kjeldahl as defined by Jackson (1973). A powdered sample of 0.25 g with concentrated H_2SO_4 has been digested using this process in the presence of a salt mixture (K_2SO_4:$CuSO_4.5H_2O$ in the 10:1 ratio) and distilled

in an alkaline medium. The released NH3 was stuck in mixed indicator boric acid and titrated against normal Sulphamic acid (H_3NSO_3).

3.8.3.5. Phosphorus content

Phosphorous content in fodder was analyzed by digesting 1 gram plant sample with di-acid after that take 10 ml of digested sample and add 10 ml of yellow reagent then make up volume by 50 ml in conical flask with distilled waterand after that with the help of spectrophotometer (420nm) method as per as procedure suggested by (Ammonium vanadomolybdate yellow colour method Richard, 1968) take the readings precisely.

3.8.3.6. Potassium content

Potassium content in fodder was analyzed by digesting 1 gram plant sample with di-acid after that take 10 ml of digested sample is taken in the conical flask and make up volume by 50 ml with distilled water and take readings with the help of flame photometer.

3.8.3.7. Nutrient uptake (kg ha^{-1})

Uptake of N, P and K by fodder was estimated by following formula.

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient content (\%)} \times \text{Dry fodder yield kg ha}^{-1}}{100}$$

3.8.4. Computation

3.8.4.1. Crop growth rate (CGR)

Dry weight gained by a unit area in a given time is called Crop growth rate of a crop. It is expressed in g plant^{-1} day^{-1}. It was calculated between 0-30, 30-60, 60-90, 90-120 and 120- 150 days after sowing. It was calculated from the dry weight of plant taken at different time intervals.

$$CGR = \frac{W_2 - W_1}{(t_2 - t_1)}$$

Where, W_1 and W_2 are plant dry weight (g) at time t_1 and t_2 respectively.

3.8.4.2. Relative growth rate (RGR) (g g^{-1} day^{-1})

RGR was presented the increase of plant material per unit weight per unit time of a crop. It is expressed in g $g^{-1}day^{-1}$. It was calculated between 30-60, 60-90, 90-120 and 120-150 days after sowing. It was calculated from the dry weight of plant taken at different time intervals. By using the formula as suggested by Enyi (1962):

$$RGR = \frac{\ln W_2 - \ln W_1}{(t_2 - t_1)}$$

Where, In W_1 and $\ln W_2$ are natural logarithm of plant dry weight (g) at time t_1 and t_2 respectively.

3.8.4.3. Leaf mass fraction (LMF)

Leaf weight ratio is the measure of leaf biomass. It is the ratio of leaf mass and the total dry mass of plant.

$$LWR = \frac{\text{Mass of leaf}}{\text{Total mass of plant}}$$

3.8.4.4. Leaf production rate

Leaf production rate can be found by counting the number of leaves was presence at time interval on tagged plants. It is expressed in leaves day^{-1}.

$$LPR = \frac{L_{n2} - L_{n1}}{(t_2 - t_1)}$$

Where,

L_{n1} and L_{n2} number of leaves at time t_1 and t_2 respectively.

3.8.5. Economics

3.8.5.1. Cost of cultivation

The cost of cultivation of the crop was calculated by considering the current charges of agricultural operations and market price of inputs involved. The sum cost of cultivation involved in different inputs and agricultural operations to

raise the crop worked out on the basis of existing market price of the seeds, fertilizers, power, wages *etc.*

3.8.5.2. Gross monetary return

Gross return was computed by converting the harvest (green fodder) into monetary terms at the prevailing market price.

Gross return (Rs ha^{-1}) = Yield (q ha^{-1}) x Price of yield (Rs q^{-1})

3.8.5.3. Net monetary return

Net return was calculated by subtracting cost of cultivation from gross return.

Net return (Rs ha^{-1}) = Gross return (Rs ha^{-1}) - Cost of cultivation (Rs ha^{-1})

3.8.5.4. Benefit: Cost ratio

The benefit: cost ratio of crop was calculated by dividing gross return by cost of cultivation.

$$\text{Benefit: cost ratio} = \frac{\text{Gross return (Rs.ha}^{-1}\text{)}}{\text{Total cost of cultivation (Rs.ha}^{-1}\text{)}}$$

3.9. Statistical analysis

A statistical analysis was laid down by Gomez and Gomez (1984) for all the pre and post-harvest observations recorded during different crop period with respect to various growth, yield and laboratory studies. The importance of treatment effects were tested with variance ratio (f-value). Appropriate laid down errors and critical difference at 5% probability level was taken to test the statistical significance of the result.

Table 3.5: Analysis of variance (ANOVA) table was prepared in the following way for each character.

Source of variance	Degree of freedom	Sum of squares	Mean sum of squares	Computed F[b]	Tabular F (0.05)
Replication	r- 1	RSS	RMS=RSS/ df	RMS/ EMS	-
Treatment	t-1	TrSS	TrMS= TrSS/df	TrMS/ EMS	-
Experimental error	(r- 1)(t- 1)	ESS	EMS= ESS/ df	-	-
Total	rt-1	TSS	-	-	-

1) SEm (Standard error of mean)

$$SEm = \frac{\sqrt{EMS}}{r}$$

2) SEd (Standard error of difference)

$$SEd = \frac{\sqrt{2EMS}}{r}$$

3) CD (Critical difference)

CD = t value at error df x SEd

4) CV (Coefficient of variation)

$$CV\ (\%) = \frac{SD}{\bar{X}}\ X\ 100$$

Where,

SD = Standard deviation,

$\overline{X}$ = Mean of character

Plate 1– Sowing of different berseem crop

Plate 2– Re-growth of berseem crop

Wardan

Bundel Berseem-2

Bundel Berseem- 3

Jawahar Berseem-1

Jawahar berseem- 5

Jawahar Berseem- 9

Continue…..

Hisar Berseem- 1

Hisar Berseem- 2

Berseem Ludhiyana- 10

Berseem Ludhiyana- 42

Berseem Ludhiyana- 43

Berseem Ludhiyana- 44

Plate 3– Different berseem varieties at cutting stages

Plate 4 – Observation recorded of different berseem varieties

Plate 5– General view of the experimental field

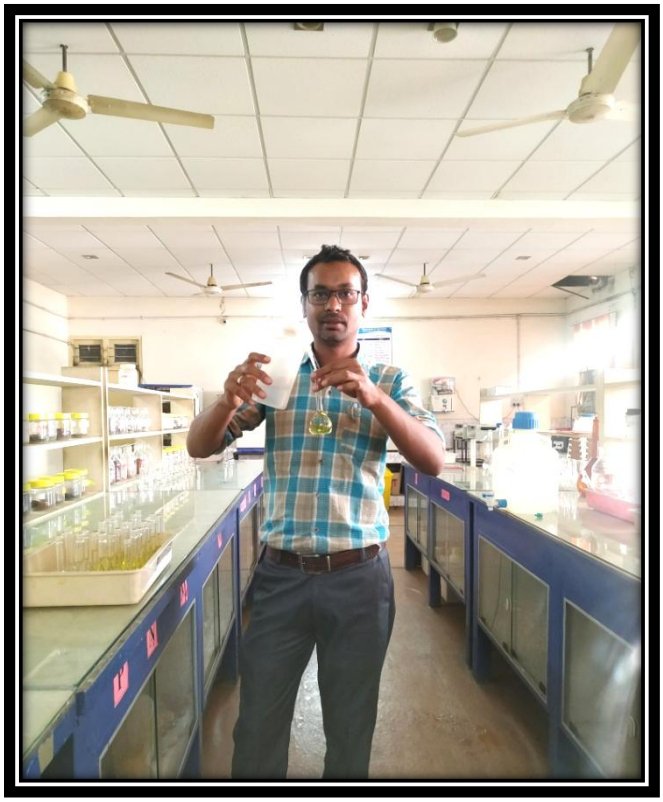

Plate 6– Quality analysis work at lab

CHAPTER - IV
RESULTS AND DISCUSSION

A field experimental was carried out during *Rabi* season of 2021 at the Research cum Instructional Farm IGKV, Raipur, (C.G.) entitled **"Study on growth, fodder yield and quality of different berseem varieties (*Trifolium alexandrinum* L.) under Chhattisgarh plains."** The data recorded on various aspects of crop growth, yield attributing characters and yield were statistically analysed and finding are presented and discussed with appropriate reasoning in this chapter.

4.1. Growth studies

4.1.1 Plant height

Data of plant heights (Table 4.1) of different berseem varieties is greatly affected by their genetic diversity. Berseem crop was harvested at 60, 90,120 and 150 days after sowing at each cut plant height depend up on the regeneration capacity of variety and growth pattern of particular variety. The plant height data indicates that the heights of all varieties of plants have increased gradually as the age of the crop progresses. The plant gained height at an accelerate rate between 30 to 90 days after sowing while at a relatively slower rate between 90 to 150 days after sowing. It was also found that if we consider plant growth rate in term of plant height, initial growth rate (height) from 30 days after sowing was found to be significantly highest on variety JB-9 (20.11 cm) which was at par with varieties JB-1, BL-43, BL-44, BB-3 and BB-2. At 60 and 90 days after sowing variety BB-3 was recorded maximum plant height (61.29 cm, 73.8 cm respectively). Among the varieties minimum plant height was recorded in variety BL-42 (52.44 cm, 57.5 cm respectively) followed by BL-44 (52.49 cm, 63.0 cm respectively). At 120 days after sowing variety JB-9 (72.1 cm) had gave highest plant height which was at par with variety JB-5, JB-1 and BB-3. At 150 days after sowing variety BB-3 (61.3 cm) had gave highest plant height and was at par with variety JB-9, JB-1, BL-43 and BB-2 and minimum plant height was recorded in BL-42 (51.67 cm) followed

by HB-2. The results that genetic variation can effect plant growth are in conformity with the findings of Cheptoo *et al.* (2020) and Kumawat *et al.* (2017). Significant variation among different berseem varieties for plant height also reported that Singh *et al.* (2020), Faridullah *et al* (2008). Akram *et al.* (2022) was found maximum plant height 76 cm and shortest plant height 47 cm. Plant height of particular variety depend on genetic makeup of variety and regeneration capacity of variety.

Table 4.1: Plant height of different berseem varieties at different time intervals

Treatments	Varieties	Plant height (cm)				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	18.04	55.20	67.1	64.60	55.31
V_2	BB-2	19.09	58.80	72.7	60.09	59.21
V_3	BB-3	19.91	61.29	73.8	71.56	61.30
V_4	JB-1	20.03	59.62	69.9	70.97	61.03
V_5	JB-5	17.55	55.89	65.6	68.65	55.02
V_6	JB-9	20.11	60.44	73.0	72.11	60.30
V_7	HB-1	17.95	57.88	66.1	54.17	53.71
V_8	HB-2	17.65	57.58	65.3	52.74	51.97
V_9	BL-10	17.42	53.76	66.4	53.63	52.34
V_{10}	BL-42	17.87	52.44	57.5	56.00	51.67
V_{11}	BL-43	19.36	53.77	68.6	60.52	57.23
V_{12}	BL-44	19.95	52.49	63.0	61.15	54.77
SEm ±		**0.58**	**1.58**	**1.95**	**2.60**	**1.48**
CD (P = 0.05)		**1.70**	**4.64**	**5.71**	**7.63**	**4.33**

4.1.2 Number of trifoliate leaves plant $^{-1}$

Data show in Table 4.2 reveals that there were significant differences in the number of trifoliate leaves among the various berseem varieties at 30, 60, 90, 120 and 150 days after sowing. Due to differing variations, the number of trifoliate leaves during the various growth phases varied greatly. As the crop's growth stages advanced under all varieties, the number of trifoliate leaves gradually increased. Maximum number of trifoliate leaves plant^{-1} produced by variety BB-2 (6.49) at 30 days after sowing followed by JB-9, BL-43, BL-44, BB-3 and JB-1. At 60 and 90 days after sowing variety BB-3 (47.47, 79.93 plant^{-1} respectively) was significantly produced maximum number of trifoliate leaves, which was at par with variety BB-

2, JB-9 and JB-1. At 90 days after sowing variety BB-3 significantly produced maximum number of trifoliate leaves and was par with BB-2 and JB-1. Whereas, produce minimum number of trifoliate leaves plant^{-1} by variety BL-42 (30.37, 55.00) at 60 and 90 days after sowing respectively. At 120 days after sowing (or just before the third cut) variety JB-9 (53.53) had significantly highest number of trifoliate leaves which was par with JB-5, JB-1, HB-1, HB- 2 and BB-3 varieties. Whereas, minimum number of trifoliate leaves plant^{-1} recorded in variety Wardan (39.55 plant^{-1}). At 150 days after sowing variety JB-9 (45.43 plant^{-1}) had gave maximum number of trifoliate leaves, which was at par with JB-, BB-3 and BB-2 varieties. Whereas, minimum number of trifoliate leaves was recorded in BL-43 (34.43 plant^{-1}) followed by HB-1. Similar significant difference for trifoliate leaves was also reported by Leghari *et al.* (2018) and Tomar (2009). Production of trifoliate leaves is the function of varietal characteristics which is ultimately reflected on green fodder yield.

Table 4.2: Number of trifoliate leaves plant^{-1} of different berseem varieties at different time intervals

Treatments	Varieties	Number of trifoliate leaves plant^{-1}				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	5.93	41.63	71.75	39.55	38.23
V_2	BB-2	6.49	45.37	78.47	43.45	41.70
V_3	BB-3	6.17	47.47	79.93	53.41	44.97
V_4	JB-1	6.05	44.86	71.81	53.21	42.60
V_5	JB-5	5.83	38.13	60.88	44.42	36.53
V_6	JB-9	6.37	45.31	78.66	53.53	45.43
V_7	HB-1	5.87	36.93	69.81	45.12	35.13
V_8	HB-2	5.79	37.77	60.53	44.76	35.67
V_9	BL-10	5.70	33.63	69.67	41.03	37.67
V_{10}	BL-42	5.67	30.37	55.00	40.77	38.20
V_{11}	BL-43	6.17	33.17	70.00	40.10	34.43
V_{12}	BL-44	6.10	31.86	61.67	40.61	35.73
SEm ±		**0.17**	**2.08**	**2.91**	**2.90**	**1.38**
CD (P = 0.05)		**NS**	**6.10**	**8.52**	**8.51**	**4.04**

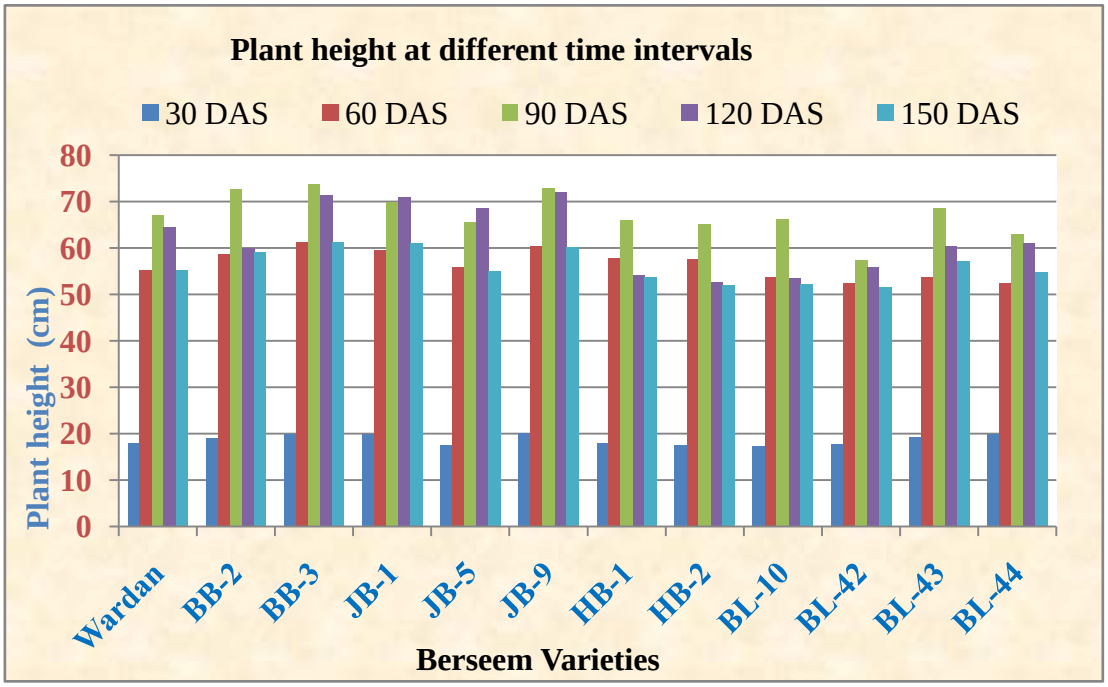

Fig. 4.1: Plant height of different berseem varieties at different time intervals

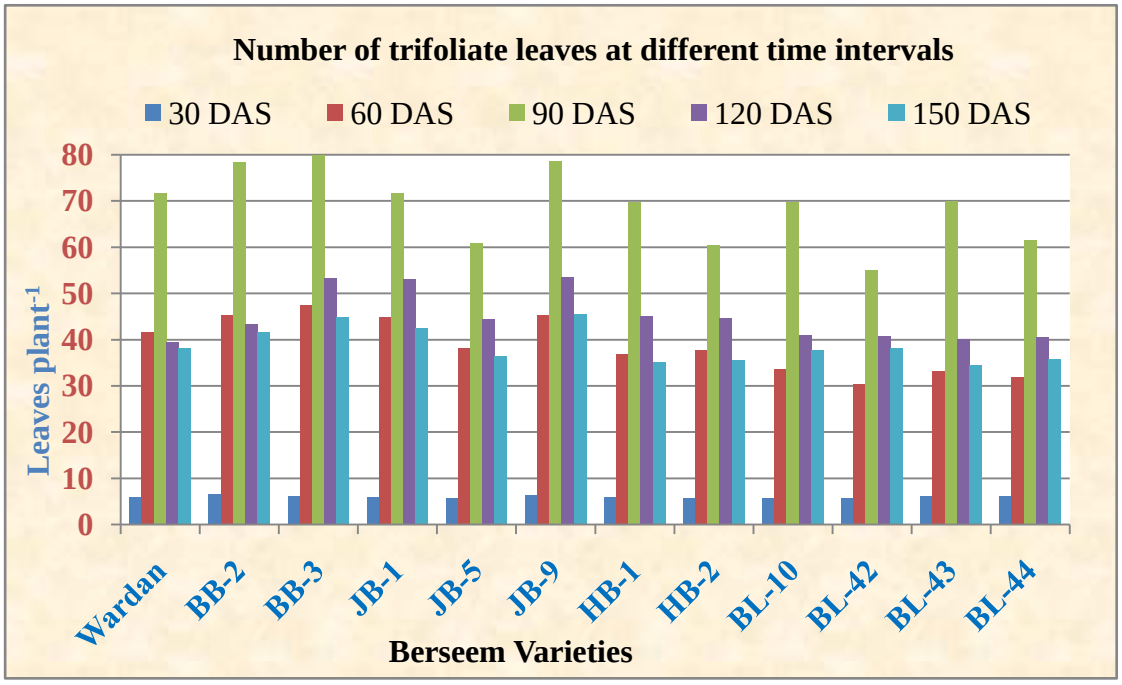

Fig. 4.2: Number of trifoliate leaves plant^{-1} of different berseem varieties at different time intervals

4.1.3 Number Shoots plant^{-1}

The data in Table 4.3 shows that the number of shoots plant^{-1} at 60, 90, 120 and 150 days after sowing influenced by the different berseem variety. At 60 and 90 days after sowing variety BB-3 (4.3, 5.97 plant^{-1} respectively) was significantly produced maximum number of shoots, however which was at par with variety BB-2 (3.93 plant^{-1}), JB-9 (4.1 plant^{-1}), JB-1 (4.13 plant^{-1}), BL-43 (3.77 plant^{-1}) and BL-44 (plant^{-1}) during 60 days after sowing. At 90 days after sowing variety BB-3 at par with BB-2 (5.77 plant^{-1}), JB-9 (5.90 plant^{-1}), HB-1 (5.13 plant^{-1}) and HB-2 (5.10 plant^{-1}), Variety BL-42 gave minimum number of shoots plant^{-1} (3.03, 4.20 respectively). At 120 and 150 days after sowing variety JB-9 (5.40, 5.0 plant^{-1}respectively) had significantly highest number of shoots, however at par with JB-5 (5.1 plant^{-1}), JB-1 (5.03 plant^{-1}) and BB-3 (5.1 plant^{-1}), minimum number of shoots plant^{-1} recorded in HB-2 (3.97 plant^{-1}) followed by BL-42 (4.07 plant^{-1}) during 120 days after sowing. At 150 days after sowing variety JB-9 at par with BB-3 (4.9 plant^{-1}) and JB-1 (4.87 plant^{-1}) varieties. Whereas, minimum number of shoots was recorded in variety BL-44 (3.8 plant^{-1}) followed by HB-2 (3.87 plant^{-1}). Significant variation among different berseem varieties for shoots also reported that Roy *et al* (2016) and Saeed *et al* (2011).

