

**Nutrient Management Through Foliar
Application of Nutrients in Lentil
(*Lens culinaris* Medik) Under Rainfed
Condition
THESIS**



Submitted to the

**Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior
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By

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CERTIFICATE – I

This is to certify that the thesis entitled “**Nutrient Management Through Foliar Application of Nutrients in Lentil (*Lens culinaris* Medik) Under Rainfed Condition**” submitted in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE** in **Agronomy** of the Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior is a record of the bonafide research work carried out by **Mr. Navin Maibara, ID No 19131104** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instruction.

No part of the thesis has been submitted for any degree or diploma or has been published. All the assistance and help received during the course of the investigation has been acknowledged by the scholar.

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This is to certify that the thesis entitled “**Nutrient Management Through Foliar Application of Nutrients in Lentil (*Lens culinaris* Medik) Under Rainfed Condition**” submitted by **Mr. Navin Maibara, ID No 19131104** to the Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior in partial fulfilment of the requirements for the degree of Master of Science in **Agriculture (Agronomy)** has been accepted after evaluation by the External Examiner and approved by the Student’s Advisory Committee after an oral examination on the same.

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbol	Legend
&	And
@	At the rate of
a.i.	Active ingredient
C.D.	Critical Difference
cm	Centimetre
C.V.	Coefficient of Variation
DAS	Days after sowing
D.F.	Degree of Freedom
EC	Emulsifiable concentration
Etc	and the rest
Fb	Followed by
Fig.	Figure (s)
g	Gram
ha	Hectare
HI	Harvest Index
i.e.	That is
K	Potassium
Kg	Kilogram (s)
Kgha ⁻¹	Kilogram per hectare
L	Litre
MSS	Mean sum of square
mg	Milligram
M	Metre (s)
N	Nitrogen
no.	Number (s)
NS	Non significant
P	Phosphorus
PE	Pre emergence
pH	Logarithm of H ⁺ activity
R.A.K.	Rafi Ahmed Kidwai
RH	Relative humidity
₹	Rupees
S.Em	Standard error of means
S.S.	Sum of square
Viz.	Namely
%	Percent
±	Plus , Minus
°C	Degree Celsius

CHAPTER - I INTRODUCTION

The Lentil (*Lens culinaris* Medik) is a lens-shaped grain legume well known as a nutritious food. Lentil is classified in the genus *Lens*, which is the subfamily of papilionaceae and the family of leguminosae (Muehlbauer *et al.*, 1985). Lentil predominantly grows under rainfed conditions and on residual/conserved soil moisture under different crop production systems. Well drained, loam soils with neutral reaction are best for lentil cultivation. Acidic soils are not fit for growing lentil. Lentil grows as an annual bushy leguminous plant typically 20-45 cm tall, which produces many small purseshaped pods containing one to two seeds each. Lentil is a self-pollinating diploid ($2n = 14$ chromosomes) annual cool season legume crop. The seed of lentil contains 1-2% fat, 24.32 % proteins, 59% carbohydrates, 2.1% minerals (Iron, cobalt and iodine), vitamins, lysine and arginine. The mix of fiber (0.7%), folic acid and potassium in lentils makes it a heart-healthy.

The important lentil producing countries are Canada, India, Turkey, Australia, Nepal, USA, China, Bangladesh. India is the second largest producer, accounting for about 22 percent of global production Anonymous; (2019). Lentil occupies second place among the winter pulses after chickpea in the country covering an area of 1.51 million hectare with a production of 1.56 million tonnes and productivity 1032 Kg/hectare. Leading six lentil producing states have been Madhya Pradesh (0.64 million tonnes), Uttar Pradesh (0.49 million tonnes), West Bengal (0.17 million tonnes), Bihar (0.14 million tonnes), Jharkhand, Rajasthan and Assam. The major lentil acreage states are Madhya Pradesh (0.56 million hectare), Uttar Pradesh (0.48 million hectare), West Bengal (0.19 million hectare), Bihar (0.15 million hectare), Jharkhand, Rajasthan and Assam. Madhya Pradesh has occupies highest area and production of lentil in India with the share of 37.02 % and 41.05% respectively. Madhya Pradesh has Second highest productivity of lentil (1145 Kg/hectare) after Rajasthan (1162 Kg/hectare) Anonymous; (2019). The highest area (thousand hectares) under lentil is found in Satna district 55.00 followed by Rajgarh (51.00), Vidisha (42.65), Narsinghpur (42.50) and Dindori (39.00) thousand hectare. Similarly, in production Satna (63.36 thousand

tones) was highest followed by Rajgarh (61.20), Narsinghpur (60.95), Vidisha (54.04) and Raisen(47.67) thousand tones. The highest productivity of lentil in Morena district (1550.00 kg/ha) followed by Jabalpur (1513.00 kg/ha), Narsinghpur (1434.00 kg/ha), Bhind (1404.00 kg/ha) and Raisen (1394.00 kg/ha) (Anonymous 2017-18).