Table 4.3: Number of shoots plant^{-1} of different berseem varieties at different time intervals

Treatments	Varieties	Number of shoots plant^{-1}			
		60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	3.47	4.53	4.47	4.37
V_2	BB-2	3.93	5.77	4.50	4.43
V_3	BB-3	4.30	5.97	5.10	4.90
V_4	JB-1	4.13	4.53	5.03	4.87
V_5	JB-5	3.57	4.93	5.10	4.50
V_6	JB-9	4.10	5.90	5.40	5.00
V_7	HB-1	3.40	5.13	4.23	4.10
V_8	HB-2	3.03	5.10	3.97	3.87
V_9	BL-10	3.27	5.03	4.27	4.10
V_{10}	BL-42	3.03	4.20	4.07	4.00
V_{11}	BL-43	3.77	4.70	4.37	4.33
V_{12}	BL-44	3.73	4.97	4.30	3.80
SEm ±		**0.21**	**0.31**	**0.18**	**0.14**
CD (P = 0.05)		**0.63**	**0.90**	**0.53**	**0.41**

4.1.4 Fresh weight plant $^{-1}$

In the barseem crop, fresh weight is taken 30, 60, 90, 120, and 150 days after sowing. Table 4.4 shows that the plant fresh weight at an accelerate rate between 0 to 90 days after sowing, while at a relatively slower rate between 90 to 150 days after sowing. At 30 days after sowing variety JB-9 (1.1 g plant^{-1}) was found to be significantly highest plant fresh weight, which was at par with varieties JB-1 (1.0 g plant^{-1}), BL-43 (1.0 g plant^{-1}), BL-44 (0.9 g plant^{-1}), BB-3 (1.0 g plant^{-1}) and BB-2 (1.0 g plant^{-1}), variety BL-10 weight (0.7 g plant^{-1}) give minimum plant fresh. At 60 and 90 days after sowing significantly maximum plant fresh weight was produced in variety BB-3 (18.31, 26.02 g plant^{-1} respectively). However, at 60 days after sowing it was at par with JB-1 (16.97 g plant^{-1}), JB-9 (16.74 g plant^{-1}), BB-2 (16.64 g plant^{-1}), BL-43 (16.17 g plant^{-1}) and BL-44 (16.06 g plant^{-1}) varieties. At 90 days after sowing variety BB-3 was at par with JB-9 (24.43 g plant^{-1}), BL-43 (23.06 g plant^{-1}), Wardan (23.03 g plant^{-1}) and BB-2 (24.77 g Plant^{-1}) varieties. At 120 and 150 days after sowing significantly highest plant fresh weight was recorded in variety JB-9 (21.92, 19.20 g plant^{-1} respectively), which was at par with variety JB-5, JB-1, BB-3 and Wardan varieties. During 150 days after sowing variety JB-9 was at par with BB-3, JB-1, JB-5, BL-43 and BB-2. Whereas, at 150 days after sowing minimum plant fresh weight was recorded with variety HB-2 (16.06 g plant^{-1}) followed by HB-1 (16.64 g plant^{-1}). Similar significant difference for fresh weight was also reported by Leghari *et al.* (2018) and Tomar (2009).

4.1.5 Dry weight plant^{-1}

Results presented in Table 4.5 indicated that the increasing dry weight of plant after the first cut to subsequent cut. Dry weight of different berseem variety was is taken 30, 60, 90, 120, and 150 days after sowing. At 30, 60 and 90 days after sowing significantly highest dry weight were recorded in variety BB-3 (0.13, 2.09, 4.35 g plant^{-1} respectively). Whereas, 60 and 90 days after sowing it was at par with variety JB-1, JB-9, BB-2, BL-43 and BL-44. At 90 days after sowing variety BB-3 was at par with JB-9 (4.28 g plant^{-1}), BL-43 (3.64 g plant^{-1}), Wardan (3.63 g plant $^{-1}$) and BB-2 (4.22 g plant $^{-1}$) varieties. During 120 days after sowing variety JB-9 (4.73 g plant^{-1}) had recorded significantly maximum plant dry weight,

which was at par with JB-5, JB-1 and BB-3 varieties. Whereas, minimum plant dry weight was recorded by HB-2 (3.43 g plant $^{-1}$). At 150 days after sowing significantly maximum plant dry weight was recorded in variety BB-3 (6.39 g plant^{-1}), which was at par with BB-2, JB-1 (6.21 g plant^{-1}) and JB-9 varieties. Whereas, minimum plant dry weight was recorded by HB-1 (4.57 g plant^{-1}) followed by HB-2 (4.61 g plant^{-1}). Tomar (2009) was reported similar significant difference for dry weight of berseem.

Table 4.4: Fresh weight plant^{-1} of different berseem varieties at different time intervals

Treatments	Varieties	Fresh weight (g plant^{-1})				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	0.87	14.15	23.03	20.12	17.22
V_2	BB-2	1.00	16.64	24.77	18.92	18.43
V_3	BB-3	1.03	18.31	26.02	21.57	19.05
V_4	JB-1	1.00	16.97	21.84	21.01	19.17
V_5	JB-5	0.87	14.31	18.84	20.35	18.18
V_6	JB-9	1.13	16.74	24.43	21.92	19.20
V_7	HB-1	0.87	13.17	17.40	18.05	16.64
V_8	HB-2	0.87	13.07	17.52	19.18	16.06
V_9	BL-10	0.73	13.15	18.14	17.48	17.09
V_{10}	BL-42	0.83	12.49	16.58	17.78	17.45
V_{11}	BL-43	1.00	16.17	23.06	18.12	17.69
V_{12}	BL-44	0.93	16.06	19.55	17.43	17.18
SEm ±		**0.07**	**0.91**	**1.03**	**0.69**	**0.53**
CD (P = 0.05)		**0.20**	**2.68**	**3.02**	**2.02**	**1.55**

Table 4.5: Dry weight plant^{-1} of different berseem varieties at different time intervals

Treatments	Varieties	Dry weight (g plant^{-1})				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	0.09	1.37	3.63	4.25	5.51
V_2	BB-2	0.12	1.79	4.22	4.29	5.91
V_3	BB-3	0.13	2.09	4.35	4.72	6.39
V_4	JB-1	0.11	2.02	3.26	4.45	6.21
V_5	JB-5	0.09	1.59	3.12	4.52	5.75
V_6	JB-9	0.13	1.93	4.28	4.73	6.00
V_7	HB-1	0.09	1.39	3.03	3.52	4.57
V_8	HB-2	0.09	1.57	2.72	3.43	4.61
V_9	BL-10	0.08	1.44	2.62	3.62	5.11
V_{10}	BL-42	0.09	1.43	2.89	3.69	5.27
V_{11}	BL-43	0.11	1.92	3.64	3.99	5.12
V_{12}	BL-44	0.11	1.87	3.46	3.58	4.74
SEm ±		**0.01**	**0.15**	**0.25**	**0.15**	**0.18**
CD (P = 0.05)		**0.02**	**0.43**	**0.72**	**0.43**	**0.53**

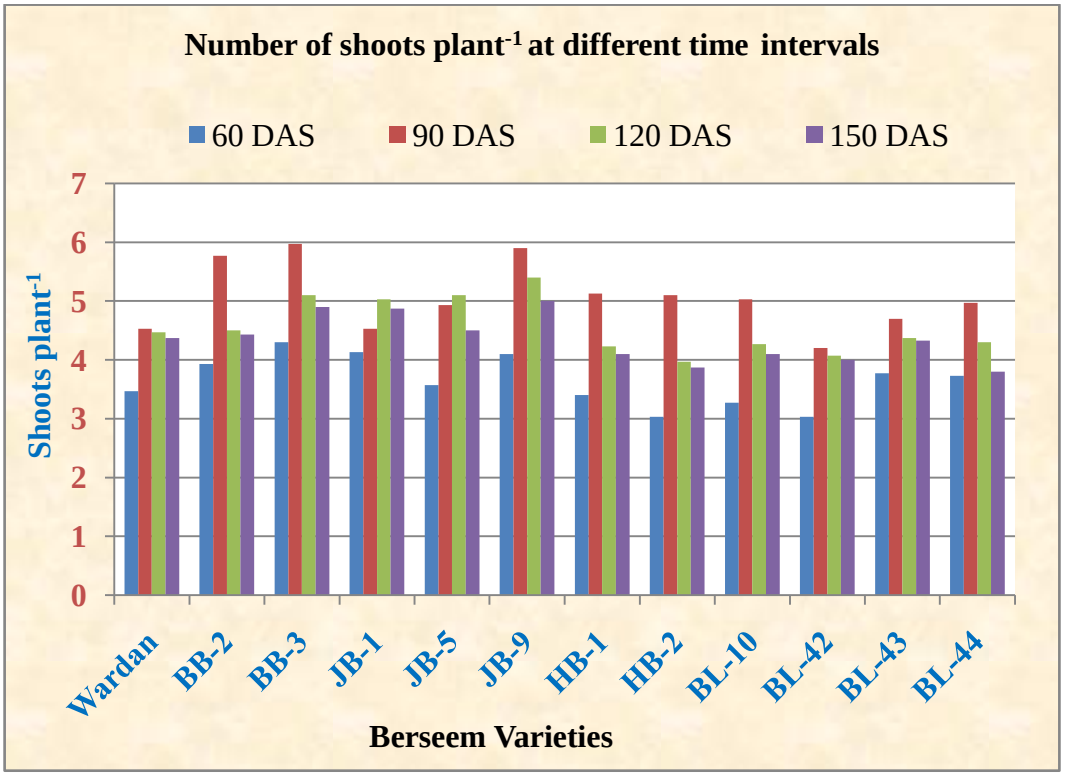

Fig. 4.3: Number of shoots plant^{-1} of different berseem varieties at different time intervals

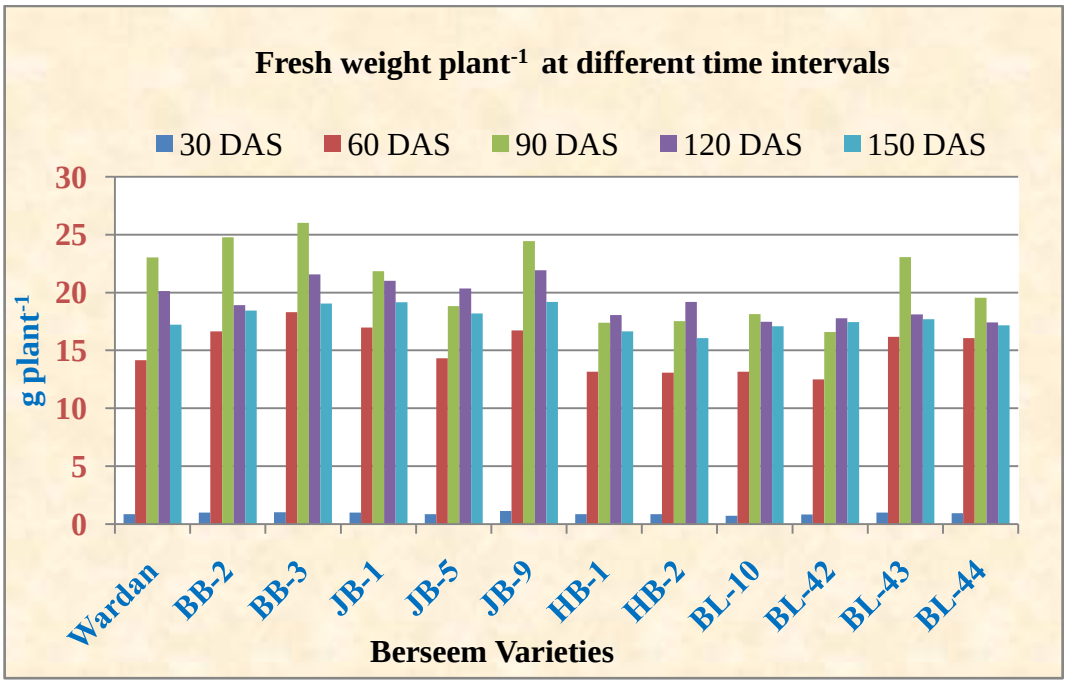

Fig. 4.4: Fresh weight plant^{-1} of different berseem varieties at different time intervals

4.1.6 Leaf fresh weight plant $^{-1}$

Results presented in Table 4.6 the leaf fresh weight of berseem varieties were taken 30, 60, 90, 120, and 150 days after sowing and to be found significant differences. During 30 days after sowing significantly maximum leaf fresh weight was recorded in variety JB-9 (0.4 g plant^{-1}). At 60, 90 and 120 days after sowing variety BB-3 (5.15, 6.23, 4.63 g plant^{-}1, respectively) produce significantly highest leaf fresh weight which was at par with JB-9, JB-1, BB-2, BL-43 and BL-44 varieties. Whereas, Wardan (3.69 g plant^{-1}) produce minimum leaf fresh weight during 60 days after sowing. During 90 days after sowing variety BB-3 was at par with JB-1, JB-9, BB-2, Wardan, BL- 43 and BL-44 varieties. At 120 days after sowing variety BB-3 at par with JB-9 (4.16 g plant^{-1}), JB-5 (4.23 g plant^{-1}), JB-1 (4.52 g plant^{-1}), HB-1 (4.15 g plant^{-1}), HB-2 (4.09 g plant^{-1}) and Wardan (4.08 g plant^{-1}) varieties. Whereas, minimum leaf fresh weight was recorded in BL-44 (3.65 g plant^{-1}) followed by BL-43 (3.66 g plant^{-1}). During 150 days after sowing variety JB-9(4.51 g plant $^{-1}$) produced significantly maximum leaf fresh weight, which was at par with BB-3 (4.41 g plant^{-1}). Whereas, minimum leaf fresh weight was recorded in Wardan (3.18 g plant^{-1}) followed by HB-2 (3.32 g plant^{-1}).

Table 4.6: Leaf fresh weight plant^{-1} of different berseem varieties at different time intervals

Treatments	Varieties	Leaf fresh weight (g plant^{-1})				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	0.30	3.69	5.04	4.08	3.18
V_2	BB-2	0.37	4.79	6.22	4.04	3.97
V_3	BB-3	0.37	5.15	6.23	4.63	4.41
V_4	JB-1	0.33	4.59	5.17	4.52	3.99
V_5	JB-5	0.27	4.10	4.46	4.23	3.64
V_6	JB-9	0.40	4.96	5.51	4.16	4.51
V_7	HB-1	0.23	3.91	4.31	4.15	3.36
V_8	HB-2	0.33	3.81	4.50	4.09	3.32
V_9	BL-10	0.30	3.98	4.04	3.72	3.54
V_{10}	BL-42	0.30	3.88	4.33	3.67	3.52
V_{11}	BL-43	0.37	5.06	5.02	3.66	3.61
V_{12}	BL-44	0.33	4.96	4.99	3.65	3.49
SEm ±		**0.02**	**0.32**	**0.45**	**0.19**	**0.17**
CD (P = 0.05)		**0.07**	**0.94**	**1.32**	**0.55**	**0.49**

4.1.7 Leaf dry weight plant $^{-1}$

The leaf dry weight of berseem varieties (presented in Table 4.7) was found significant differences at different time intervals. Variety BB-3 (0.06, 0.78 g plant^{-1} respectively) gives significantly maximum leaf dry weight during 30 and 60 days after sowing, which was at par on JB-9 (0.06, 0.69 g plant^{-1}), BB-2 (0.05, 0.66 g plant^{-1} respectively), JB-1 (0.05, 0.7 g plant^{-1} respectively), BL-43 (0.05, 0.74 g plant^{-1}) and BL-44 (0.05, 0.73 g plant^{-1}) respectively. Whereas, Variety HB-1 (0.03 g plant^{-1}) was produce minimum leaf dry weight during 30 days after sowing. At 90,120 and 150 days after sowing variety JB-9(1.32, 1.21, 1.39g plant^{-1}) was significantly highest value of leaf dry weight and was at par with varieties BB-2 (1.31 g plant $^{-1}$), Wardan (1.09 g plant^{-1}) and BB-3 (1.27 g plant $^{-1}$) during 90 days after sowing. Whereas, at 120 days after sowing variety JB-9 was found at par with BB varieties -3, JB-5 and JB-1.

Table 4.7: Leaf dry weight plant^{-1} of different berseem varieties at different time intervals

Treatments	Varieties	Leaf dry weight (g plant^{-1})				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	0.04	0.51	1.09	1.02	1.13
V_2	BB-2	0.05	0.66	1.31	1.02	1.29
V_3	BB-3	0.06	0.78	1.27	1.20	1.36
V_4	JB-1	0.05	0.70	0.97	1.11	1.27
V_5	JB-5	0.04	0.60	0.93	1.19	0.99
V_6	JB-9	0.06	0.69	1.32	1.21	1.39
V_7	HB-1	0.03	0.53	0.90	0.93	0.80
V_8	HB-2	0.04	0.57	0.82	0.94	0.91
V_9	BL-10	0.04	0.57	0.88	0.98	0.88
V_{10}	BL-42	0.04	0.59	0.96	0.91	0.89
V_{11}	BL-43	0.05	0.74	1.10	0.97	1.04
V_{12}	BL-44	0.05	0.73	1.06	0.89	1.02
SEm ±		**0.00**	**0.06**	**0.09**	**0.05**	**0.10**
CD (P = 0.05)		**0.01**	**0.17**	**0.25**	**0.15**	**0.30**

Similarly variety JB-9 was at par with BB-3, JB-1 and Wardan during 150 days after sowing. However, minimum leaf dry weight was recorded in variety HB-2, BL-44 and HB-1during 90,120 and 150 days after sowing. Similar observation was also reported by Nand *et al.* (2018).

4.1.8 Stem fresh weight plant $^{-1}$

Observation on fresh stem weight at the first, second, third and fourth cuts presented in Table 4.8, shows significant differences in fresh stem weigh during different cutting interval. At 30 days after sowing there was no significance difference on stem fresh weight of among the varieties. Variety BB-3 (13.16, 19.79 g plant^{-1} respectively) produced maximum fresh stem weight during 60 and 90 days after sowing which was fund at par with varieties JB-1 (12.38 g plant^{-1}), JB-9(11.77 g plant^{-1}), BB-2 (11.85 g plant^{-1}) at 60 days after sowing. Whereas, it was at par with JB-9, BL-43, Wardan and BB-2 during 90 days after sowing. At 120 days after sowing variety JB-9 (17.76 g plant^{-1}) had produced significantly highest stem fresh weight which was found at par with varieties JB-5, JB-1, BB-3, and Wardan. However, minimum stem fresh weight was recorded in BL-10 (13.75 g plant^{-1}) at 120DAS. During fourth cut (150 DAS) variety JB-1 (15.18 g plant^{-1}) produces significantly highest stem fresh weight, which was at par with BB-3 (14.64 g plant^{-1}), JB-9 (14.7 g plant^{-1}) and JB-5 (14.54 g plant^{-1}). BL-43 (13.93 g plant^{-1}), BL-44 (14.25 g plant^{-1}) and BB-2 (14.45 g plant^{-1}). Significant differences for stem fresh weight were also reported by Nand *et al.* (2018).

Table 4.8: Stem fresh weight plant^{-1} of different berseem varieties at different time intervals.

Treatments	Varieties	Stem fresh weight (g plant^{-1})				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	0.57	10.46	17.99	16.04	13.37
V_2	BB-2	0.63	11.85	18.54	14.88	14.45
V_3	BB-3	0.77	13.16	19.79	16.94	14.64
V_4	JB-1	0.67	12.38	16.67	16.49	15.18
V_5	JB-5	0.60	10.20	14.38	16.12	14.54
V_6	JB-9	0.63	11.77	18.92	17.76	14.70
V_7	HB-1	0.63	9.26	13.09	13.90	12.61
V_8	HB-2	0.53	9.26	13.02	15.09	12.75
V_9	BL-10	0.43	9.17	14.11	13.75	13.55
V_{10}	BL-42	0.53	8.62	12.26	14.11	13.93
V_{11}	BL-43	0.63	11.11	18.04	14.46	14.25
V_{12}	BL-44	0.60	11.10	14.56	13.79	13.02
SEm ±		**0.06**	**0.70**	**0.78**	**0.69**	**0.46**
CD (P = 0.05)		**NS**	**2.04**	**2.28**	**2.02**	**1.36**

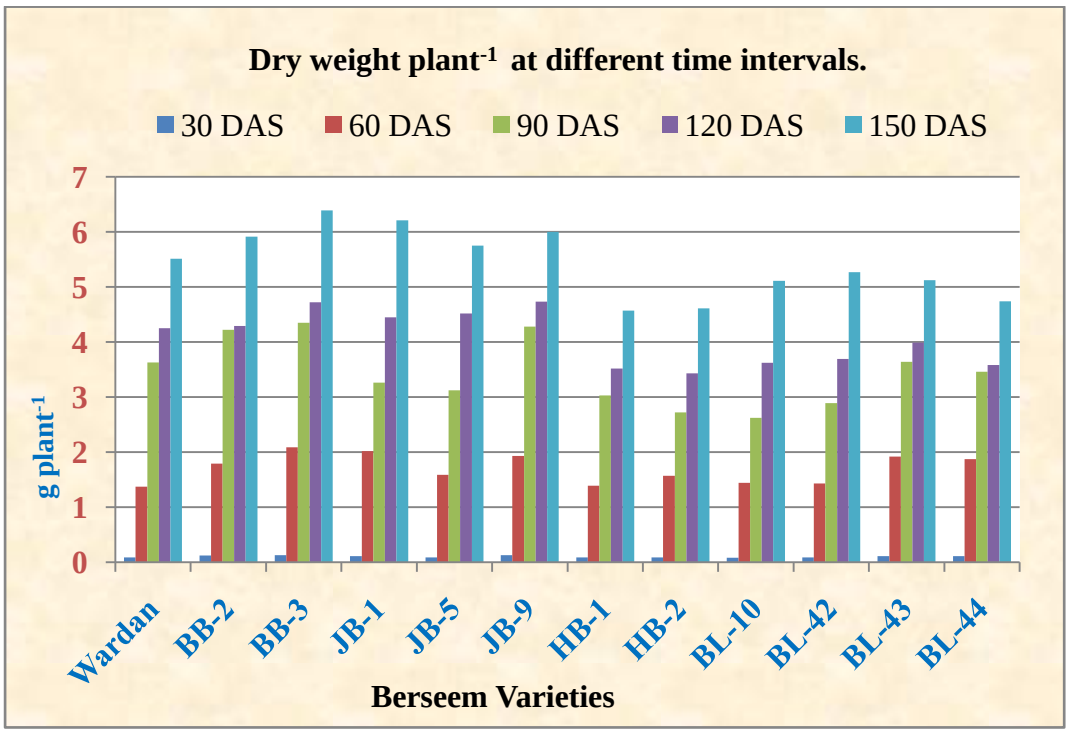

Fig. 4.5: Dry weight plant^{-1} of different berseem varieties at different time intervals.

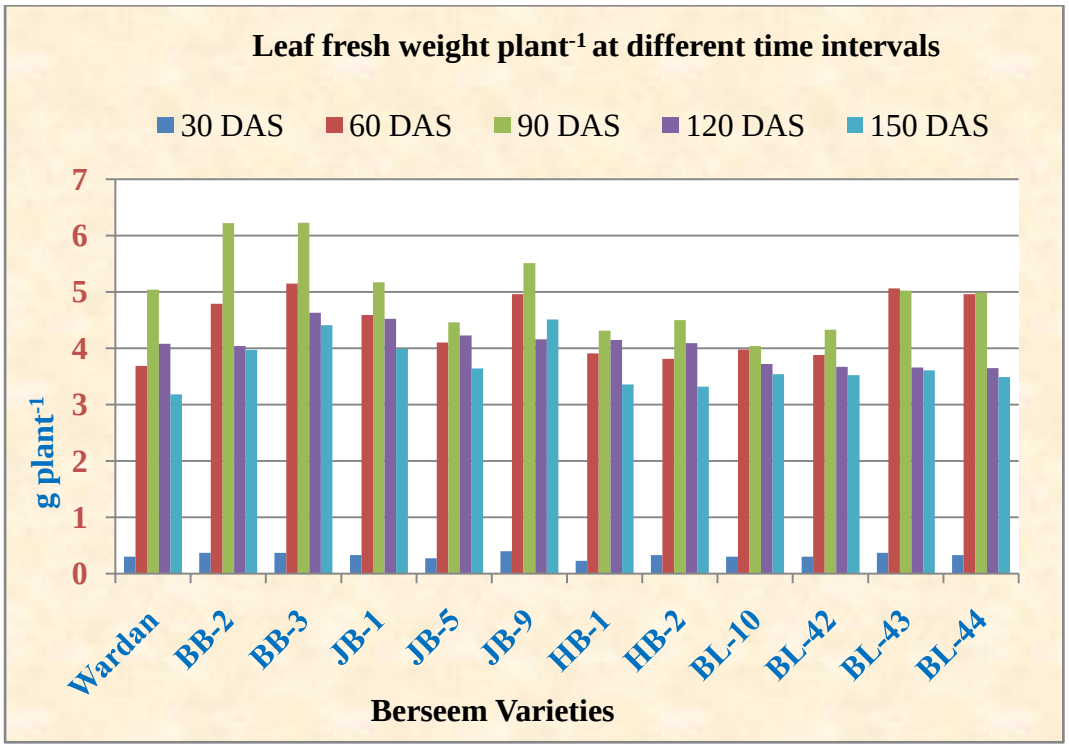

Fig. 4.6: Leaf fresh weight plant^{-1} of different berseem varieties at different time intervals.

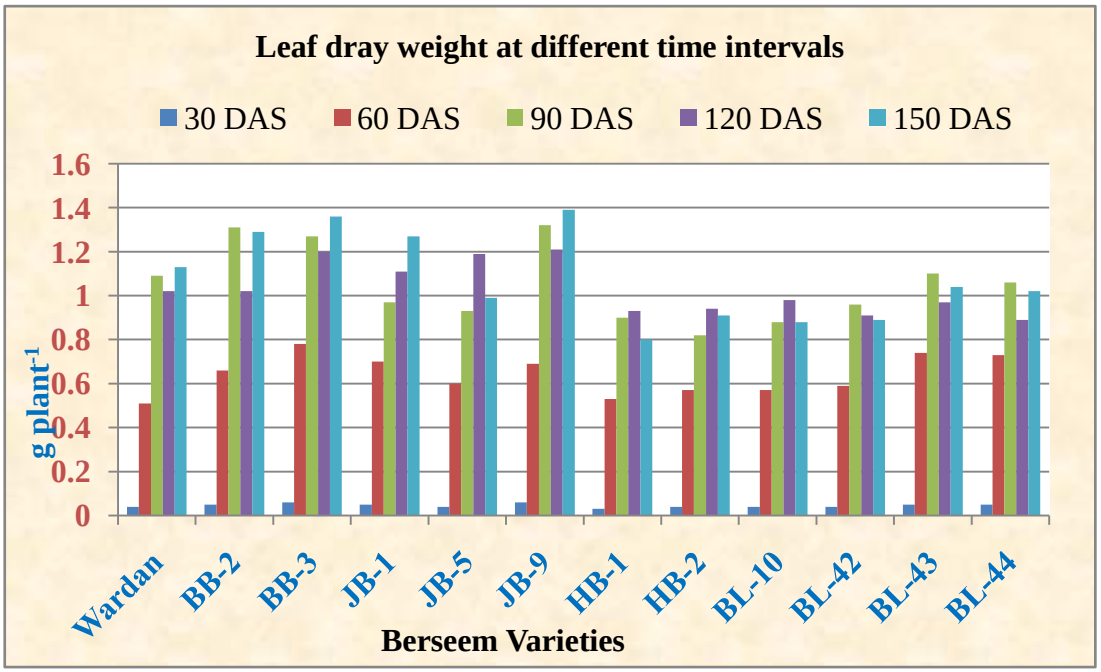

Fig. 4.7: Leaf dry weight plant^{-1} of different berseem varieties at different time intervals

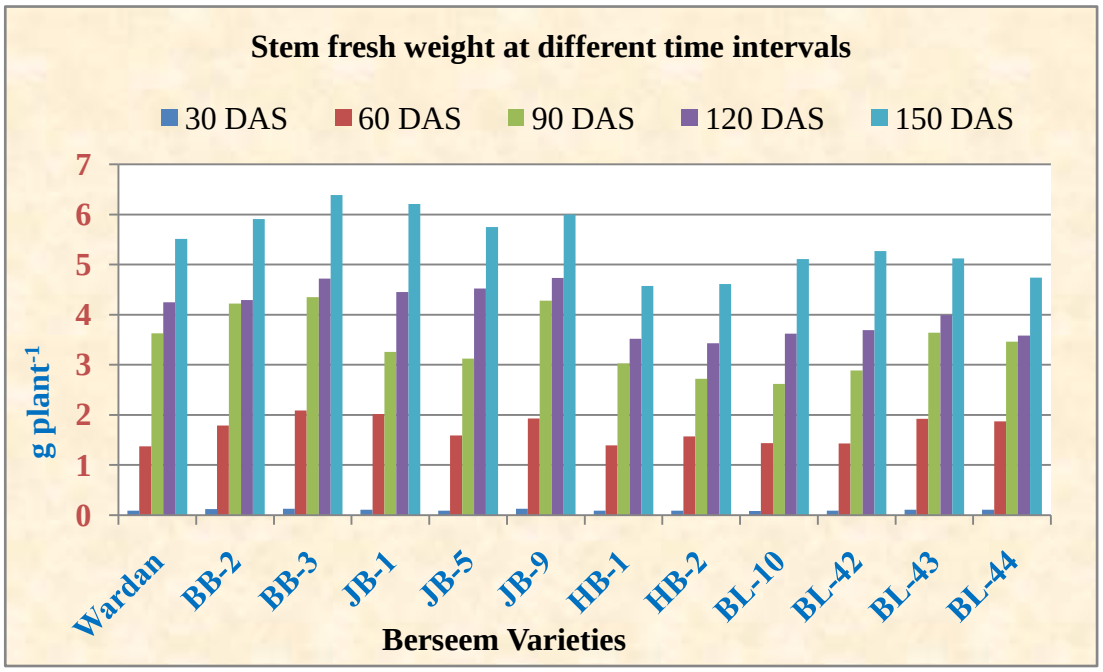

Fig. 4.8: Stem fresh weight plant^{-1} of different berseem varieties at different time intervals

4.1.9 Stem dry weight plant $^{-1}$

Data show in Table 4.9 shows that, significant difference in stem dry weight at first, second, third and fourth cuts by different varieties. Variety BB-3 (0.07g plant^{-1}) produced significantly maximum stem dry weight during 30 days after sowing, which was at par with varieties JB-9 (0.07 g plant^{-1}), BB-2 (0.06 g plant^{-1}), JB-1 (0.06 g plant^{-1}), BL-43 (0.06g plant^{-1}) and BL-44 (0.06 g plant^{-1}). During 60 days after sowing variety JB-1 (1.31 g plant^{-1}) gives significantly maximum stem dry weight, which was at par on JB-9, BB-2, BB-3, BL-43 and BL-44 whereas BL-42 (0.85 g plant^{-1}) produce minimum stem dry weight. At 90 days after sowing variety BB-3 (3.07 g plant^{-1}) was produce significantly highest value of stem dry weight, which was at par with varieties BB-2 (2.91 g plant^{-1}), Wardan (2.54 g plant^{-1}), JB-9 (2.96 g plant $^{-1}$) and BL-43 (2.54 g plant^{-1}). During 120 days after sowing variety JB-9(3.52 g plant^{-1}) was produce significantly highest value of stem dry weight, which was at par with BB-3 (3.52 g plant^{-1}), JB-5 (3.33 g plant^{-1}) and JB-1 (3.34 g plant^{-1}), BB-2 (3.27 g plant^{-1}) and Wardan (3.23 g plant^{-1}). During 150 days after sowing variety BB-3 (5.03 g plant^{-1}) produce significantly maximum stem dry weight, which was at par with JB-1 (4.94 g plant^{-1}), BB-2 (4.62 g plant^{-1}), JB-9(4.61 g plant^{-1}) and JB-5 (4.76 g plant^{-1}). However, minimum stem dry weight was recorded in HB-2 (3.70 g plant^{-1}) at 150 days after sowing.

4.1.10 Leaf: stem ratio

We already know that the leaf to stem ratio affects how much energy a plant has available for growth and how readily nutrients in the soil are absorbed by roots. As the increases number of leaf to stem ratio in berseem varieties so will the energy level and nutrient level are increased. Leaf: Stem ratio taken from 30, 60, 90, 120, and 150 days after sowing and to be found no significant differences among the varieties (Data show in Table 4.10). Leaf: Stem ratio of different berseem varieties are in decreasing trends as advancement of crop age. Variety HB-2 (0.94) was maximum recorded ratio of leaf and stem during 30 days after sowing followed by JB-9(0.86) and BL-10 (0.93). During 60 days after sowing variety BL-42 (0.69) recorded maximum ratio of leaf and stem followed by BL-44

(0.64) and BL-10 (0.66), minimum produce ratio of leaf and stem JB-1 (0.54) followed by JB-9 (0.56) and HB-2 (0.56). During 90 days after sowing variety BL-42 (0.5) was found maximum ratio of leaf and stem followed by JB-9(0.45) and BB-2 (0.45), whereas minimum produce ratio of leaf and stem JB-1 (0.42) followed by BB-3 (0.42) and HB-1 (0.42).). During 120 days after sowing Variety HB-2 (0.38) was recorded maximum ratio of leaf and stem followed by HB-1 (0.37) and BL-10 (0.37), whereas minimum produce leaf and stem ratio by Wardan (0.31). During150 days after sowing Variety JB-9(0.3) was recorded maximum ratio of leaf and stem followed by BB-2 (0.28), BB-3 (0.27) and BL-44 (0.27), minimum produce ratio of leaf and stem BL-42 (0.2) followed by JB-5 (0.21) and HB-1 (0.21) and BL-10 (0.21). Kumawat *et al.* (2017) similar reported that the Leaf: stem ratio did not influence significantly among different genotypes of berseem.

4.2 Yield studies

4.2.1. Green fodder yield each cut and total

In the Barseem crop, the first cutting took place 60 days after sowing, and the subsequent cutting followed by 30 days interval. A total of four cuttings were performed 60, 90, 120, and 150 days after sowing. Data shows in Table 4.11 berseem varieties had a significant impact on the green fodder yield at the first, second, third, and fourth cuttings and in total biomass production. Performance of different varieties depends on growth habit, genetic makeup of the varieties interaction with environment and climatic condition.

During first and second cut variety BB-3 was produced significantly maximum green fodder yield (124.0, 176.5 q ha^{-1}, respectively). However, at first cut this variety was at par with JB-1, BB-2 JB-9, BL-43 and BL-44 varieties whereas, it was at par with JB-9, JB-1 and BB-2 varieties during second cut. During first cut lowest green fodder yield was recorded in variety BL-42 (105.1 q ha^{-1}) followed by HB-2 (105.7 q ha^{-1}). However, it was minimum in variety HB-2 (112.1 q ha^{-1}) followed by BL-42 (127.3 q ha^{-1}) during second cut. During third and fourth cut maximum green fodder yield was produced by variety JB-9 (151.7, 85.3 q ha^{-1}, respectively) which was at par with varieties JB-5, JB-1 and BB-3 on

third cut whereas, it was at par with BB-3, JB-1 and BB-2 during fourth cut. Among the varieties lowest green fodder yield was recorded in HB-2 (87.5 q ha^{-1}) followed by HB-1 (105.9 q ha^{-1}) at during third cut and variety BL-44 (59.5 q ha^{-1}) followed by Wardan (61.5 q ha^{-1}) at during fourth cut. Significantly maximum total green fodder yield produced by variety BB-3(529.9 q ha^{-1}) which was found statistically at par with variety JB-9(524.6 q ha^{-1}), JB-1 (498.4 q ha^{-1}) and BB-2 (497.4 q ha^{-1}). This might be due to higher plant height, more number of trifoliate leaves $plants^{-1}$, more number of shoot $plants^{-1}$, more fresh and dry weight of per plant and suitable climatic condition contributed to the maximized green fodder yield of variety BB-3, JB-9, JB-1 and BB-2. Whereas, Minimum total green fodder yield was produced by variety HB-2 (374.7 q ha^{-1}) followed by BL-42 (414.7 q ha^{-1}) and HB-1 (428.6 q ha^{-1}). The results are conformity with the similar results was also reported by Singh *et al.* (2020), Kumar *et al.* (2021) and Dinesh Nargesh (2012).

4.2.2. Dry fodder yield each cut and total

Data show in Table 4.12 that the berseem variety had a significant impact on dry fodder yield at second third and fourth cuttings. The dry matter content increased with advancement of crop age which reflects on dry matter yield of berseem varieties. At first cut there was no significant differences among the variety, however variety JB-1 was given maximum dry fodder yield (14.6 q ha^{-1}) followed by BB-3, JB-9. At second, third and fourth cuts significantly maximum dry fodder yield was produced by variety BB-3 (26.3, 30.4, 25.2 q ha^{-1} respectively). However, at second cut by variety BB-3 was at par with variety BB-2, JB-9 and JB-1 similarly at third cut it was at par with JB-9, JB-1 and JB-5. During fourth and last variety BB-3 was found at par with BB-2, JB-1, JB-5, JB-9, BL-10, BL-42 and BL-43. At second and third cuts variety HB-2 was (17.3, 17.5 q ha^{-1} respectively) lowest for dry fodder yield whereas, variety BL-44 produced lowest dry fodder yield among all berseem varieties during fourth cut. Significantly maximum total dry fodder yield was recorded with variety BB-3 (95.8 q ha^{-1}) which was at par with variety JB-9, JB-1 and BB-2. However, variety HB-2 (67.7 q ha^{-1}) produced minimum total dry fodder yield followed by HB-1 and BL-44. Similar results were also reported by Devi and Satpal (2019).

Table 4.9: Stem dry weight plant^{-1} of different berseem varieties at different time intervals

Treatments	Varieties	Stem dry weight (g plant^{-1})				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	0.05	0.87	2.54	3.23	4.38
V_2	BB-2	0.06	1.14	2.91	3.27	4.62
V_3	BB-3	0.07	1.31	3.07	3.52	5.03
V_4	JB-1	0.06	1.31	2.29	3.34	4.94
V_5	JB-5	0.05	0.99	2.19	3.33	4.76
V_6	JB-9	0.07	1.23	2.96	3.52	4.61
V_7	HB-1	0.05	0.86	2.13	2.59	3.77
V_8	HB-2	0.05	1.01	1.90	2.49	3.70
V_9	BL-10	0.04	0.86	1.75	2.64	4.23
V_{10}	BL-42	0.05	0.85	1.93	2.78	4.38
V_{11}	BL-43	0.06	1.18	2.54	2.97	4.08
V_{12}	BL-44	0.06	1.14	2.40	2.69	3.72
SEm ±		**0.01**	**0.10**	**0.19**	**0.14**	**0.21**
CD (P = 0.05)		**0.02**	**0.29**	**0.56**	**0.40**	**0.62**

Table 4.10: Leaf: Stem ratio of different berseem varieties at different time intervals

Treatments	Varieties	Leaf: Stem ratio				
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
V_1	Wardan	0.83	0.58	0.43	0.31	0.26
V_2	BB-2	0.83	0.58	0.45	0.33	0.28
V_3	BB-3	0.75	0.60	0.42	0.34	0.27
V_4	JB-1	0.78	0.54	0.42	0.33	0.26
V_5	JB-5	0.72	0.60	0.43	0.36	0.21
V_6	JB-9	0.86	0.56	0.45	0.34	0.30
V_7	HB-1	0.62	0.62	0.42	0.37	0.21
V_8	HB-2	0.94	0.56	0.43	0.38	0.25
V_9	BL-10	0.93	0.66	0.50	0.37	0.21
V_{10}	BL-42	0.82	0.69	0.50	0.33	0.20
V_{11}	BL-43	0.82	0.63	0.43	0.33	0.26
V_{12}	BL-44	0.80	0.64	0.44	0.34	0.27
SEm ±		**0.11**	**0.04**	**0.03**	**0.02**	**0.03**
CD (P = 0.05)		**NS**	**NS**	**NS**	**NS**	**NS**

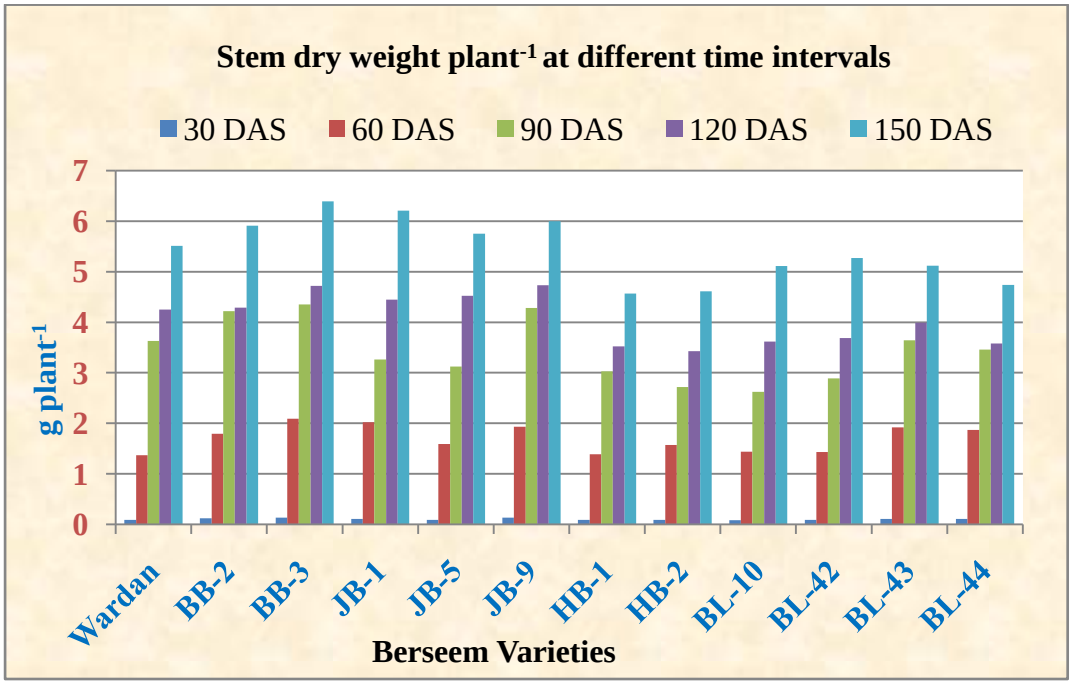

Fig. 4.9: Stem dry weight plant^{-1} of different berseem varieties at different time intervals

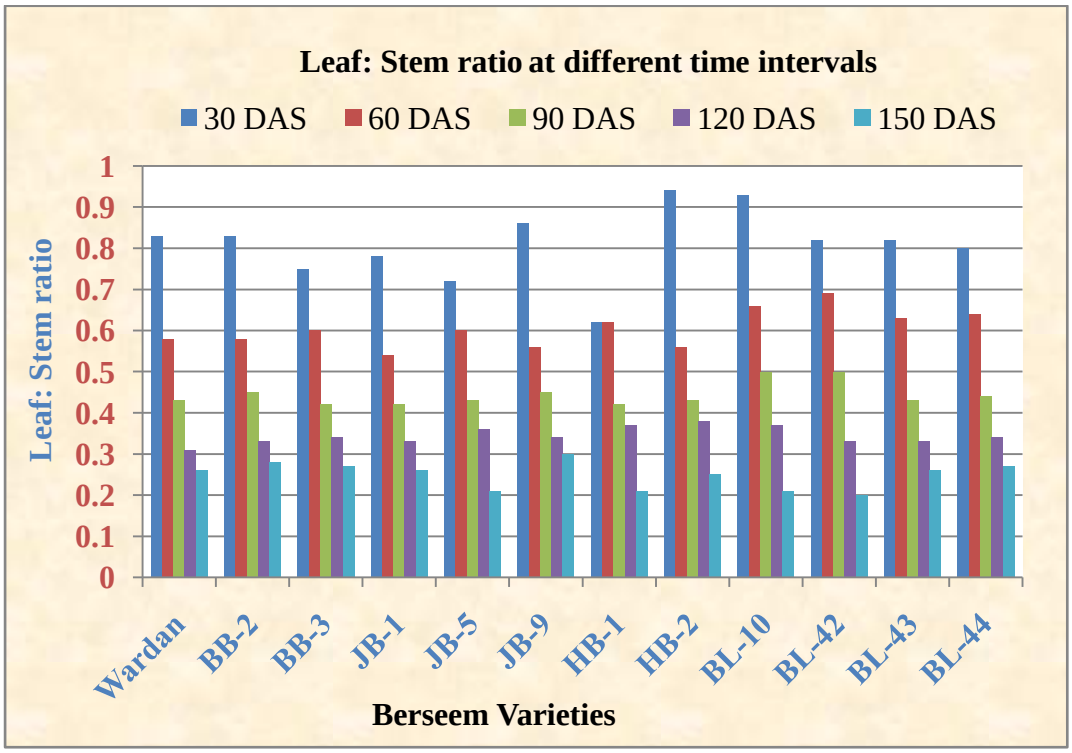

Fig. 4.10: Leaf: Stem ratio of different berseem varieties at different time intervals

Table 4.11: Green fodder yield of different berseem varieties at different cuts

Treatments	Varieties	Green fodder yield (q ha^{-1})				
		1st Cut	2nd Cut	3rd Cut	4th Cut	Total
V_1	Wardan	110.1	155.7	125.5	61.5	452.8
V_2	BB-2	114.4	170.4	133.3	79.3	497.4
V_3	BB-3	124.0	176.5	148.2	81.3	529.9
V_4	JB-1	120.8	155.3	147.0	75.4	498.4
V_5	JB-5	112.1	147.4	143.6	69.4	472.4
V_6	JB-9	117.0	170.6	151.7	85.3	524.6
V_7	HB-1	110.9	146.4	105.9	65.5	428.6
V_8	HB-2	105.7	112.1	87.5	69.4	374.7
V_9	BL-10	107.7	138.2	118.6	71.4	435.9
V_{10}	BL-42	105.1	127.3	112.9	69.4	414.7
V_{11}	BL-43	120.2	146.8	124.8	77.4	469.1
V_{12}	BL-44	114.8	140.2	120.6	59.5	435.1
SEm ±		**3.73**	**5.3**	**5.12**	**4.55**	**11.36**
CD (P = 0.05)		**10.94**	**15.55**	**15.02**	**13.5**	**33.33**

Table 4.12: Dry fodder yield of different berseem varieties at different cuts

Treatments	Varieties	Dry fodder yield (q ha^{-1})				
		1st Cut	2nd Cut	3rd Cut	4th Cut	Total
V_1	Wardan	12.5	22.5	24.2	19.7	78.9
V_2	BB-2	13.1	25.1	26.8	25.0	90.1
V_3	BB-3	13.8	26.3	30.4	25.2	95.8
V_4	JB-1	14.6	24.6	29.8	23.9	93.0
V_5	JB-5	13.2	22.5	28.7	22.0	86.4
V_6	JB-9	13.5	25.5	30.2	24.7	93.9
V_7	HB-1	13.2	22.1	20.8	18.0	74.0
V_8	HB-2	13.0	17.3	17.5	19.9	67.7
V_9	BL-10	13.4	20.1	23.0	21.4	77.8
V_{10}	BL-42	12.9	19.4	21.8	21.0	75.0
V_{11}	BL-43	13.9	22.0	24.5	22.4	83.0
V_{12}	BL-44	13.8	20.9	23.8	16.4	74.9
SEm ±		**0.46**	**0.75**	**1.24**	**1.46**	**1.99**
CD (P = 0.05)		**NS**	**2.19**	**3.64**	**4.28**	**5.84**

4.2.3. Productivity of green fodder each cut

Productivity in q ha^{-1} day^{-1} represents the growth pattern and regeneration capacity of berseem varieties over the time period. Data presented in Table 4.13 shows that per day productivity of green fodder yield was maximum during second cut in all the varieties after that productivity was slightly in declining trends.

However, per day productivity of green fodder yield was minimum at first cut, this may be due to during early crop growth stage growth was at slower rate up to 60 days of growth period. After first cut berseem crop obtain grand growth period and produced higher green fodder yield. At first and second cut variety BB-3 was produced significantly maximum per day productivity of green fodder (2.07, 5.88 q ha^{-1} day^{-1}, respectively). However, at first cut this variety was at par with JB-1, BB-2, JB-9, BL- 43 and BL-44 varieties. During second cut variety BB-3 was at par with JB-9 (5.69 q ha^{-1} day^{-1}) and BB-2 (5.68 q ha^{-1} day^{-1}). During third and fourth cut variety JB-9 (5.06, 2.84 q ha^{-1} day^{-1}, respectively) had gave significantly highest productivity of green fodder which was at par with variety JB-5, JB-1 and BB-3 during third cut. At fourth cut variety JB-9 significantly at par with BB-3, JB-1, BL-43 and BB-2. Among the varieties lowest productivity of green fodder was recorded in HB-2 (2.92 q ha^{-1} day^{-1}) followed by HB-1 during third cut and variety BL-44 (1.98 q ha^{-1} day^{-1}) followed by Wardan during forth cut. Significantly maximum total per day productivity was recorded with BB-3 Variety (3.53 q ha^{-1} day^{-1}) which was at par with variety JB-9, JB-1 and BB-2. Whereas, variety HB-2 (2.5q ha^{-1} day-1) produced lowest total productivity of green fodder followed by BL-42 and HB-1.The results are conformity with the similar results was also reported by Kumar *et al.* (2021).

Table 4.13: Productivity of green fodder yield of different berseem varieties at different cuts

Treatments	Varieties	Productivity of green fodder yield (q ha^{-1} day^{-1})				
		1st Cut	2nd Cut	3rd Cut	4th Cut	Total
V_1	Wardan	1.83	5.19	4.18	2.05	3.02
V_2	BB-2	1.91	5.68	4.44	2.64	3.32
V_3	BB-3	2.07	5.88	4.94	2.71	3.53
V_4	JB-1	2.01	5.18	4.90	2.51	3.32
V_5	JB-5	1.87	4.91	4.79	2.31	3.15
V_6	JB-9	1.95	5.69	5.06	2.84	3.50
V_7	HB-1	1.85	4.88	3.53	2.18	2.86
V_8	HB-2	1.76	3.74	2.92	2.31	2.50
V_9	BL-10	1.79	4.61	3.95	2.38	2.91
V_{10}	BL-42	1.75	4.24	3.76	2.31	2.76
V_{11}	BL-43	2.00	4.89	4.16	2.58	3.13
V_{12}	BL-44	1.91	4.67	4.02	1.98	2.90
SEm ±		**0.06**	**0.18**	**0.17**	**0.15**	**0.08**
CD (P = 0.05)		**0.18**	**0.52**	**0.5**	**0.44**	**0.22**

4.2.4. Productivity of dry fodder each cut

Data show in Table 4.14 that the productivity of dry fodder at an accelerate rate between first, second and third cut. While at relatively slower rate between third to fourth cut. First cut was taken 60 days after sowing, berseem varieties was found non significant at this stage. During second, third and fourth cuts variety BB-3 was giving significantly maximum productivity of dry fodder yield (0.878, 1.01 and 0.84 q ha^{-1} respectively). However, at second cut which was at par with variety BB-2, JB-9 and JB-1. During third cut variety BB-3 was at par with JB-9, JB-1, JB-5 and BB-2. During fourth cut variety BB-3 was significantly at par with BB-2, JB-1, JB-5, JB-9, BL-10 and BL-43. Varieties BL-44 (0.55 q ha^{-1} day^{-1}) was recorded lowest productivity of dry fodder during fourth cut. Significantly maximum total productivity of dry fodder was recorded with variety BB-3 (0.639 q ha^{-1} day^{-1}) and was at par with varieties JB-9, JB-1 and BB-2. However, variety HB-2 (0.45 q ha^{-1} day^{-1}) was lowest in total productivity of dry fodder yield followed by HB-1. The results are conformity with the similar results was also reported by Kumar *et al.* (2021).

Table 4.14: Productivity of dry fodder yield of different berseem varieties at different cuts

Treatments	Varieties	Productivity of dry fodder yield(q ha^{-1} day^{-1})				
		1st Cut	2nd Cut	3rd Cut	4th Cut	Total
V_1	Wardan	0.21	0.75	0.81	0.66	0.53
V_2	BB-2	0.22	0.84	0.89	0.83	0.60
V_3	BB-3	0.23	0.88	1.01	0.84	0.64
V_4	JB-1	0.24	0.82	0.99	0.80	0.62
V_5	JB-5	0.22	0.75	0.96	0.73	0.58
V_6	JB-9	0.23	0.85	1.01	0.82	0.63
V_7	HB-1	0.22	0.74	0.69	0.60	0.49
V_8	HB-2	0.22	0.58	0.58	0.66	0.45
V_9	BL-10	0.22	0.67	0.77	0.71	0.52
V_{10}	BL-42	0.22	0.65	0.73	0.70	0.50
V_{11}	BL-43	0.23	0.73	0.82	0.75	0.55
V_{12}	BL-44	0.23	0.70	0.79	0.55	0.50
SEm ±		**0.01**	**0.02**	**0.04**	**0.05**	**0.01**
CD (P = 0.05)		**NS**	**0.07**	**0.12**	**0.14**	**0.04**

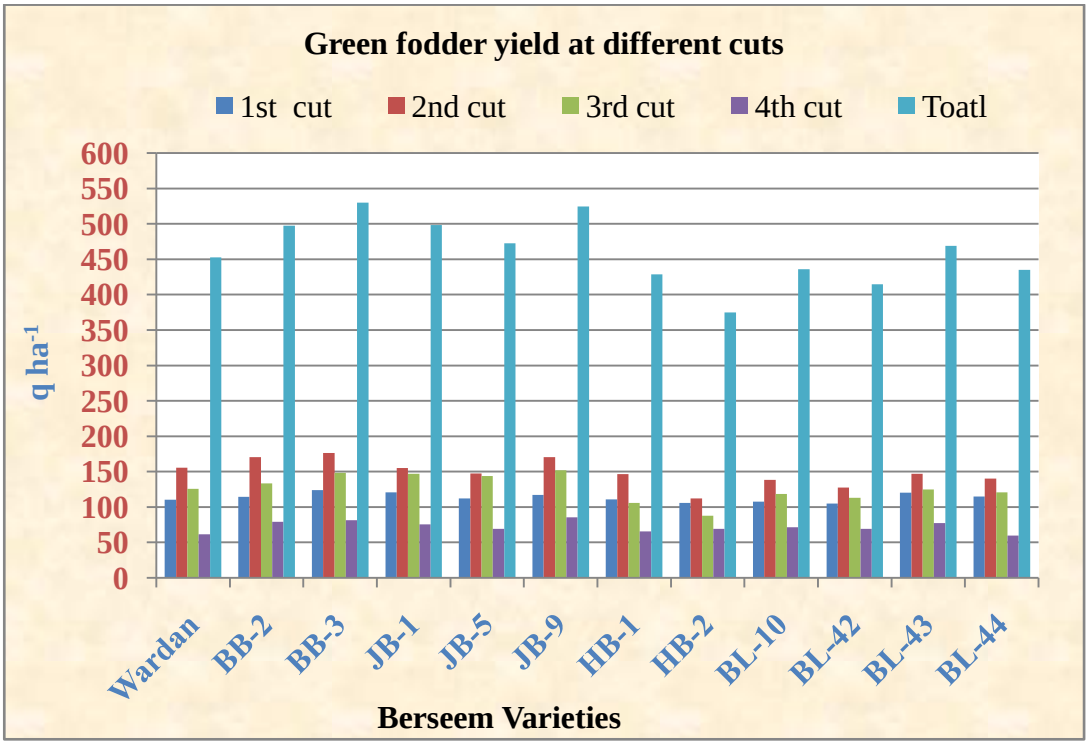

Fig. 4.11: Green fodder yield of different berseem varieties at different cuts

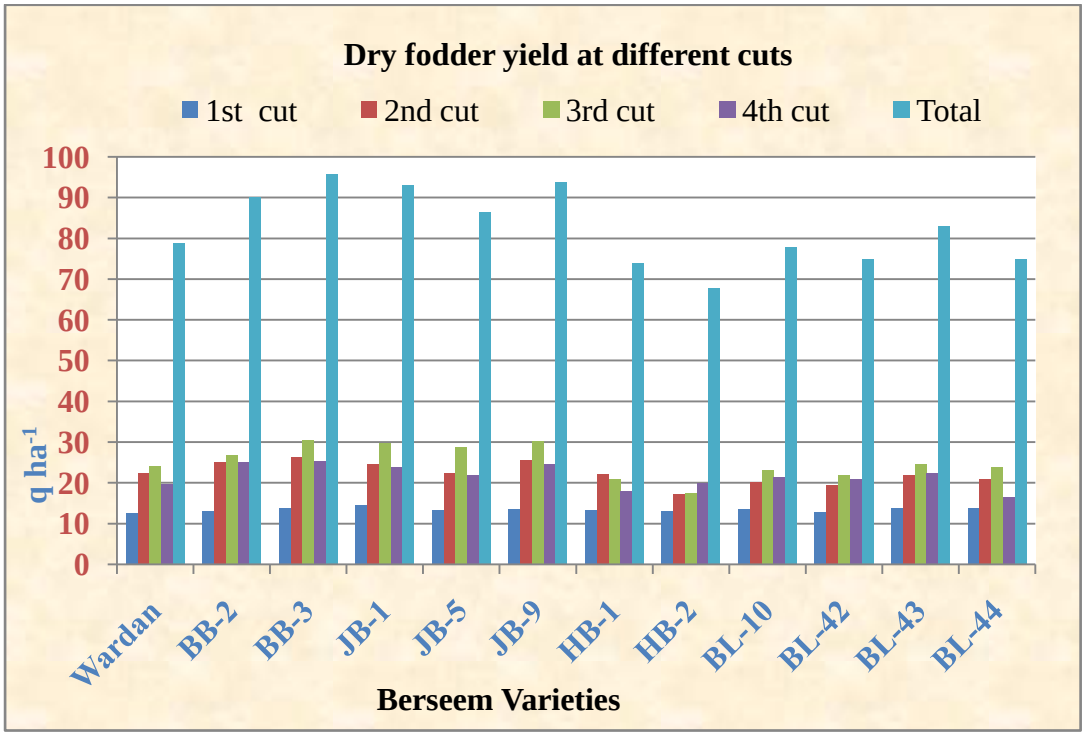

Fig. 4.12: Dry fodder yield of different berseem varieties at different cuts

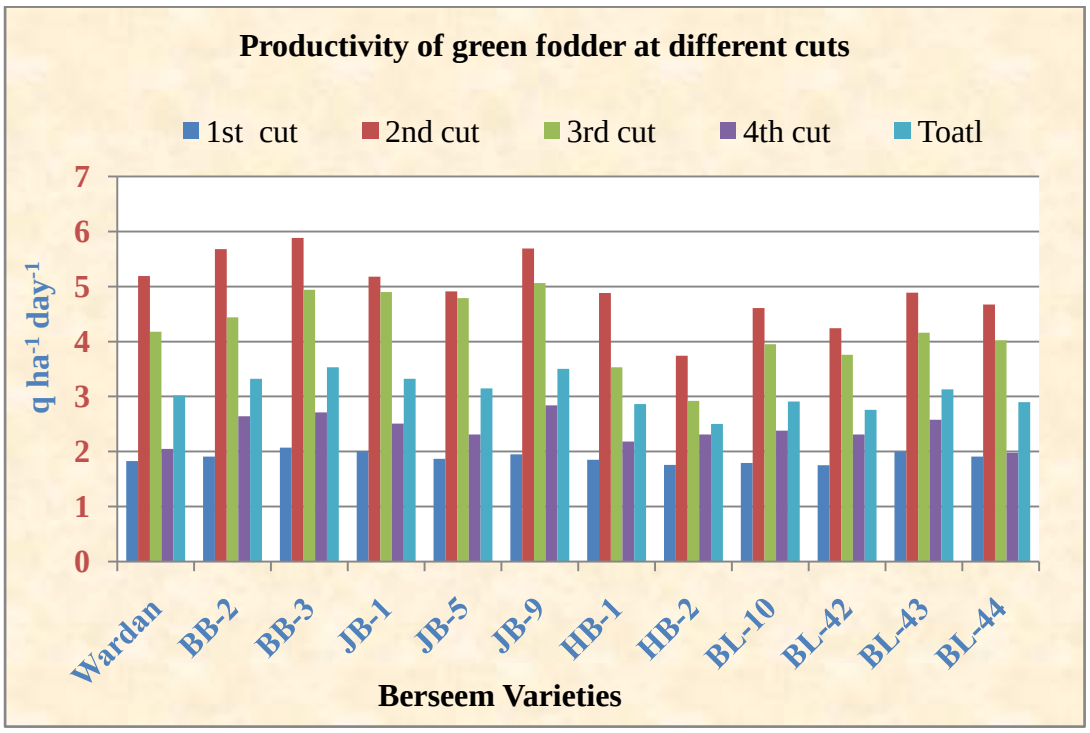

Fig. 4.13: Productivity of green fodder yield of different berseem varieties at different cuts

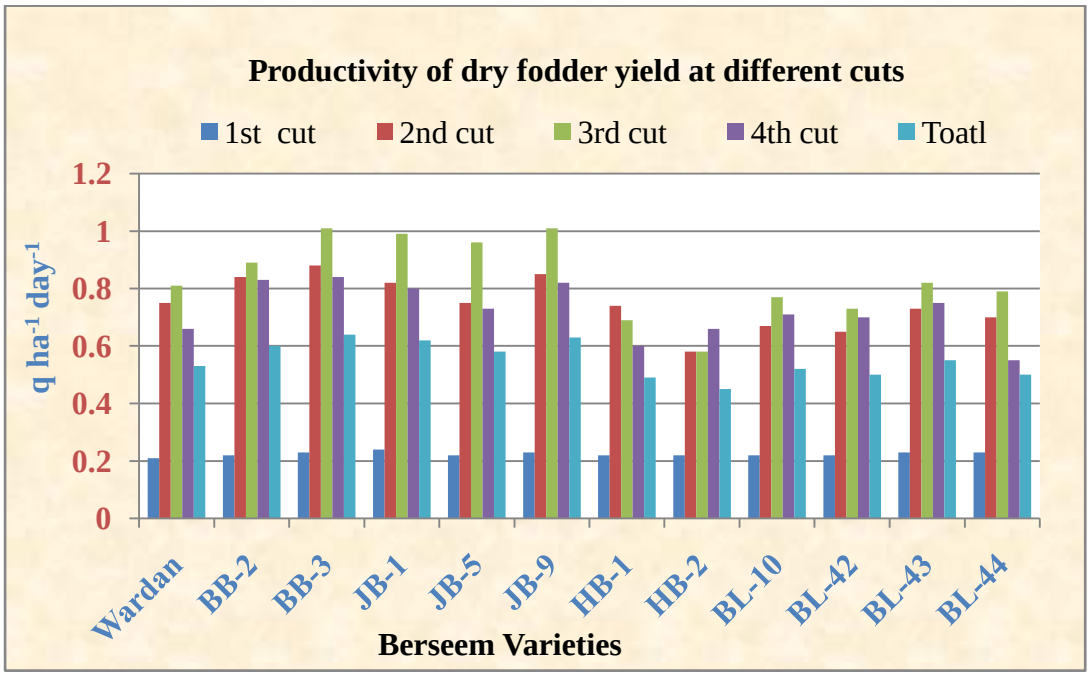

Fig. 4.14: Productivity of dry fodder yield of different berseem varieties at different cuts

4.3. Quality study

4.3.1. Crude protein yield at each cut and total

Data on crude protein yield presented in Table 4.15 shows that berseem varieties significantly differ in total crude protein yield as well as in different cuts. During first cut significantly maximum crude protein yield was produced by variety BL-43 (2.91 q ha^{-1}), which was at par with BB-2, BB-3, JB-1, JB-9, HB-1, BL-10, BL-42 and BL-44varieties. During second, third and fourth cut maximum crude protein yield was produced by BB-3 (6.15, 5.55, 4.52 q ha^{-1} respectively). However at second cut it was at par with variety JB-9(5.72 q ha^{-1}). Similarly during third cut it was at par with JB-9(5.42 q ha^{-1}), JB-1 (5.3 q ha^{-1}), and BB-2 (4.87 q ha^{-1}) varieties. At fourth cut variety BB-3 significantly at par with BB-2 (4.48 q ha^{-1}), JB-1 (4.18 q ha^{-1}) and JB-9(4.36 q ha^{-1}) varieties. However minimum crude protein yield was recorded by variety BL-44 (2.60 q ha^{-1}) followed by HB-1 (3.19 q ha^{-1}). Significantly maximum total crude protein yield was found in variety BB-3 (18.91 q ha^{-1}), which was at par with JB-9 (18.24q ha^{-1}) varieties. However, variety HB-2 (11.90 q ha^{-1}) was produced minimum total crude protein yield followed by BL-42 (13.90 q ha^{-1}). The results are conformity with the similar results were also reported by Devi and Satpal (2019) and Kumar *et al.* (2021).

4.3.2. Crude protein content at each cut

The data present in Table 4.16 shows that, during first cut there was non significant difference of crude protein content among the variety, however crude protein content was maximum presence of variety BL-44 (20.98 %) followed by BL-43 (20.86 %). During second cut significantly maximum crude protein content was present in variety BL-42 (23.45 %), which was at par with BB-3 (23.35 %), JB-9(22.44 %), BB-2 (21.46 %), JB-1 (21.42 %), JB-5 (23 %), BL-44 (22.58 %) and BL-10 (23.38 %) varieties. During third cut significantly maximum crude protein content was present in variety HB-1 (19.07 %), which was statistically at par with Wardan (17.84 %), BB-2 (18.17 %), BB-3 (18.25 %), JB-9(17.95 %), JB-1 (17.75 %) and HB-2 (17.8 %) varieties. During fourth cut significantly maximum crude protein content was present in variety BB- 3(17.95 %), which was at par with JB- 9 (17.62%), Wardan (17.40 %), BB- 2 (17.95 %), JB- 1 (17.51 %), and

HB- 1 (17.77 %) varieties. However minimum crude protein content (%) was presence in variety BL-42 (15.52 %) followed by BL- 43 (16.09 %).Similar results reported that Singh *et al*. (2020) and Kumar *et al.* (2021). Significant variation among different berseem varieties for crude protein also reported by Ali *et al.* (2018), Roy *et al* (2016) and Kumar *et al.* (2021).

Table 4.15: Crude protein yield of different berseem varieties at different cuts

Treatments	Varieties	Crude protein yield (q ha^{-1})				
		1st Cut	2nd Cut	3rd Cut	4th Cut	Total
V_1	Wardan	2.38	4.24	4.33	3.42	14.36
V_2	BB-2	2.69	5.39	4.87	4.48	17.44
V_3	BB-3	2.68	6.15	5.55	4.52	18.91
V_4	JB-1	2.87	5.27	5.30	4.18	17.63
V_5	JB-5	2.57	5.19	4.79	3.54	16.09
V_6	JB-9	2.75	5.72	5.42	4.36	18.24
V_7	HB-1	2.67	4.48	3.96	3.19	14.29
V_8	HB-2	2.50	2.97	3.11	3.32	11.90
V_9	BL-10	2.77	4.70	3.82	3.49	14.78
V_{10}	BL-42	2.68	4.53	3.44	3.25	13.90
V_{11}	BL-43	2.91	4.52	4.01	3.61	15.06
V_{12}	BL-44	2.88	4.72	3.90	2.60	14.11
	SEm ±	**0.09**	**0.24**	**0.24**	**0.24**	**0.39**
	CD(P=0.05)	**0.25**	**0.71**	**0.71**	**0.69**	**1.15**

Table 4.16: Crude protein content of different berseem varieties at different cuts

Treatments	Varieties	Crude protein content (%)			
		1st Cut	2nd Cut	3rd Cut	4th Cut
V_1	Wardan	19.08	18.83	17.84	17.40
V_2	BB-2	20.55	21.46	18.17	17.95
V_3	BB-3	19.41	23.35	18.25	17.95
V_4	JB-1	19.60	21.42	17.75	17.51
V_5	JB-5	19.54	23.00	16.70	16.12
V_6	JB-9	20.37	22.44	17.95	17.62
V_7	HB-1	20.30	20.30	19.07	17.77
V_8	HB-2	19.29	17.13	17.80	16.65
V_9	BL-10	20.72	23.38	16.73	16.35
V_{10}	BL-42	20.79	23.45	15.75	15.52
V_{11}	BL-43	20.86	20.55	16.25	16.09
V_{12}	BL-44	20.98	22.58	16.36	15.90
SEm ±		**0.62**	**0.86**	**0.49**	**0.41**
CD (P = 0.05)		**NS**	**2.53**	**1.44**	**1.19**

4.3.3. Dry matter content at each cut

The data presented in Table 4.17 shows that, the presence of dry matter content (%) on berseem is increasing trends after every cut. During first cut significantly maximum dry matter content (%) was found in variety BL-10 (12.4 %), which was at par with JB-1 (12.1 %), JB-5 (11.7 %), HB-1 (11.9 %), HB-2 (12.3 %), and BL-44 (12 %) varieties. However, minimum dry matter content (%) was presence in variety BB-3 (11.1 %) followed by Wardan (11.4 %). During second and third cuts there were no significant differences among the variety. However second cut maximum dry matter content (%) was present in variety JB-1 (15.9 %) followed by HB-2 (15.5 %). During third cut maximum dry matter content (%) was present in variety BB-3 (20.5 %) followed by JB-1 (20.3 %). At fourth cut significantly maximum dry matter content (%) was presence in variety Wardan (32 %), which was at par with BB-2 (31.5%), BB-3 (31%), JB-1 (31.7%) and JB-5 (31.6 %) varieties. However, varieties HB-1 (27.5%) was recorded minimum dry matter content (%) followed by BL-44 (27.6 %) during fourth cut. The results are conformity with the similar results was also reported by Singh *et al.* (2020).

Table 4.17: Dry matter content of different berseem varieties at different cuts

Treatments	Varieties	Dry matter content (%)			
		1st Cut	2nd Cut	3rd Cut	4th Cut
V_1	Wardan	11.40	14.43	19.37	32.00
V_2	BB-2	11.47	14.77	20.13	31.50
V_3	BB-3	11.13	14.97	20.53	31.00
V_4	JB-1	12.13	15.87	20.27	31.70
V_5	JB-5	11.73	15.30	20.00	31.60
V_6	JB-9	11.53	14.93	19.90	29.00
V_7	HB-1	11.87	15.07	19.63	27.50
V_8	HB-2	12.27	15.47	19.93	28.70
V_9	BL-10	12.40	14.53	19.33	29.90
V_{10}	BL-42	12.27	15.20	19.33	30.20
V_{11}	BL-43	11.60	15.07	19.60	29.00
V_{12}	BL-44	12.00	14.93	19.73	27.60
SEm ±		**0.24**	**0.28**	**0.56**	**0.50**
CD (P = 0.05)		**0.69**	**NS**	**NS**	**1.45**

4.3.4. Nitrogen content at each cut

The data presented in Table 4.18 shows that the nitrogen content during first cut there were no significant differences among the variety, however maximum nitrogen content (%) was presence in variety BL-44 (3.36 %) followed by BL-43 (3.34 %). At second cut significantly maximum nitrogen content (%) was present in variety BL-42 (3.75%), which was statistically at par with BB-3 (3.74 %), JB-9(3.59 %), BB-2 (3.43 %), JB-1 (3.43 %) JB-5 (3.68 %), BL-44 (3.61 %) and BL-10 (3.74 %) varieties. During third cut significantly maximum nitrogen content (%) was presence in variety HB-1 (3.05 %), which was at par with Wardan (2.85 %), BB-2 (2.91 %), BB-3 (2.92 %), JB-9(2.87 %), JB-1 (2.84 %) and HB-20 (2.85 %) varieties. During fourth cut significantly maximum nitrogen content (%) was found in variety BB- 3(2.87 %), which was at par with JB- 9 (2.82 %), Wardan (2.78 %), BB- 2 (2.87 %), JB- 1 (2.80 %), and HB- 1 (2.84 %) varities. However, minimum nitrogen content (%) was found in variety BL-42 (2.48 %) followed by in BL- 43 (2.57 %). Significant variation among different berseem varieties for nitrogen content also reported that Malvi *et al* (2019).

Table 4.18: Nitrogen content of different berseem varieties at different cuts

Treatments	Varieties	Nitrogen content (%)			
		1st Cut	2nd Cut	3rd Cut	4th Cut
V_1	Wardan	3.05	3.01	2.85	2.78
V_2	BB-2	3.29	3.43	2.91	2.87
V_3	BB-3	3.11	3.74	2.92	2.87
V_4	JB-1	3.14	3.43	2.84	2.80
V_5	JB-5	3.13	3.68	2.67	2.58
V_6	JB-9	3.26	3.59	2.87	2.82
V_7	HB-1	3.25	3.25	3.05	2.84
V_8	HB-2	3.09	2.74	2.85	2.66
V_9	BL-10	3.32	3.74	2.68	2.62
V_{10}	BL-42	3.33	3.75	2.52	2.48
V_{11}	BL-43	3.34	3.29	2.60	2.57
V_{12}	BL-44	3.36	3.61	2.62	2.54
SEm ±		**0.10**	**0.14**	**0.08**	**0.06**
CD (P = 0.05)		**NS**	**0.40**	**0.23**	**0.19**

4.3.5. Phosphorus content at each cut

Data in Table 4.19 shows that during first and second cut phosphorus content of berseem varieties are approximately equal. After second cut phosphorus content are low in berseem varieties. During first cut significantly maximum phosphorus content was presence in variety BL-10 (0.16 %), which was at par with JB-9(0.15 %), BB-3 (0.15 %), BB-2 (11.9 %) and Wardan (0.15 %) varieties. At second cut significantly maximum phosphorus content was presence in variety BB-3 (0.16 %), which was at par with JB-9 (0.15 %) and BL-10 (0.15 %) varieties. However minimum phosphorus content was presence in BL-44 (0.13 %) followed by BL-43 (0.13 %), Wardan (0.13 %) and HB-2 (0.13 %) varieties. During third and fourth cut there were no significant differences among the variety, however maximum phosphorus content was presence in variety Wardan (0.07, 0.06 % respectively). The results are conformity with the similar results was also reported by Gangwar *et al.* (2014).

Table 4.19: Phosphorus content of different berseem varieties at different cuts

Treatments	Varieties	Phosphorus content (%)			
		1st Cut	2nd Cut	3rd Cut	4th Cut
V_1	Wardan	0.15	0.13	0.07	0.06
V_2	BB-2	0.15	0.14	0.06	0.05
V_3	BB-3	0.15	0.16	0.05	0.05
V_4	JB-1	0.11	0.14	0.05	0.05
V_5	JB-5	0.12	0.14	0.05	0.05
V_6	JB-9	0.15	0.15	0.05	0.05
V_7	HB-1	0.12	0.14	0.06	0.06
V_8	HB-2	0.13	0.13	0.06	0.06
V_9	BL-10	0.16	0.15	0.06	0.05
V_{10}	BL-42	0.13	0.14	0.06	0.05
V_{11}	BL-43	0.12	0.13	0.05	0.06
V_{12}	BL-44	0.12	0.13	0.06	0.06
SEm ±		**0.01**	**0.00**	**0.00**	**0.00**
CD (P = 0.05)		**0.02**	**0.01**	**NS**	**NS**

4.3.6. Potassium content at each cut

Data presented in Table 4.20 shows that during first cut to subsequent cut potassium content of berseem are decreasing rate trends. During first cut significantly maximum potassium content (%) was found in variety Wardan (2.6

%), which was at par with JB-9(2.39 %), BB-3 (2.22 %), BL-10 (2.23 %), BL-43 (2.35 %), BL-44 (2.25 %) and HB-2 (2.4 %) varieties. During second cut there were no significant differences among the berseem varieties. However, maximum potassium content was presence in variety HB-2 (1.80 %) followed by BB-3 (1.64 %). During third cut significantly maximum potassium content (%) was presence in variety BL-42 (1.74 %), which was at par with JB-9(1.70 %), BB-3 (1.71 %), BL-43 (1.67%) and BL-44 (1.72 %) varieties. During fourth cut significantly maximum potassium content was found in variety JB-9(1.10 %) give (%), which was at par with BB-2 (1.07 %) and BL-10 (1.02 %) varieties. Whereas, minimum potassium content (%) was presence found in BL-44 (0.93 %) followed by HB-2 (0.94 %). The results are conformity with the similar results was also reported by Shahrajabian *et al.* (2019) and Soleymani *et al.* (2011).

Table 4.20: Potassium content of different berseem varieties at different cuts

Treatments	Varieties	Potassium content (%)			
		1st Cut	2nd Cut	3rd Cut	4th Cut
V_1	Wardan	2.60	1.39	1.61	0.99
V_2	BB-2	2.11	1.43	1.31	1.07
V_3	BB-3	2.22	1.64	1.71	0.96
V_4	JB-1	1.83	1.47	1.53	1.01
V_5	JB-5	1.83	1.50	1.70	0.99
V_6	JB-9	2.39	1.59	1.28	1.10
V_7	HB-1	2.14	1.49	1.58	0.97
V_8	HB-2	2.40	1.80	1.32	0.94
V_9	BL-10	2.23	1.60	1.44	1.02
V_{10}	BL-42	2.19	1.53	1.74	1.01
V_{11}	BL-43	2.35	1.51	1.67	0.96
V_{12}	BL-44	2.25	1.47	1.72	0.93
SEm ±		**0.13**	**0.10**	**0.04**	**0.03**
CD (P = 0.05)		**0.38**	**NS**	**0.11**	**0.08**

4.3.7. Nitrogen uptake

Data presented in Table 4.21 shows that during first cut significantly maximum nitrogen uptake by variety BL-43 (46.56 kg ha^{-1}), which was at par with JB-9, BB-3, BB-2, JB-1, HB-1, BL-10, BL-42 and BL-44 varieties. At second cut significantly maximum nitrogen uptake was found in variety BB-3 (98.47 kg ha^{-1}), which was at par with JB-9(91.45 kg ha^{-1}). During third and fourth cut significantly maximum nitrogen uptake was found in variety BB-3 (88.85, 72.36

kg ha^{-1} respectively), which was at par with BB-2 (77.88 kg ha^{-1}), JB-1 (84.84 kg ha^{-1}) and JB-9(86.71 kg ha^{-1}) varieties during third cut. During fourth cut variety BB-3 was at par with BB-2 (71.74 kg ha^{-1}) followed by JB-1 (66.94 kg ha^{-1}) and JB-9(69.70 kg ha^{-1}) varieties. However, minimum nitrogen uptake was found in BL-44 (41.65 kg ha^{-1}) followed by HB-1 (50.98 kg ha^{-1}). Significantly maximum total nitrogen uptake was found in variety BB-3 (302.6 kg ha^{-1}), which was at par with JB-9(291.8 kg ha^{-1}). Whereas, minimum nitrogen uptake was found in HB-2 (188.1 kg ha^{-1}) followed by BL-42 (222.4 kg ha^{-1}). The results are conformity with the similar results was also reported by Singh *et al.* (2020), nitrogen uptake ranged between 219.64- 291.52 (kg ha^{-1}).

Table 4.21: Nitrogen uptake of different berseem varieties at different cuts

Treatments	Berseem varieties	Nitrogen uptake (kg ha^{-1})				
		1st Cut	2nd Cut	3rd Cut	4th Cut	Total
V_1	Wardan	38.04	67.78	69.24	54.77	229.8
V_2	BB-2	43.07	86.29	77.88	71.74	279.0
V_3	BB-3	42.91	98.47	88.85	72.36	302.6
V_4	JB-1	45.97	84.37	84.85	66.94	282.1
V_5	JB-5	41.13	83.00	76.70	56.58	257.4
V_6	JB-9	43.98	91.45	86.71	69.70	291.8
V_7	HB-1	42.75	71.63	63.29	50.98	228.6
V_8	HB-2	40.05	47.55	47.45	53.06	188.1
V_9	BL-10	44.28	75.23	61.09	55.86	236.5
V_{10}	BL-42	42.83	72.49	55.02	52.07	222.4
V_{11}	BL-43	46.56	72.40	64.19	57.83	241.0
V_{12}	BL-44	46.14	75.60	62.37	41.65	225.8
SEm ±		**1.37**	**3.88**	**3.88**	**3.79**	**6.23**
CD (P = 0.05)		**4.02**	**11.39**	**11.38**	**11.12**	**18.28**

4.3.8. Phosphorus uptake

Data presented in Table 4.22 shows that during first cut significantly maximum phosphorus uptake was found in variety BL-10 (2.16 kg ha^{-1}), which was at par with JB-9(1.96 kg ha^{-1}), BB-3 (2.06 kg ha^{-1}) BB-2 (1.96kg ha^{-1}) and Wardan (1.85 kg ha^{-1}) varieties. At second cut significantly maximum phosphorus uptake was found in variety BB-3 (4.21 kg ha^{-1}), which was statistically at par with JB-9(3.83 kg ha^{-1}). During third cut significantly maximum phosphorus uptake was found in variety BB-3 (1.66 kg ha^{-1}), which was at par with JB-9(1.58 kg ha^{-1}), JB-

1 (1.64 kg ha^{-1}), JB-5 (1.53 kg ha^{-1}) BB-2 (1.48 kg ha^{-1}), BL-44 (1.49 kg ha^{-1}) and Wardan (1.61 kg ha^{-1}) varieties. During fourth cut there were no significant differences among the variety. However, highest phosphorus uptake was found in variety BL-43 (1.4kg ha^{-1}) followed by BB-3 (1.38 kg ha^{-1}). Whereas, minimum phosphorus uptake was found in BL-44 (1.0 kg ha^{-1}) followed by HB-1 (1.04 kg ha^{-1}). Significantly maximum total phosphorus uptake was found in varieties BB-3 (9.31 kg ha^{-1}), which was statistically at par with variety JB-9(8.64 kg ha^{-1}). Whereas, lowest phosphorus uptake was found in HB-2 (6.4 kg ha^{-1}) followed by BL-44 (6.8 kg ha^{-1}) varieties.

Table 4.22: Phosphorus uptake of different berseem varieties at different cuts

Treatments	Varieties	Phosphorus uptake (kg ha^{-1})				
		1st Cut	2nd Cut	3rd Cut	4th Cut	Total
V_1	Wardan	1.85	3.01	1.61	1.11	7.58
V_2	BB-2	1.96	3.55	1.48	1.36	8.35
V_3	BB-3	2.06	4.21	1.66	1.38	9.31
V_4	JB-1	1.60	3.35	1.64	1.28	7.88
V_5	JB-5	1.56	3.13	1.53	1.16	7.37
V_6	JB-9	1.96	3.83	1.58	1.28	8.64
V_7	HB-1	1.59	3.00	1.20	1.04	6.83
V_8	HB-2	1.71	2.30	1.13	1.26	6.40
V_9	BL-10	2.16	3.06	1.28	1.16	7.65
V_{10}	BL-42	1.64	2.71	1.30	1.12	6.77
V_{11}	BL-43	1.62	2.90	1.35	1.40	7.26
V_{12}	BL-44	1.60	2.73	1.49	1.00	6.83
SEm ±		**0.11**	**0.14**	**0.10**	**0.10**	**0.29**
CD (P = 0.05)		**0.33**	**0.40**	**0.28**	**NS**	**0.85**

4.3.9. Potassium uptake

Data presented in Table 4.23 shows that the during first and second cut there were no significant differences of among the varieties. However maximum potassium uptake was found in variety BL-43 (32.84 kg ha^{-1}) followed by Wardan (32.32 kg ha^{-1}) during first cut. During second cut maximum potassium uptake was found in variety BB-3 (43.39 kg ha^{-1}) followed by JB-9(40.59 kg ha^{-1}). During third cut significantly maximum potassium uptake was found in variety BB-3 (51.77 kg ha^{-1}), which was at par with JB-1 (45.43 kg ha^{-1}), JB-5 (48.50 kg ha^{-1}) varieties. During fourth cut significantly maximum potassium uptake was found in variety BB-2 (26.78 kg ha^{-1}), which was at par with BB-3 (24.18 kg ha^{-1}) and JB-1

(24.21 kg ha^{-1}) varieties. Significantly maximum total potassium uptake was found in variety BB-3 (150.7 kg ha^{-1}), which was statistically at par with JB-9(138.67 kg ha^{-1}). Whereas, minimum total potassium uptake was found in HB-2 (104.28 kg ha^{-1}), followed by HB-1 (111.31kg ha^{-1}) varieties. The results are conformity with the similar results was also reported by Singh *et al.* (2020).

Table 4.23: Potassium uptake of different berseem varieties at different cuts

Treatments	Varieties	Potassium uptake (kg ha^{-1})				
		1st Cut	2nd Cut	3rd Cut	4th Cut	Total
V_1	Wardan	32.32	31.53	39.11	19.65	122.60
V_2	BB-2	27.76	36.06	35.03	26.78	125.63
V_3	BB-3	30.73	43.39	51.77	24.18	150.07
V_4	JB-1	26.71	36.14	45.43	24.21	132.48
V_5	JB-5	24.04	34.02	48.50	21.91	128.47
V_6	JB-9	32.26	40.59	38.75	27.07	138.67
V_7	HB-1	28.15	32.89	32.89	17.38	111.31
V_8	HB-2	31.25	31.22	23.01	18.80	104.28
V_9	BL-10	29.67	31.97	33.20	21.72	116.55
V_{10}	BL-42	28.36	29.64	37.89	21.06	116.96
V_{11}	BL-43	32.84	33.51	41.01	21.48	128.84
V_{12}	BL-44	30.92	30.85	40.84	15.21	117.82
SEm ±		**1.94**	**2.78**	**2.23**	**1.63**	**4.95**
CD (P = 0.05)		**NS**	**NS**	**6.54**	**4.79**	**14.52**

4.4. Computation

4.4.1. Crop growth rate (CGR)

The net outcome of photosynthesis and respiration is represented by the rate of crop growth. Crop growth rate of different berseem varieties computed for 0-30, 30-60, 60-90, 90-120 and 120-150 days after sowing. The Fig. 4.15 shows that the Overall growth stages the variety BB-3 was show highest crop growth rate followed by JB-1, BB-2 and JB-9. Whereas, minimum crop growth rate was found in HB-1 followed by HB-2.

4.4.2. Relative growth rate (RGR)

Relative growth rate was presented the increase of plant material per unit weight per unit time of a crop. It was calculated between 30-60, 60-90, 90-120 and 120-150 days after sowing. Fig. 4.16 shows that the overall growth stages, the variety BB-3 was show highest relative growth rate followed by JB-9, BB-2 and

JB-1. Whereas, minimum relative growth rate was found BL-10 followed by HB-2 varieties.

4.4.3. Leaf mass fraction (LMF)

Leaf weight ratio is the measure of leaf biomass. It is the ratio of leaf mass and the total dry mass of plant. Leaf weight ratio calculated between 0-30, 30-60, 60-90, 90-120 and 120-150 days after sowing. Overall growth stages the variety BL-10 was show highest leaf weight ratio followed by JB-9 and HB-2, minimum leaf weight ratio was found HB-1 followed by JB-1 and JB-5.

4.4.4. Leaf production rate

Leaf production rate can be found by counting the number of leaves was presence at specific time interval on tagged plants. It is expressed in leaves day^{-1}. Leaf production rate was calculated between 0-30, 30-60, 60-90, 90-120 and 120-150 days after sowing. Leaf production rate was increasing trends up to 90 days after sowing, after that it was decreasing trends. Overall growth stages the variety JB-9 was show highest leaf production rate followed by BB-3 and JB-1 and BB-2. Whereas, minimum leaf production rate was found BL-43 followed by HB-1.

4.5. Economics

In addition to maximising crop yields, agricultural research's ultimate goal is to generate the highest possible financial returns. Because of this, it's important to calculate economic factors like the cost of cultivation (Rs), gross financial return (Rs), net returns (Rs), and B: C ratio in order to assess the effects of varieties and gauge their utility for farmers.

4.5.1 Cost of cultivation

The data presented in Table 4.26 shows that the cost of cultivation various berseem varieties are the same due to a set of practises used in all varieties.

The data presented in Table 4.24 shows that the operation wise expenditure for the berseem crop. The maximum expenditure was recorded on cutting cost (Rs. 18000) per hectare, which contributes to 40.4 percent of total cost followed by sowing cost (11.78 %), irrigation cost (11.67 %), field preparation (10.77 %), fertilizer cost (10.68 %), interest on capital (9.09 %) and weeding cost (5.61 %).

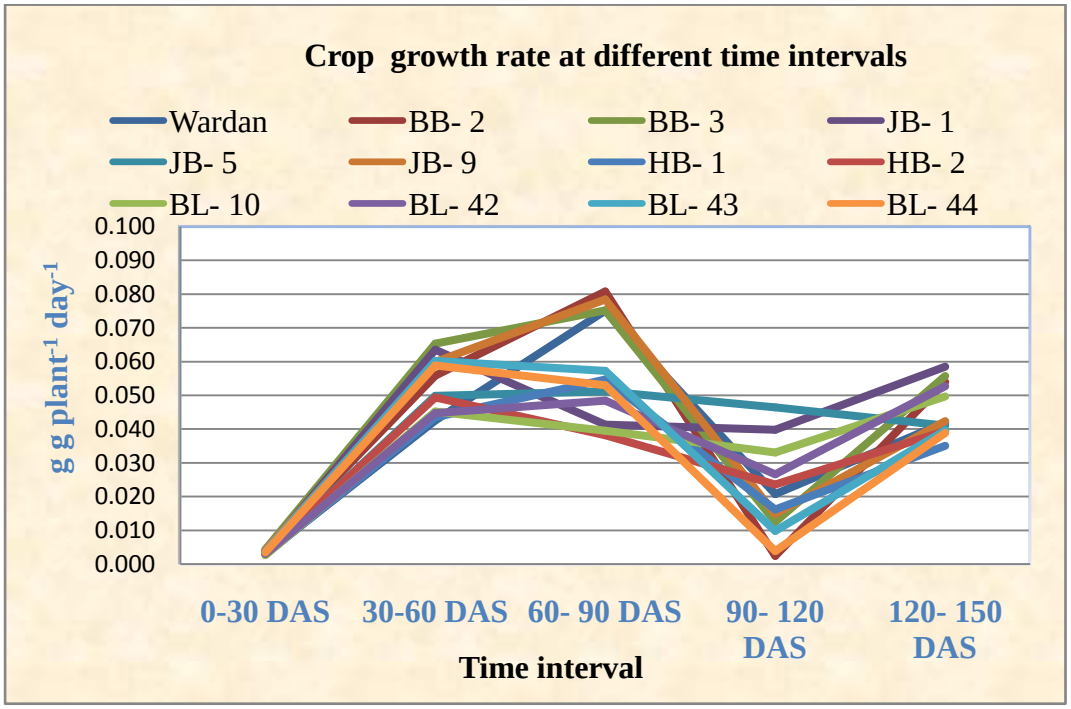

Fig. 4.15: Crop growth rate (g g plant^{-1} day^{-1}) of different berseem varieties

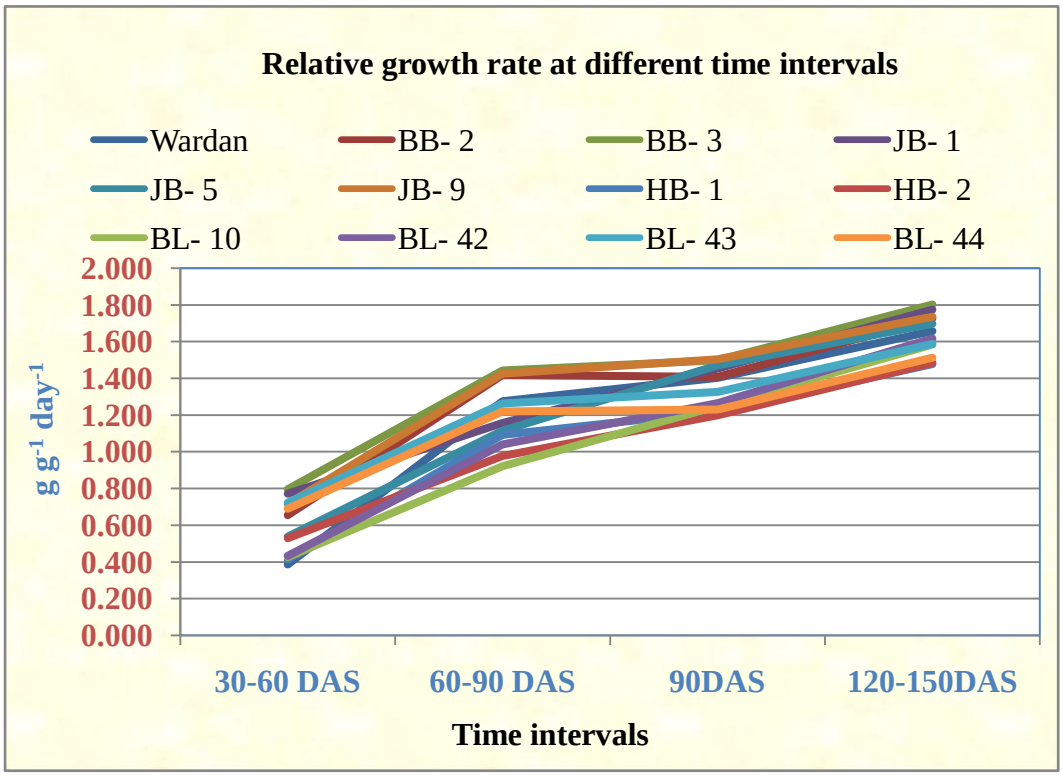

Fig. 4.16: Relative growth rate (g g plant^{-1} day^{-1}) of different berseem varieties

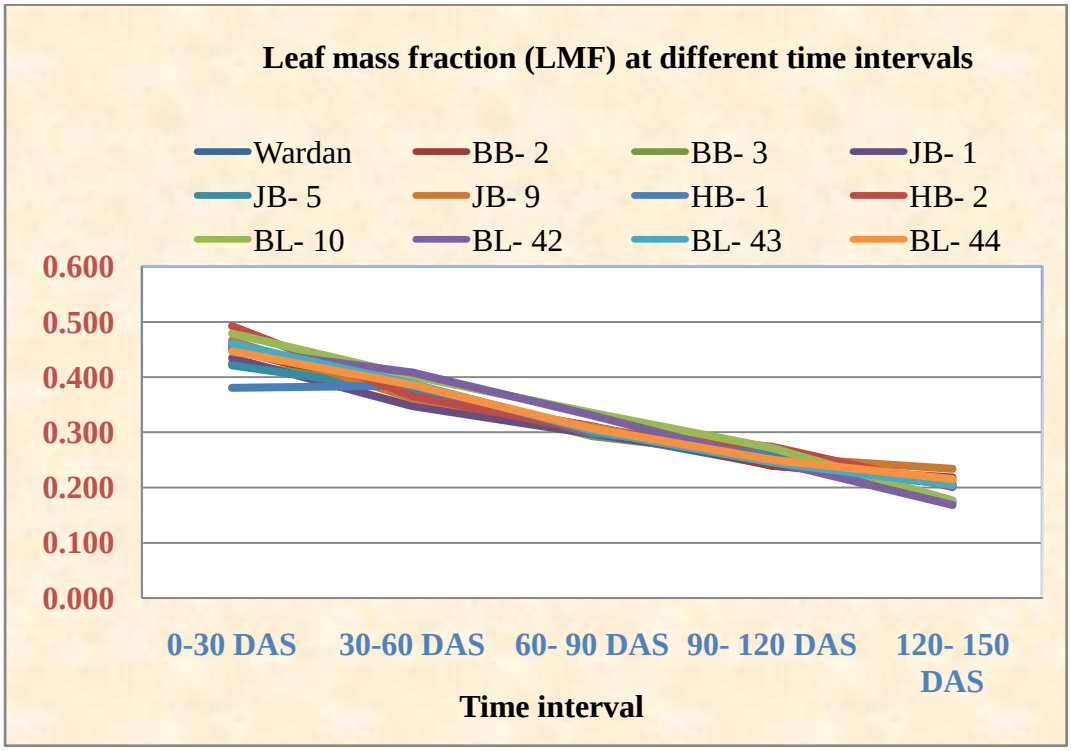

Fig. 4.17: Leaf mass fraction (LMF) of different berseem varieties

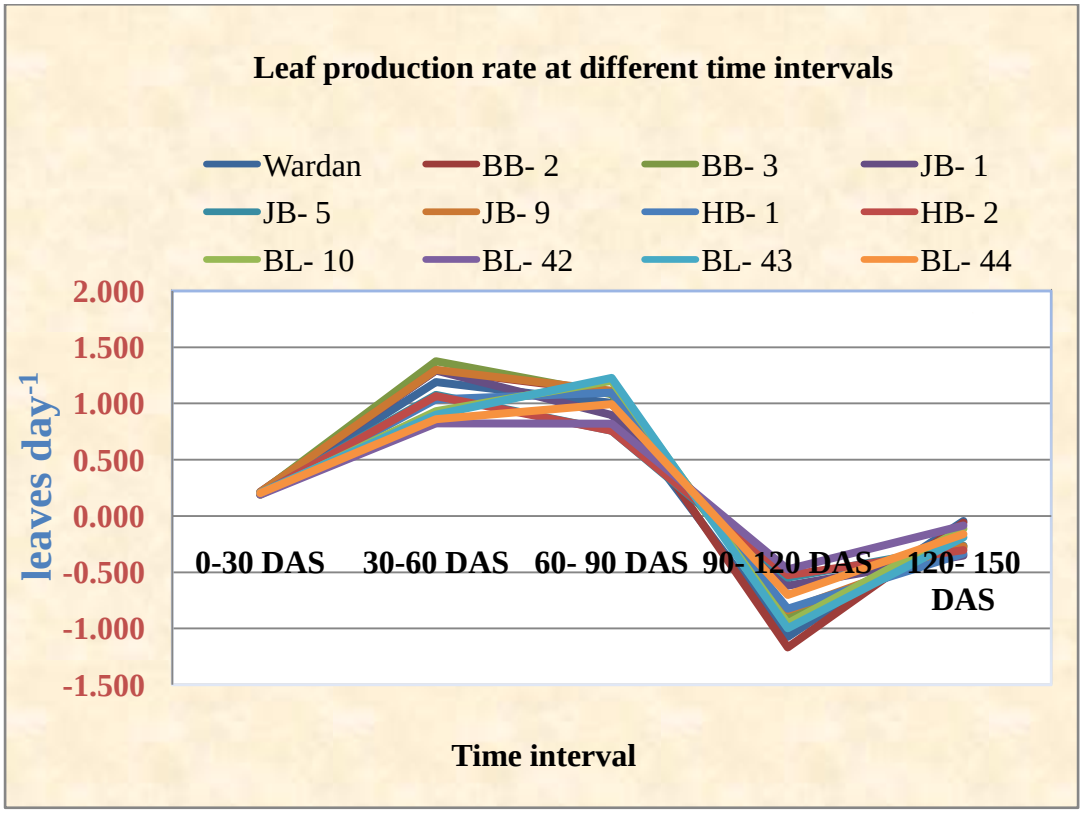

Fig. 4.18: Leaf production rate of different berseem varieties

Item wise cost of cultivation presented in Table 4.25 shows that the maximum expenditure was recorded on item total labour cost (Rs. 24000) per hectare, which contributes to 53.86 percent of total cost followed by tractor power cost (10.77 %), fertilizer cost (10.11 %), interest on capital (9.09 %), seed cost (8.98 %) and irrigation cost (7.18%).

Table 4.24: Operation wise cost expenses on per hectare basis

S. No.	Operation	Cost (Rs.)	Contribution (%)
1.	Field preparation	4800	10.77
2.	Sowing cost	5250	11.78
3.	Fertilizer cost	4757	10.68
4.	Irrigation cost	5200	11.67
5.	Weeding cost	2500	5.61
6.	Cutting cost	18000	40.40
7.	Interest on capital (10 %)	4051	9.09
	Total operation cost	**44558**	**100**

Table 4.25: Item wise cost distribution on per hectare basis

S. No.	Item	Cost (Rs.)	Contribution (%)
1.	Tractor power cost	4800	10.77
2.	Total labour cost	24000	53.86
3.	Seed cost	4000	8.98
4.	Fertilizer cost	4507	10.11
5.	Irrigation cost	3200	7.18
6.	Interest on capital (10 %)	4051	9.09
	Total operation cost	**44558**	**100**

4.5.2. Gross monetary return

There is a direct relationship between gross monetary return and yield because the higher the yield, higher will be gross return. Data presented in Table 4.24 reveals that variety BB-3 (132487 Rs. ha^{-1}) was received maximum gross return followed by JB-9 (131148 Rs. ha^{-1}), JB-1 (124603 Rs. ha^{-1}) and BB-2 (124603 Rs. ha^{-1}). Whereas, variety HB-2 (99663 Rs. ha^{-1}) noted the lowest gross monetary return followed by BL-42 (103679 Rs. ha^{-1}).

4.5.3 Net monetary return

Data presented in Table 4.24 reveals that variety BB-3 (87929 Rs. ha^{-1}) received maximum net monetary return followed by JB-9(86590 Rs. ha^{-1}), JB-1 (80045 Rs. ha^{-1}) and BB-2 (79797 Rs. ha^{-1}). Variety HB-2 (49105 Rs. ha^{-1}) noted the lowest net monetary return followed by BL-42 (59121 Rs. ha^{-1}). Variety BB-3 was recorded maximum net monetary return because of it was produced significantly maximum green yield with the set same practice of packages of all varieties.

4.5.4 Benefit: Cost ratio

Data presented in Table 4.26 reveals that variety BB-3 (2.97) was recorded maximum B: C ratio followed by JB-9 (2.94), JB-1 (2.80) and BB-2 (2.79). Variety HB-2 (2.10) noted the lowest B: C ratio followed by BL-42 (2.33).

Table 4.26: Cost of cultivation, Gross monetary return, Net monetary return and Benefit: Cost ratio of different berseem varieties

Treatments	Varieties	Cost of cultivation (Rs. ha^{-1})	Gross monetary return (Rs. ha^{-1})	Net monetary return (Rs. ha^{-1})	B : C ratio
V_1	Wardan	44558	113199	68640.8	2.54
V_2	BB-2	44558	124355	79797.0	2.79
V_3	BB-3	44558	132487	87928.7	2.97
V_4	JB-1	44558	124603	80044.9	2.80
V_5	JB-5	44558	118108	73549.5	2.65
V_6	JB-9	44558	131148	86589.9	2.94
V_7	HB-1	44558	107150	62591.6	2.40
V_8	HB-2	44558	93663	49104.9	2.10
V_9	BL-10	44558	108984	64426.2	2.45
V_{10}	BL-42	44558	103679	59120.8	2.33
V_{11}	BL-43	44558	117265	72706.6	2.63
V_{12}	BL-44	44558	108786	64227.8	2.44

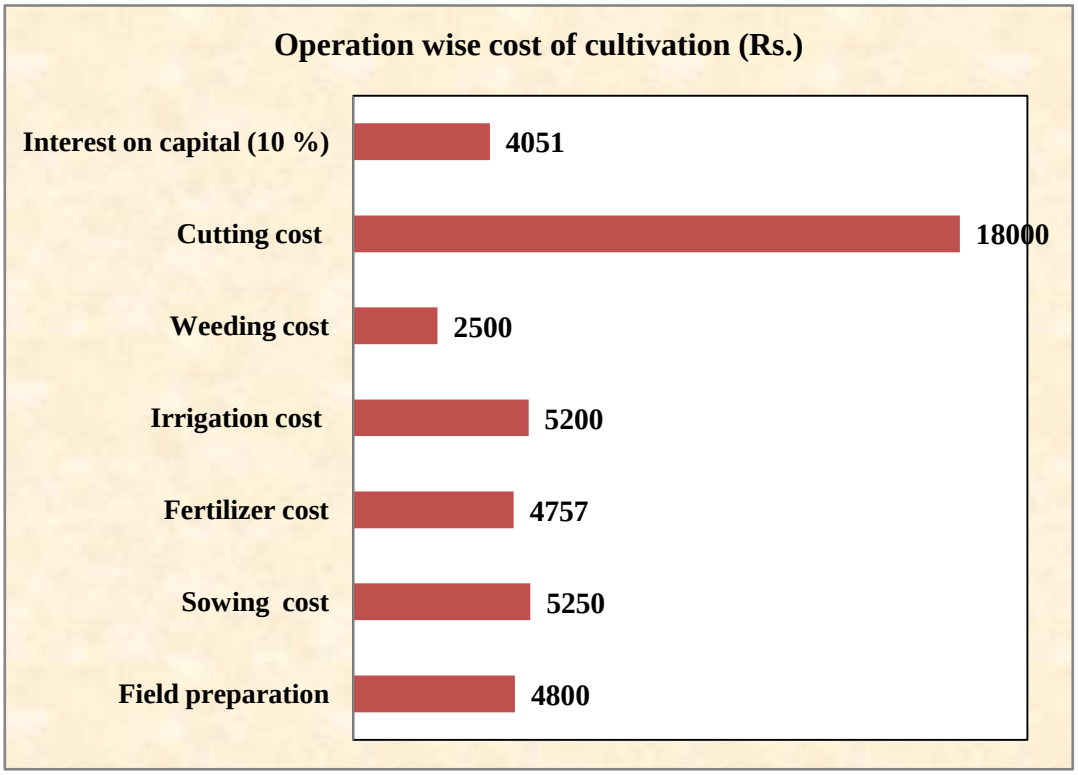

Fig.4.19: Operation wise cost of cultivation (per hectare basis

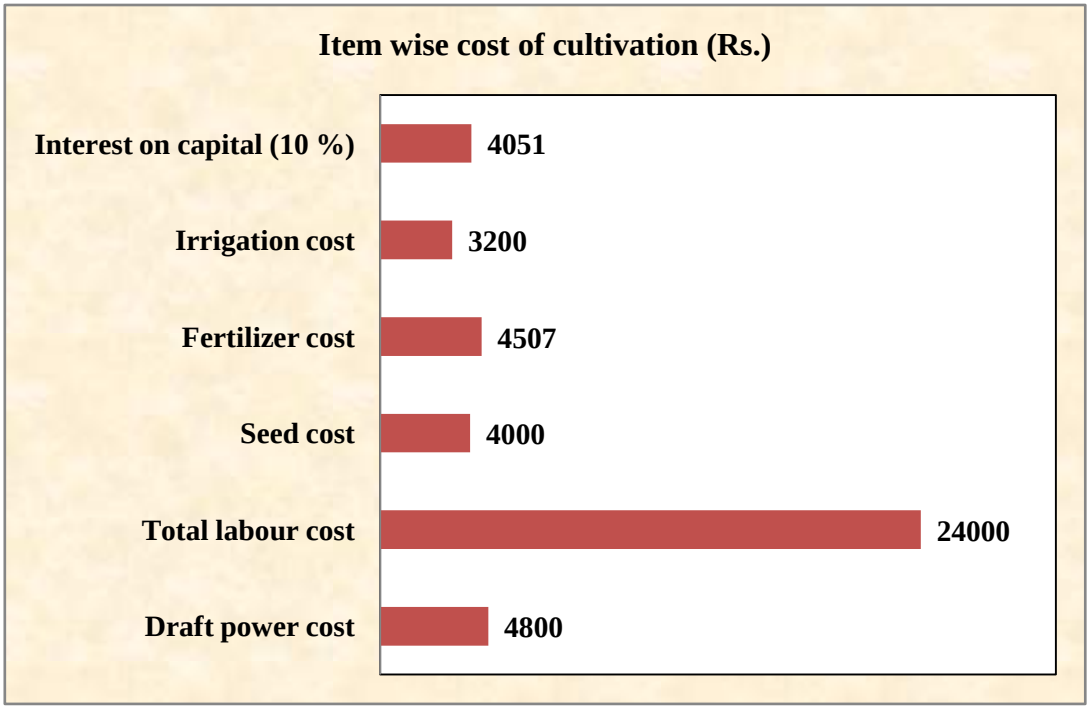

Fig.4.20: Item wise cost of cultivation (per hectare basis)

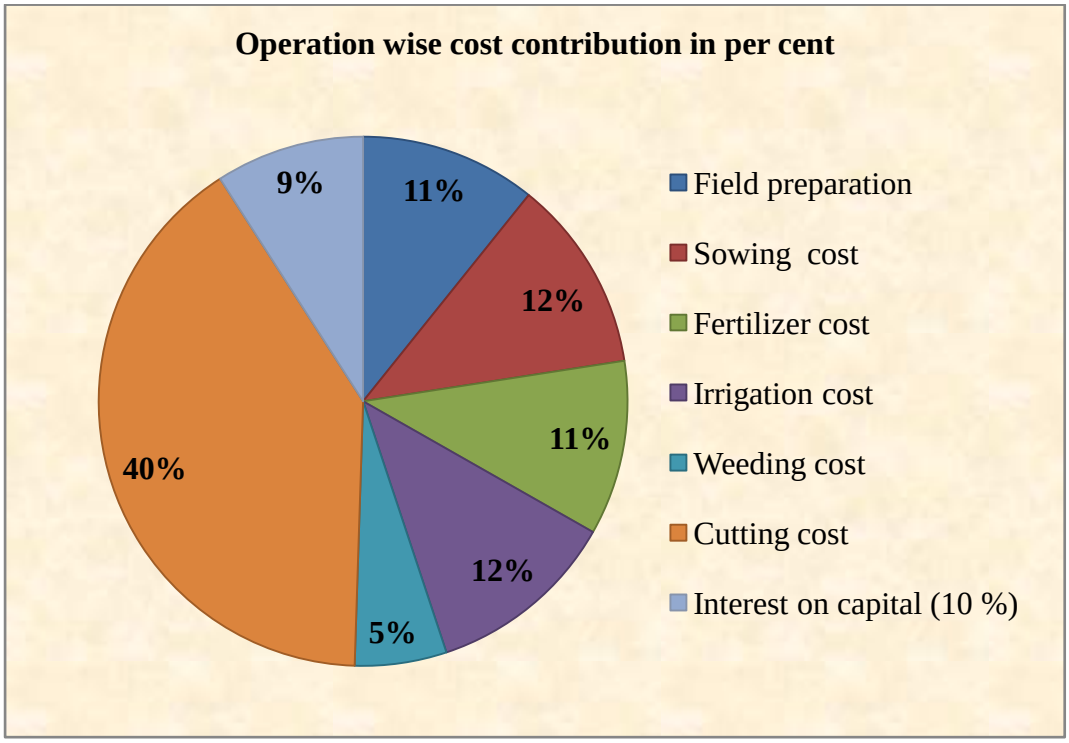

Fig.4.21: Operation wise cost expenses in per cent (per hectare basis)

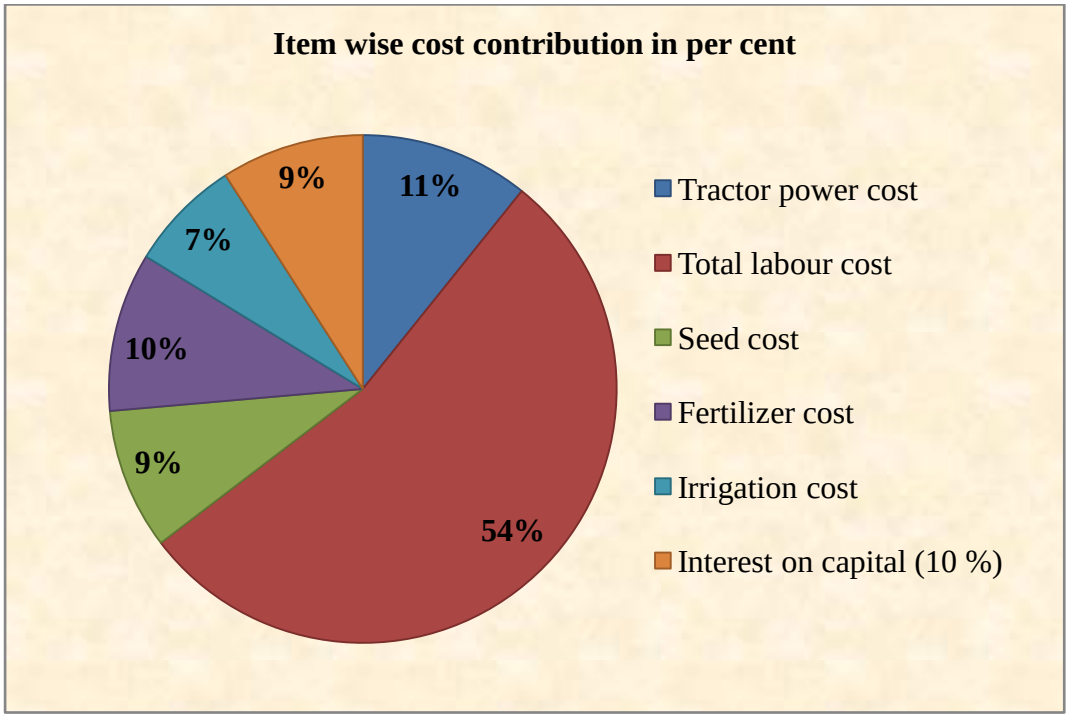

Fig.4.22: Item wise cost expenses in per cent (per hectare basis)

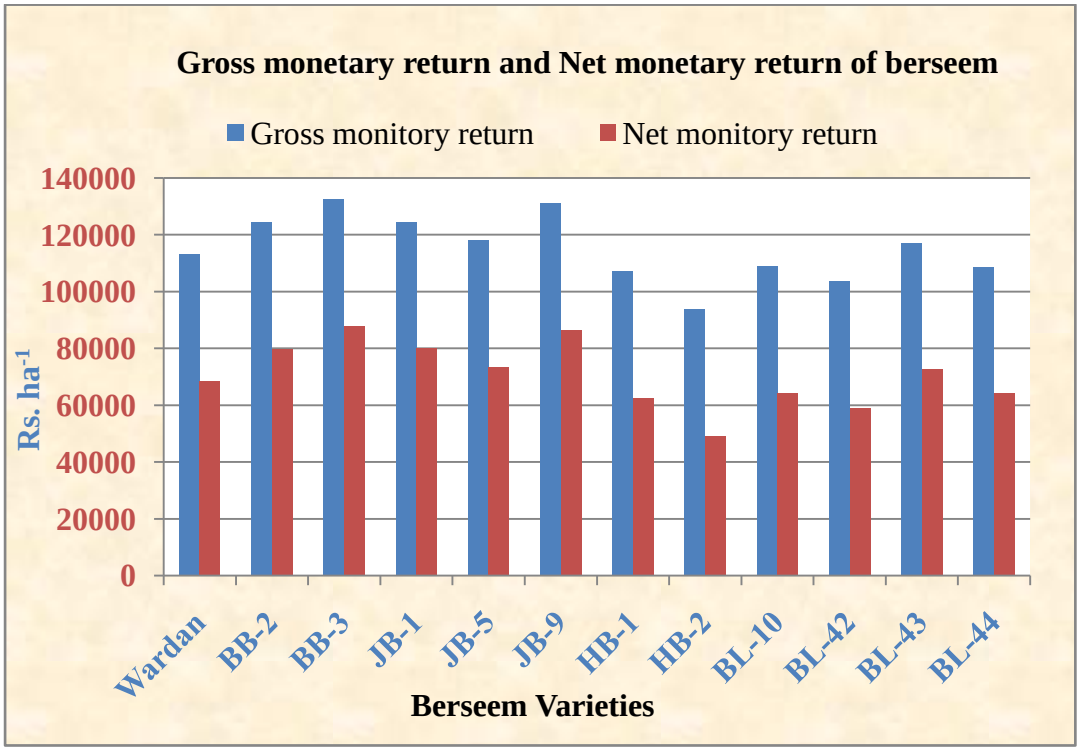

Fig. 4.23: Gross monetary return, and Net monetary return of different berseem varieties

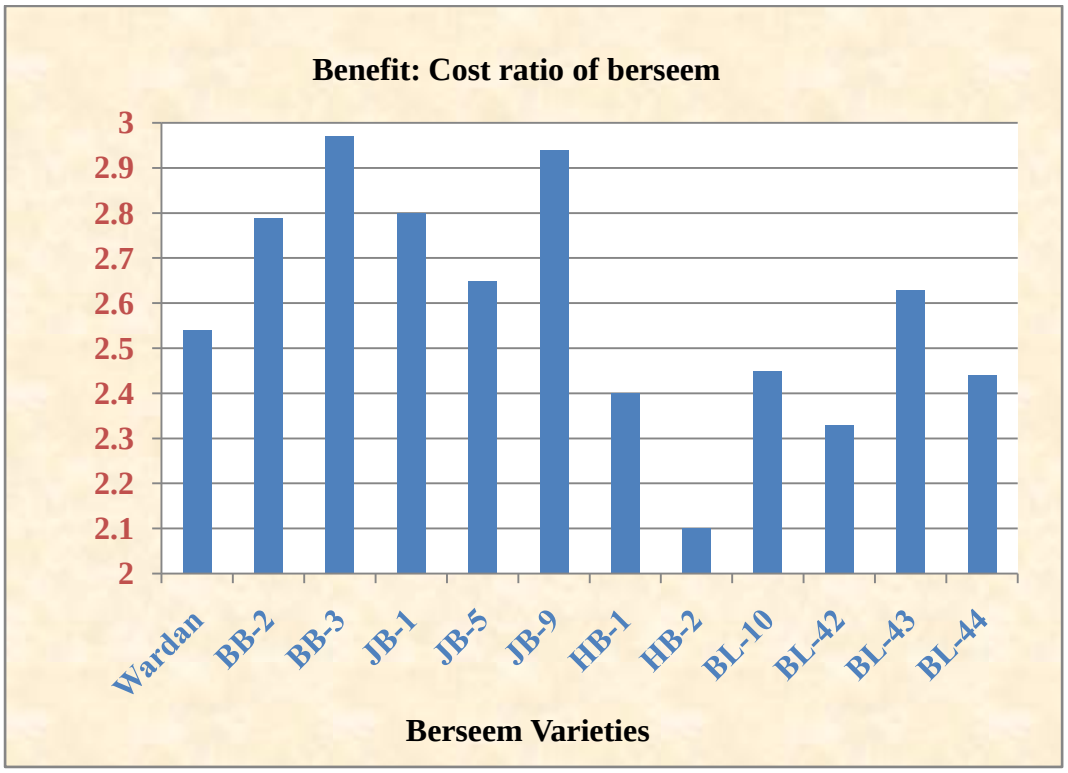

Fig. 4.24: Benefit: cost ratio of different berseem varieties

CHAPTER - V

SUMMARY AND CONCLUSION

A field experimental was carried out during *Rabi* season of 2021 at the Research cum Instructional Farm IGK, Raipur, (C.G.) entitled **"Study on growth, fodder yield and quality of different berseem varieties (*Trifolium alexandrinum* L.) under Chhattisgarh plains."** Major objective of the present investigation are:-

1. To study the suitable high fodder yielding varieties of berseem for Chhattisgarh plains.
2. To evaluate the different quality parameters of berseem varieties.
3. To work out the economics of berseem varieties.

The field experiment was conducted in randomized block design with twelve treatments and replicated thrice. The climate of the region was sub humid. The soil was clayey being alkaline in reaction (7.9 pH) with low nitrogen content 150.52 kg ha^{-1}, low in phosphorous 7.41 kg ha^{-1} and high in potassium 319 kg ha^{-1}. The twelve berseem variety is namely Wardan, Bundel Berseem– 2, Bundel Berseem– 3, Jawahar Berseem- 1, Jawahar Berseem- 5, Jawahar Berseem- 9, Hisar Berseem–1, Hisar Berseem- 2, Berseem Ludhiyana- 10, Berseem Ludhiyana- 42, Berseem Ludhiyana- 43 and Berseem Ludhiyan- 44. Varieties were supplied with N-20, P_2O_5 – 80, K_2O- 30 kg ha^{-1} through urea, single super phosphate and murate of potash. All variety was sown on 15th November 2021.

The results are highlighted below

1. Among the varieties initial growth rate in terms of plant height was maximum recorded in variety BB- 3 during 60, 90 and 150 days after sowing, but 30 and 120 days after sowing JB-9 was recorded maximum plant height. During 60 and 90 days after sowing maximum number of trifoliate laves $plant^{-1}$ was recorded in variety BB- 3, but 120 and 150 days after sowing JB-9 was registered maximum number of trifoliate laves. During 30 and 60 days after sowing maximum number of shoots $plant^{-1}$was recorded in variety BB-

3, but 120 and 150 days after sowing JB-9 was registered maximum number of shoots. Fresh weight plant^{-1} was maximum recorded in variety BB- 3 during 30 and 60 days after sowing but it was higher in JB- 9 at 120 and 150 days after sowing. Dry weight plant^{-1} was maximum recorded in variety BB-3 during 30, 60, 90 and 150 days after sowing but it was higher in JB- 9 at 120 days after sowing. During 30 and 150 days after sowing leaf fresh weight plant^{-1} was maximum recorded in variety JB- 9 but it was higher in BB- 3 at 60, 90 and 120days after sowing. Leaf dry weight plant^{-1} was maximum recorded in variety BB- 3 during 30 and 60 days after sowing but it was maximum in JB- 9 at 90, 120 and 150 days after sowing. Stem fresh weight plant^{-1} was maximum recorded in variety BB- 3 during 30 and 60 days after sowing but it was higher in JB- 9 at 120 and JB- 1 during 150 days after sowing. Variety HB-2 (0.94) was maximum recorded leaf and stem ratio during 30 days after sowing , during 60, 90 and 120 days after sowing variety BL-42 recorded maximum leaf and stem ratio but 150 days after sowing Variety JB-9(0.3) was recorded maximum ratio of leaf and stem

2. Among the different berseem varieties maximum crop growth rate was recorded by BB-3 during total crop period followed by JB-1, JB- 9 and BB-2. Overall growth stages the variety BB-3 was recorded maximum relative growth rate followed by JB-9, BB-2 and JB-1. Whereas, minimum relative growth rate was found in variety BL-10 followed by HB-2. Variety BL-10 was recorded maximum LWR (leaf weight ratio) followed by JB-9 and HB- 2 varieties. Whereas, minimum LWR was found in variety HB-1 followed by JB-1 and JB-5 varieties. Maximum LPR (leaf production rate) was recorded in variety JB-9 followed by BB-3 and JB-1 and BB-2 varieties. Whereas, minimum leaf production rate was recorded by BL-43 followed by HB-1.

3. Among the different berseem varieties maximum total green fodder yield was recorded in variety BB-3 (530 q ha^{-1}) followed by JB-9 (524.6 q ha^{-1}), JB-1 (498.4 q ha^{-1}) and BB-2 (497.4 q ha^{-1}) varieties. Maximum total dry fodder yield was recorded by variety BB-3(95.8 q ha^{-1}) followed by JB-9 (93.9 q ha^{-1}), JB-1 (93.0 q ha^{-1}) and BB-2 (90.1 q ha^{-1}) varieties.

4. Maximum total crude protein yield was recorded by BB-3 (18.91 q ha^{-1}) followed by JB-9 (18.24q ha^{-1}). Whereas, minimum total crude protein yield was recorded in variety HB-2 (11.90 q ha^{-1}) followed by BL-42 (13.90 q ha^{-1}). During first cut maximum crude protein content was presence in variety BL-44 (20.98 %) followed by BL-43 (20.86 %). At second cut maximum crude protein content was recorded in variety BL-42 (23.45 %). At third cut maximum crude protein content was recorded by HB-1 (19.07 %). During fourth cut maximum crude protein content was presence in variety BB-3(17.95 %).
5. Significantly maximum total nitrogen uptake was found in variety BB-3 (302.6 kg ha^{-1}), which was at par with JB-9(291.8 kg ha^{-1}). Whereas, minimum nitrogen uptake was found in HB-2 (188.1 kg ha^{-1}) followed by BL-42 (222.4 kg ha^{-1}). Significantly maximum total phosphorus uptake was found in varieties BB-3 (9.31 kg ha^{-1}), which was statistically at par with variety JB-9(8.64 kg ha^{-1}). Whereas, lowest phosphorus uptake was found in HB-2 (6.4 kg ha^{-1}) followed by BL-44 (6.8 kg ha^{-1}) varieties. Significantly maximum total potassium uptake was found in variety BB-3 (150.07 kg ha^{-1}), which was statistically at par with JB-9(138.67 kg ha^{-1}). Whereas, minimum total potassium uptake was found in HB-2 (104.28 kg ha^{-1}), followed by HB-1 (111.31kg ha^{-1}) varieties.
6. During first cut maximum nitrogen content (%) was presence in variety BL-44 (3.36 %) followed by BL-43 (3.34 %). At second cut significantly maximum nitrogen content (%) was present in variety BL-42 (3.75%), during third cut significantly maximum nitrogen content (%) was presence in variety HB-1 (3.05 %) but during fourth cut significantly maximum nitrogen content (%) was found in variety BB- 3(2.87 %). During first cut significantly maximum phosphorus content was presence in variety BL-10 (0.16 %), At second cut significantly maximum phosphorus content was presence in variety BB-3 (0.16 %), During third and fourth cut however maximum phosphorus content was presence in variety Wardan (0.07, 0.06 % respectively). During first cut significantly maximum potassium content (%) was found in variety Wardan (2.6 %) but during second cut maximum.

7. Potassium content was presence in variety HB-2 (1.80 %). During third cut significantly maximum potassium content (%) was presence in variety BL-42 (1.74 %), during fourth cut significantly maximum potassium content was found in variety JB-9(1.10 %).
8. Variety BB-3 was recorded maximum gross monetary returns (124355 Rs h^{a-1}), net monetary returns (87928.7 Rs ha^{-1}) and B: C ratio (2.97) which was found at nearly equal with JB-9, JB-1 and BB-2varieties (Rs 86,589, 80,044 and 79,797 ha^{-1} net monetary returns respectively).

CONCLUSION

Among different varieties of berseem studied for Chhattisgarh plains, variety BB-3 was recorded significantly maximum green fodder yield (530. q ha^{-1}), dry fodder yield (95.80 q ha^{-1}), productivity of green and dry fodder (3.53 q ha^{-1} day^{-1} and 0.64 q ha^{-1} day^{-1}), which was found at par with varieties JB-9, JB-1 and BB-2 (524, 498 and 497q ha^{-1} green fodder yield respectively).

Variety BB-3 recorded significantly maximum total crude protein yield (18.91 q ha^{-1}), crude protein content (19.41, 23.35, 18.25 and 17.95 at first, second, third and fourth cut respectively) and dry matter content (11.13, 14.97, 20.53 and 31.00 per-cent at first, second, third and fourth cut) which was found at par with varieties JB- 9, Wardan, BB- 2 (17.95 %), JB- 1 and HB- 1.

Economics of berseem varieties shows that variety BB-3 recorded maximum gross monetary returns (1, 24,355 Rs ha^{-1}), net monetary returns (87,928 Rs ha^{-1}) and B: C ratio (2.97) followed by varieties JB-9, JB-1 and BB-2 (Rs 86,589, 80,044 and 79,797 ha^{-1} net monetary returns respectively).

Suggestions for future work

1. The study should be repeated for at least one more year to confirm the findings.
2. The research work should be repeated at various locations to minimize the environmental impact on research finding.
3. More cutting can be done by reducing the cutting time intervals.

REFERENCES

Abdel-Malik, W.H., El-Sayes, M.F., Khinizie, A.E.M., & Niemelainen, O. (2002). Effect of foliar mineral fertilization of berseem (*Trifolium alexandrinum* L.). In *Multi-function grasslands: quality forages, animal products and landscapes. Proceedings of the 19th General Meeting of the European Grassland Federation, La Rochelle, France, 27-30 May 2002,* Organizing Committee of the European Grassland Federation. pp. 60-61.

Agrawal, B.L., Jain, S.C., Agrawal, S.B. and Bhadouria, U.P.S. (1995). Interaction effect of phosphorus and sulphur on chemical composition of berseem cultivars. *Adv. Agric. Res. in India.* 4 : 126-133.

Ahmad, S., Habib, G., Siddiqui, M., & Khan, M.A. (2001). Effect of seed scarification, rhizobium inoculation and phosphorus fertilization on yield and nutritive value of barseem. *Sarhad Journal of Agriculture (Pakistan)*.

Akram, M.I., Akhtar, L.H., Minhas, R., Zubair, M., Bukhari, M.S.J., Ullah, R. & Nisar, S. (2022). Enhancing Seed and Fodder Yield Potential of Berseem (*Trifolium alexandrinum* L) with Combined Application Phosphorous and Potassium under Irrigated Conditions of Bahawalpur, Pakistan. *Egyptian Journal of Agronomy*.

Ali, H., Naseer, M., & Sajad, M.A. (2012). Phytoremediation of heavy metals by *Trifolium alexandrinum*. *International Journal of Environmental Sciences*, *2*(3), 1459-1469.

Anonymous (2018). Demand and supply projections towards 2033. Crops, livestock, fisheries and agricultural inputs. The Working Group Report (February, 2018). NitiAyog, New Delhi.

AOAC (1995). Official Methods of Analysis, 16th edn. Association of Official Analytical Chemists, Arlington, U. S. A, ID No. 984.13.

Badawy, A., EL-Nahrawy, S., & Bondok, A. (2018). Genetic variability and path-coefficient analysis for forage yield and its components in Egyptian clover. *Journal of Agricultural Chemistry and Biotechnology*, *9*(12), 295-301.

Barik, A. K., & Mukherjee, A.K. (1990). Effect of dates of sowing, seed rates and level of phosphates on the seed production of berseem at short and mild winter of West Bengal. *Environment and Ecology*, 8(1B), 288-289.

Bhilare, R.L., & Desale, J.S. (2003). Effect of sulphur fertilization on fodder quality of berseem. *Journal of Maharashtra Agricultural Universities (India)*.

Cheptoo *et al.* (2020). Genotypic variations in some egyptian clover (*Trifolium alexandrinum L.*) Varieties for forage yield.

Chintapalli, B.B., C. Subhash, Pooja Dhuppara and D. Sarveshwara Rao (2012). Studies on the potential of integrated nutrient management for improving the vegetative and reproductive performance of berseem crop. *Forage Res*. 37(4): 248-250.

Choubey, S., & Bhacat, R.K. (1998). Effect of Lime and phosphorus on Forage Productivity of Berseem (*Trifolium alexandrium* L.). *Journal of research-birsa agricultural university*, *10*, 58-59.

Dahiya, H.S., Sheoran, H.S., & Tomar, J.A.I.B.I.R. (2019). Effect of biofertilizers and cutting management on yield and yield attributes of different cultivars of berseem (*Trifolium alexandrinum* L.). *Forage Res*, *45*(2), 151-155.

Devi, U. and Satpal, (2019). Performance of berseem (*Trifolium alexandrinum* L.) genotypes at different phosphorus levels. *Forage Res.*, 44 (4): 260-263.

El-Karamany, M.F., Bakry, B.A., & Elewa, T.A.E.F. (2014). Integrated action of mixture rates and nitrogen levels on quantity and quality of forage mixture from Egyptian clover and barley in sandy soil. *Agricultural Sciences*, *5*(14), 1539.

El-Naby, A., Zeinab, M., Rajab, M.N., Walaa, M.E., & Abd El-Aziz, T.K. (2016). Evaluation of quality characters of some Egyptian clover genotypes. *International Journal of Applied and Pure Science and Agriculture (IJAPSA) Volume*, *2*.

Enyi, B.A.C. (1962). Comparative growth-rates of upland and swamp rice varieties. *Annals of Botany*, 467-487.

Faridullah, A. Alam, S. Yamamoto, M. Irshad, M. Qasim, M. Alam, M. Din, N. Khan, Md. I. Uddin and Toshimasa Honna (2008). Agronomic performances of different berseem cultivars tested at Gilgit, northern areas, Pakistan. *Life sciences international journal,* 2 (3): 707-713. *Forage Research*, 46 (2): pp. 168-175

Gaikwad, (2009). Effect of nutrient management on green forage yield and quality of berseem. M.Sc. (Agronomy) Thesis, Mahatma Phule Krishi Vidyapeeth, RAHURI - 413722, dist. Ahmednagar, Maharashtra, India, Pp.75.

Gangwar, S., Naik, K. R., & Dubey, M. (2014). NPK content of seed grain and straw influenced by different organic nutrient management under rice based cropping systems. *Plant Archives*, 14(1), 549-551.

Godara, A.S., Joshi, U.N., & Yogesh, J. (2016). Response of berseem (*Trifolium alexandrinum* L.) genotypes to different phosphorus levels. *Forage Research*, *42*(1), 40-43.

Gomez, K.A., & Gomez, A.A. (1984). *Statistical procedures for agricultural research*. John wiley & sons.

Gondal, M.R., *et al.* (2021). Role of weedicides for weed management and improvement in production of berseem (*Trifolium alexandrinum* L.) fodder. *International Journal of Agricultural Technology* 17(4):1329-1344.

Gondal, M.R., Rizvi, S.A., Hanif, M.S., Mahmood, T., Naseem, W., Hayat, S., Mustafa, S., Pervez, A. and Khan, A. (2021). Developing the quality seed production technology for berseem (*Trifolium alexandrinum* L.) fodder. *International Journal of Agricultural Technology* 17(2):479-496.

Gondal, M.R., Rizvi, S.A., Hanif, M.S., Mahmood, T., Naseem, W., Hayat, S. & Khan, A. (2021). Developing the quality seed production technology for berseem (*Trifolium alexandrinum* L.) fodder. *International Journal of Agricultural Technology* 17(2):479-496

Hamdard, M. S., Khan, D. M., & Younis, M. (1985). The effect of NPK fertilizers on the chemical composition and nutritive value of berseem. *Journal of Agricultural Research*. interval on forage yield and quality of berseem. *Indian Journal Agricultural, 23 (1): 31-36.*

Jackson, M.L., 1967. Soil Chemical Analysis. Prentice-Hall of India Pvt. Ltd., New Delhi, 498.

Jackson, M.L. (1973). Soil chemical analysis, pentice hall of India Pvt. *Ltd., New Delhi, India, 498*, 151-154.

Jadhav, S.L., Keskar, P.B., & Nagre, P.K. (1995). Effect of irrigation and phosphorous level on the green fodder yield and protein content of Berseem. *Punjabrao Krishi Vidhyapeeth Research Journal (India)*.

Jan, B., *et al.* (2014). Effect of Arbuscular Mycorrhiza Fungal Inoculation with Compost on Yield and Phosphorous Uptake of Berseem in Alkaline Calcareous Soil. *American Journal of Plant Sciences*, 5, 1359-1369.

Karwasra R.S. and Anil Kumar Gupta S.N. (2006). Effect of FYM, nitrogen and phosphorus levels on the green forage yield of berseem (*Trifolium alexandrinum*). *Haryana journal of Agronomy*, 22 (1): 94-95.

Kramany, E.l. *et al.* (2012). Effect of Mixture Rates on Forage Mixture of Egyptian Clover (*Trifolium alexandrinum L.*) With Triticale (*X Triticosecale Wittmack*) under newly reclaimed sandy soil. *Australian Journal of Basic and Applied Sciences*, 6(5): 40-44.

Kumar *et al.* (2021). Genotypic response of berseem (*Trifolium alexandrinum* L.) To different phosphorus levels. Ccs haryana Agricultural University. Forage Res., 47 (3): pp. 329-333.

Kumar, H., Kumar, S., & Yadav, S.S. (2007). Integrated nutrient management in berseem (*Trifolium alexandrinum* L.). *Forage res*, *33*(1), 67-69.

Kumawat, S.M., & Khinchi, V.I.M.A.L. (2017). Effect of phosphorus levels on forage yield of promising multicut genotypes of berseem (*Trifolium alexandrinum* L.). *Forage Research*, *43*(3), 223-226.

Leghari, S.J., Soomro, A.A., Laghari, G.M., Talpur, K.H., Soomro, F.A., Mangi, M.H., & Mahmood, N. (2018). Effect of NPK rates and irrigation frequencies on the growth and yield performance of *Trifolium alexandrium* L. *AIMS Agriculture and Food*, *3*(4), 397-405.

Livestock Census, 20th (2019). All India report, Ministry of Agriculture & Farmers Welfare, Department of Animal Husbandry, Dairying & Fisheries (Animal Husbandry Statistics Division) Krishi Bhawan, New Delhi.

Malvi, V., Dotaniya, C.K., & Dixit, H.C. (2019). Effect of potassium and sulphur on yield and quality of berseem (*Trifolium alexandrinum*). *Annals of Plant and Soil Research*, *21*(2), 145-148.

Mandal, S. and Chakraborty, T. (1998). Effect of phosphorus sources with different doses on growth and yield of berseem. *Forage Res.* 24 (2): 119-120.

Mani, S.K. and Singh, M.M. (1997). Effect of phosphorus levels and cutting interval on forage yield and quality of berseem. Indian J. agric. Sci. 67 (12): 604-605.

Mendhe, S.N., Zope, S.R., Nandanwar, R.S. and Suryavanshi, B.W. (1995). Effect of cutting management and phosphorus on berseem. *Forage Res.* 21 (1) : 49-53.

Moawad, H., El-Maksoud, H.K.A. and Sadd, R.N. (1996). Response of berseem clover to rock phosphate fertilization and dual inoculation with Rhizobium and vesicular arbuscular mycorrhiza (VAM). *Egyptian Journal Microbiol*ogy, 31 (1) : 13-23.

Muhammad, D., Misri, B., El-Nahrawy, M., Khan, S., & Serkan, A. (2014). Egyptian clover (*Trifolium alexandrinum*) king of forage crops. *FAO, Regional Office for the Near East and North Africa, Cairo, Egypt*, 127.

Muhammad, D., Misri, B., El-Nahrawy, M., Khan, S., & Serkan, A. (2014). Egyptian clover (*Trifolium alexandrinum*) king of forage crops. *FAO, Regional Office for the Near East and North Africa, Cairo, Egypt*, 137.

Mukesh, K., Bhagat, S., & Dhaka, A.K. (2017). Integrated nutrient management strategies for increasing annual forage crops productivity-a review. *Forage Research*, *43*(1), 9-16.

Munde, P.R. and Shelke, V.B. (1993). Effects of irrigation and phosphorus on N content, uptake and crude protein in forage berseem. *Journal of Maharashtra agriculture University*, 18: 24-26.

Nand, V., Gupta, R.K., Yadav, R.S., Singh, K.D., Yadav, R.K., & Srivastav, A.K. (2018). Impact of integrated nutrient management (INM) on growth of Barseem (*Trifolium alexandrinum* L.) at various cutting stages. *Journal of Pharmacognosy and Phytochemistry*, *4*, 254-258.

Nand, V., Gupta, R.K., Yadav, R.S., Singh, K.D., Yadav, R.K., & Srivastav, A.K. (2018). Impact of integrated nutrient management (INM) on growth of Barseem (*Trifolium alexandrinum* L.) at various cutting stages. *Journal of Pharmacognosy and Phytochemistry*, *4*, 254-258.

Nargesh, D. (2012). *Performance of berseem varieties at different levels of nitrogen and phosphorus* (Doctoral dissertation, M. Sc thesis., Department of Soil Science & Agricultural Chemistry, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya College of Agriculture, Gwalior (MP).

Olsen, S.R., (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate (No. 939). US Department of Agriculture.

Pal et al. (2019). Pre- and post-emergence herbicidal effect on weeds, fodder yield and quality of berseem in lowland region of Western Himalayas. *Indian Journal of Weed Science* 51(2): 173–177

Pal, M.S. et al. (2017). Effect of bio-fertilizers on productivity and profitability of berseem (*Trifolium alexandrinum*) in Tarai region of Western Himalayas. Department of Agronomy, G B Pant University of Agriculture & Technology, Pantnagar- 263145 (Uttarakhand). *Indian Journal of Plant and Soil*, 4 (1)

PAL, M.S., & Joshi, Y.P. (2018). Tillage options and its effect on productivity, profitability and quality of forage under feed/food-fodder based cropping system in mollisols. *Forage Research*, *43*(4), 291-294.

Panwar, K.S., & Jain, J.K. (1974). Note on the effect of nitrogen and phosphorus on the dry matter production and uptake of nitrogen and phosphorus by berseem fodder. *Indian journal of agricultural research*.

Patel, J.R. (1998). Effect of nitrogen and phosphorus on fodder and seed yield of berseem. *Forage Res*. 24 (1) : 49- 50.

Piper, C.S. (1966). Soil and plant analysis. Inter Science Publisher Inc. New York Philips-Journa l32-36. Piper, C.S. 1967. Soil and Plant analysis. Asia Publishing House, New Delhi, :30-38.

Rana, D.S., Sheoran, R.S., Joon, R.K. and Yadav, B.D. (1992). Effect of sowing dates, seed rates and phosphorus levels on fodder and seed production of Egyptian clover. *Forage Research*. 18 (1): 34-36.

Richard, L.A. (1954). Diagnosis and Improvement of Saline and Alkaline Soils. Handbook: 60, US, *Dept. of Agriculture*.

Roy, D.C., & Jana, K. (2016). Biomass production and quality of berseem fodder (*Trifolium alexandrinum* L.) as influenced by application of phosphorus and phosphate solubilizing bacteria. *Adv Life Sci*, *5*, 1225-1229.

Saeed, B., Durrani, Y., Gul, H., Said, A., Wahab, S., Ayub, M. & Ahmad, I. (2011). Forage yield of berseem (*Trifolium alaxandrium*) as affected by phosphorus and potassium fertilization. *African Journal of Biotechnology*, *10*(63), 13815-13817.

Salama, H.S.A. (2015). Interactive Effect of Forage Mixing Rates and Organic Fertilizers on the Yield and Nutritive Value of Berseem Clover (*Trifolium alexandrinum* L.) and Annual Ryegrass (Lolium multiflorum Lam.). *Agricultural Sciences*, 6, 415-425.

Satpal, R.S., & Sheoran, J.T.Y. Jindal, (2020). Phosphorus influenced nutritive value, yield and economics of berseem (*Trifolium alexandrinum* L.) genotypes. *Chemical Science Review and Letters*, *9*(34), 365-373. *Science*. 67 (12): 604-605.

Seiam, M.A., & Mohamed, E.S. (2020). Forage yield, quality characters and genetic variability of some promising egyptian clover populations. *Egyptian Journal of Plant Breeding*, *24*(4), 839-858.

Shahrajabian, M.H., Khoshkharam, M., Sun, W., & Cheng, Q. (2019). Exploring responses of berseem clover cultivars in low input cultivation management for agricultural sustainability. *World Scientific News*, *131*, 197-206.

Sharma, B.L., Sharma, P.K. and Yadav, G.L. (1998). Effect of FYM, nitrogen and phosphorus levels on the green forage yield of berseem. *Forage Research*. 24 (3): 181- 182.

Sharma, R.K. and Paradkar, V.K. (1995). Effect of simazine and nitrogen application on the forage yield of berseem. Current *science Univ. agric. Sci*., Bangalore. 24 (4) : 75.

Sharma, S. K. and Sharma, S. N. (2004). Response of berseem (*Trifolium alexandrium*) to integrated nutrient management. *Annals of Agricultural Research*. 25(3): 429-432.

Sheoran, R.S., Rana, D.S., Joon, R.K., Yadav, B.D. and Jatastra. (1992). Forage and seed production of berseem varieties under varying phosphorus levels. *Forage Research*. 18 (1): 37-41.

Shrivastava, A.K., Sarvade, S., Bisen, N.K., Prajapati, B., Agrawal, S.B., & Goswami, P. (2020). Growth and Yield of Rabi Season Forage Crops under Chhattisgarh Plain of Madhya Pradesh, India. *Int. J. Curr. Microbiol. App. Sci*, *9*(2), 878-885.

Singh, B., Singh, M.P., Bishnoi, S.R. and Singh, M.P. (1996). Effect of continuous application of phosphorus and FYM on yield of berseem and fertility status of soil. *Journal Agriculture Res*earch. Punjab Agric. Univ. 23(1): 20-25.

Singh, D. *et. al.* (2020). Comparative analysis of exotic and notified berseem (*Trifolium alexandrinum* L.) Varieties for fodder, Quality and nutrients uptake.

Singh, S.R., & Prasad, N.K. (1997). Evalution of Saftal (Trifolium resupinatun L.) genotypes with Berseem (*Trifolum alxandrium* L.) under different P Levels. *Journal of Research-Birsa Agricultural University, 9:*, 85-86.

Sinha, M.N., & Rai, R.K. (1995). Effect of frequency of cutting berseem and fertility levels on yield of fodder and seed. *Annals of Agricultural Research*, *16*, 230-231.

Soleymani, A., & Shahrajabian, M.H. (2012). Forage yield and quality in intercropping of forage corn with different cultivars of berseem clover in different levels of nitrogen fertilizer. *Journal of Food, Agriculture and Environment*, *10*(1), 602-604.

Sood, B.K., & Kumar, N. (1994). Effect of nitrogen and phosphorus on forage yield and nutrient uptake of oatberseem mixture. *Crop Res, 8*, 239-244.

Sood, B.R., Kapoor, S.S. and Sharma, V.K. (1994). Effect of phosphorus levels and cutting frequencies on forage and seed yield of berseem. *Forage Research.* 20 (1) : 57- 62.

Srinivasa, R.C., Subba, R., Srivastava, S., & Singh, S.P. (1999). Crop response, uptake and the efficiency of potassium in berseem and sudan grass on a Typic Haplustert. *J Potassium Res*, *15*, 113-118.

Tiwana, U.S., & Puri, K.P. (2003). Response of berseem to Sulphur under different fertilizer levels. *Forage Research, 29*, 94-96.

Tomar, G.S. (2009). Effect of phosphorus fertilization and organic Manuring on growth, quality, forage and seed yield of berseem (*Trifolium alexandrinum* L.) Ph.D. Thesis (Agronomy) IGKV, Raipur.

Tufail, M.S., Krebs, G.L., Southwell, A., Piltz, J.W., Norton, M.R., & Wynn, P.C. (2020). Enhancing performance of berseem clover genotypes with better harvesting management through farmers' participatory research at smallholder farms in Punjab. *Scientific Reports*, *10*(1), 1-12.

Valiki, S. R. H., Ghanbari, S., Golmohammadzadeh, S., & Alaeiyan, Y. (2015). Yield and quality of Berseem (*Trifolium alexandrinum* L.) in response to nitrogen fertilization and plant density. *International Research Journal of Applied and Basic Sciences, 9*(6), 873-877.

Vijay, D., Manjunatha, N., Maity, A., Kumar, S., Wasnik, V.K., Gupta, C.K. & Ghosh, P.K. (2017). Berseem-Intricacies of seed production in India. *ICAR-IGFRI Technical Bulletin. Indian Grassland and Fodder Research Institute (IGFRI), Jhansi, UP, India. bit. ly/2EtAm1q*.

Virender, S., & Narwal, S.S. (2001). Effect of Rhizobium seed inoculation and nitrogen on the fodder quality of berseem (*Trifolium alexandrinum* L.) under different levels of phosphorus in Hisar, India. *Res. Crops*, *2*(2), 123-133.

Vision (2050). Indian Grassland and Fodder Research Institute (Indian Council of Agricultural Research) Gwalior Road, Jhansi - 284 003

Yadav, I., Sreenath, P., Rajpali, S.K., & Sharma, R.K. (1989). Economics and resource-use productivity of egyptian clover (*Trifolium alexandrinum*) for fodder production on small and large farms around jhansi district. *Indian Journal of Agricultural Sciences, 59*(3), 199-202.

Yucel, C. (2019). Forage yield and quality attributes of berseem clover genotypes under mediterranean climate. *Int. J. Innov. Approaches Agric. Res, 3*, 491-503.

Appendix- A

Weekly meteorological data during crop period from 15 Nov 2021 to15 April 2022

Date	Temp. (°C)		RF (mm)	RH I (%)	RH II (%)	WS (kmph)	EP (mm)	SS (hr)
	Max.	Min.						
Nov 15-21	30.4	20.9	0.0	91.1	54.6	4.2	2.7	4.8
Nov 22-28	30.4	18.0	6.9	90.6	41.1	2.3	2.8	6.4
Nov 29- Dec 5	28.3	13.6	0.0	85.3	39.4	3.1	2.9	7.8
Dec 6- 12	28.6	17.6	0.0	86.9	46.3	3.5	2.9	4.6
Dec 13- 19	27.0	11.6	0.0	86.1	38.1	2.3	2.4	5.0
Dec 20- 26	26.7	8.3	0.0	90.3	32.3	1.7	2.3	6.0
Dec 27- 2 Jan	24.9	14.6	11.8	92.1	64.1	3.1	1.6	1.5
Jan 3- 9	27.4	13.1	0.0	93.0	43.9	1.9	2.1	7.5
Jan 10- 16	22.8	16.5	2.1	93.6	76.4	3.9	1.3	1.3
Jan 17- 23	27.0	11.9	0.4	90.6	37.1	2.6	2.6	7.9
Jan 24- 30	24.7	10.1	0.0	87.9	34.3	2.5	2.9	7.0
Jan 31- Feb 6	28.7	11.1	0.0	85.6	27.1	2.5	3.9	8.7
Feb 7-13	28.0	11.5	1.0	88.7	33.3	1.2	3.1	7.7
Feb 14-20	29.0	14.5	0.0	78.7	36.0	1.3	3.1	5.8
Feb 21- 27	32.8	14.7	0.0	83.3	29.6	2.0	4.2	7.0
Feb 28- March 6	33.1	17.3	0.0	81.3	31.6	1.2	4.0	6.5
March 7- 13	34.0	16.5	0.0	69.7	20.6	1.7	4.9	8.6
March 14-20	37.5	19.0	0.0	74.3	21.4	1.3	5.9	8.9
March 21- 27	38.5	21.4	0.0	68.3	26.0	2.1	6.4	6.6
March 28- April 3	40.7	19.8	0.0	67.9	13.0	0.8	6.3	7.8
April 4-10	40.4	24.8	0.0	59.7	27.7	3.1	7.2	6.7
April 11- 15	40.8	26.5	0.0	59.2	28.2	5.6	8.9	5.0

Source: Department of Agrometeorology Indira Gandhi Krishi Vishwavidyalaya Krishak Nagar, Raipur – 492012 (C.G.)

Appendix- B

Item wise cost of cultivation of berseem

Items of expenditure	Particular	Per unit Rate	Expenditure (Rs.)
Land preparation			
Tilling with cultivator	2 pass (2.5 hr)	800 hr^{-1}	2000
Harrowing with disc harrow	2 pass (2.5 hr)	800 hr^{-1}	2000
Leveling (by leveler)	1 pass (1 hr)	800 hr^{-1}	800
Sowing	5 man days	250 man^{-1} day	1250
Seed cost	25 kg ha^{-1}	Rs 160 kg^{-1}	4000
Fertilizer			
N-20 kg ha^{-1}	Urea -43.47 kg ha^{-1}	5.92 kg^{-1}	257
P_2O_5-80 kg ha^{-1}	SSP- 500 kg ha^{-1}	6.5 kg^{-1}	3250
K_2O-30 kg ha^{-1}	MOP- 50 kg ha^{-1}	20 kg^{-1}	1000
Labour for fertilizer application	1 labours	250 man^{-1} day	250
Irrigation	8 irrigation	400 $irrigation^{-1}$	3200
Labour for irrigation	1 labour $irrigation^{-1}$	250 man^{-1} day	2000
Weeding one times	10 labour $weeding^{-1}$	250 man^{-1} day	2500
Harvesting four times	18 man days for one cut	250 man^{-1} day	18000
		Total	**40507**
Interest on capital invested	6 months		4051
		Grand Total	**44558**

Appendix- C

Crop growth rate of different berseem varieties

Treatments	Varieties	CGR (g g plant^{-1} day^{-1})				
		0-30 DAS	30-60 DAS	60-90 DAS	90-120 DAS	120-150 DAS
V_1	Wardan	0.003	0.043	0.075	0.021	0.042
V_2	BB-2	0.004	0.056	0.081	0.002	0.054
V_3	BB-3	0.004	0.065	0.075	0.012	0.056
V_4	JB-1	0.004	0.064	0.041	0.040	0.059
V_5	JB-5	0.003	0.050	0.051	0.046	0.041
V_6	JB-9	0.004	0.060	0.078	0.015	0.042
V_7	HB-1	0.003	0.044	0.055	0.016	0.035
V_8	HB-2	0.003	0.049	0.038	0.024	0.039
V_9	BL-10	0.003	0.045	0.040	0.033	0.050
V_{10}	BL-42	0.003	0.045	0.048	0.027	0.053
V_{11}	BL-43	0.004	0.060	0.057	0.010	0.040
V_{12}	BL-44	0.004	0.059	0.053	0.004	0.039

Appendix- D

Relative growth rate of different berseem varieties

Treatments	Varieties	RGR (g g^{-1} day^{-1})			
		30-60 DAS	60-90 DAS	90-120 DAS	120-150 DAS
V_1	Wardan	0.387	1.277	1.403	1.658
V_2	BB-2	0.655	1.420	1.408	1.728
V_3	BB-3	0.796	1.444	1.500	1.803
V_4	JB-1	0.771	1.158	1.454	1.775
V_5	JB-5	0.538	1.115	1.470	1.697
V_6	JB-9	0.716	1.427	1.505	1.737
V_7	HB-1	0.412	1.092	1.220	1.478
V_8	HB-2	0.529	0.978	1.199	1.485
V_9	BL-10	0.427	0.923	1.251	1.585
V_{10}	BL-42	0.434	1.041	1.266	1.618
V_{11}	BL-43	0.723	1.263	1.327	1.588
V_{12}	BL-44	0.690	1.220	1.230	1.513

Appendix- E

Leaf mass fraction (LMF) of different berseem varieties

Treatments	Varieties	LMF				
		0-30 DAS	30-60 DAS	60-90 DAS	90-120 DAS	120-150 DAS
V_1	Wardan	0.458	0.370	0.301	0.240	0.205
V_2	BB-2	0.451	0.366	0.311	0.239	0.218
V_3	BB-3	0.426	0.376	0.293	0.255	0.213
V_4	JB-1	0.434	0.347	0.297	0.249	0.205
V_5	JB-5	0.421	0.376	0.301	0.263	0.172
V_6	JB-9	0.466	0.361	0.310	0.255	0.234
V_7	HB-1	0.380	0.384	0.298	0.265	0.175
V_8	HB-2	0.492	0.365	0.303	0.274	0.201
V_9	BL-10	0.479	0.402	0.336	0.272	0.177
V_{10}	BL-42	0.451	0.408	0.331	0.248	0.168
V_{11}	BL-43	0.461	0.388	0.303	0.245	0.204
V_{12}	BL-44	0.446	0.386	0.307	0.250	0.215

Appendix- F

Leaf production rate of different berseem varieties

Treatments	Varieties	LPR (leaves day^{-1})				
		0-30 DAS	30-60 DAS	60-90 DAS	90-120 DAS	120-150 DAS
V_1	Wardan	0.198	1.190	1.004	-1.073	-0.044
V_2	BB-2	0.216	1.296	1.103	-1.167	-0.058
V_3	BB-3	0.206	1.377	1.082	-0.884	-0.281
V_4	JB-1	0.202	1.294	0.898	-0.620	-0.354
V_5	JB-5	0.194	1.077	0.758	-0.549	-0.263
V_6	JB-9	0.212	1.298	1.112	-0.838	-0.270
V_7	HB-1	0.196	1.036	1.096	-0.823	-0.333
V_8	HB-2	0.193	1.066	0.759	-0.526	-0.303
V_9	BL-10	0.190	0.931	1.201	-0.954	-0.112
V_{10}	BL-42	0.189	0.823	0.821	-0.474	-0.086
V_{11}	BL-43	0.206	0.900	1.228	-0.997	-0.189
V_{12}	BL-44	0.203	0.859	0.994	-0.702	-0.163

RESUME

Name	:	Jeetendra Kumar Sahu
Fathers name	:	Ganguram Sahu
Date of Birth	:	05/11/1989
E-mail	:	jsjittu0007@gmail.com
Permanent Address	:	Village – Sahda , Post Office - Bhawanipur, Tehsil - Palari, District – Balodabazar - Bhatapara (C.G.) Pincode - 493229

Academic qualification:-

Exam	Year	Division	Percent/ OGPA	Board/ University	Major subject
HSSC	2007	2nd	55.6 %	CG Board	Mathematics
B.Sc. (Hort.)	2011	2nd	6.88 (OGPA)	IGKV Raipur	Horticulture
M.Sc. (Ag.)		Appearing		IGKV Raipur	Agronomy

Professional Experience	:	RAEO (Rural Agricultural Extension Officer) RHWE (Rural Horticultural Work Experience)
Membership Professional	:	NO
societies	:	NO
Awards/ recognitions	:	NO
publications	:	NO

Signature