The major constraints are being poor crop establishment and moisture stress in the later stages of crop growth and it affects the productivity. Farmers are very much habituated to apply basal dose of fertilizer in lentil, which ultimately results in poor yield (Ram and Punia, 2018). Rainfed condition reduces crop yield due to lack of nutrients movement by water from soil to plants. Under this circumstance foliar application of fertilizer would be more efficient and economical than the soil application (Rajesh and Paulpandi, 2013). On the other hand, foliar application is regarded as a preferred solution when quick supply of nutrients is hindered or the soil conditions are not conducive for the absorption of nutrients (Salisbury and Ross, 1985). Pods and seeds development are mainly dependent on nitrogen and carbon accumulation, prior to podding stage but root fails to absorb nitrogen from dry soil. Under this condition foliar application of nutrients helps the nutrients to reach the site of food synthesis directly, leading no wastage and quick supply of food and thereby reduce the requirement of fertilizers. Foliar fertilization is a way in which plant are provided with nutrition by spraying with fertilizers on their aerial part specially leaves. As most of nutrients such as P, K micronutrients get fixed in the soil as insoluble form making their availability relatively low. Foliar application of nutrients under such conditions plays a prime role in providing nutrition to the crops. Foliar nutrition has been more favourable for short duration crops which cannot take nutrients efficiently from soil (Ganpathy *et al.*, 2008). Foliar nutrition is considered as an efficient and economic method for supplementing a part of the nutrient requirement at critical stages of crop growth. The interest on foliar fertilization has risen as a result of the many advantages of the methods of application of foliar nutrients, such as rapid and effective response to plant needs, regardless of soil conditions (Kerin and Berova, 2003). Additional foliar application during the growth and development of crops can improve their nutrient balance, which

lead to an increase in yield and quality (Kolota and Osinska, 2001). Terminal moisture stress for cultivation of lentil in Madhya Pradesh further aggravated the problem of realizing productivity. Promotion of extra short duration varieties (<100 days maturity), adoption of in situ moisture conservation measures, water harvesting and recycling, foliar spray of 2% DAP / Urea / NPK (19:19:19) / *Jeevamrit* at flowering and pod development stage need to be popularized and Strengthened.

The word *Jeevamruta* refers to life (*jeeva*) supporting holy liquid (*amruth*). The *Jeevamruth* is ecofriendly organic preparations made from mixing 10 kg local cow dung with 10 litres cow urine, add 2 kg jaggery, 2 kg pulse flour and 2 kg handful of garden soil and the volume made up to 200 litres. Keep the drum in shade covering with wet gunny bag and stir the mixture clockwise thrice a day and incubate (Vasanthkumar, 2006). The use of organic liquid products such as *Jeevamruth* results in higher growth, yield and quality of crops. *Jeevamruth* contain macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Palekar, 2006; Natarajan, 2007; Sreenivasaet al., 2010).

Thus, the present study “Nutrient Management Through Foliar Application of Nutrients in Lentil (*Lens culinaris* M.) Under Rainfed Condition” is conducted in *rabi* season 2020-21 for the following objectives:-

1. To study the growth performance and yield attributes of lentil under different foliar spray of nutrients.
2. To study the effect of foliar application of nutrients on yield of lentil.
3. To work out the economics of different treatments.

CHAPTER – II

REVIEW OF LITERATURE

The literature pertaining to the experiment entitled “**Nutrient management through foliar application of nutrients in lentil (*lens culinaris* m.) Under rainfed condition**” are very scarce. Hence available have been reviewed and presented in this chapter under different headings as follows: .

2.1 Effect of foliar spray of nutrients on growth performance and yield attributes

Garcia and Hanway (1976) suggested that foliar application of N and other nutrients may be effective in extending the pod filling period by delaying senescence.

Growada and Growada (1980) reported that the maximum number of pods per plant has been observed when NPK was supplied to plants both through foliage and soil while minimum number of pods per plant was noted in the plants with mixed NPK.

Solaiappan *et al.* (2002) reported that in rainfed red gram foliar spray of 2% DAP might have supplied nitrogen and phosphorus at the flag end of the crop and might have helped in effective translocation of the nutrients from one plant part to other.

El-Karmany *et al.* (2003) reported that In case of lentil the results showed that the basal dose of fertilizer application and fertilizer spray treatments significantly improved the seed yield of lentil cultivar Subrata. The highest seed yield (2045 kg ha⁻¹) was recorded with application of 2% urea spray over basal dose of fertilizer application. The result established the positive effect of supplying legume plants with supplementary nitrogen to have beneficial effects on enhancing growth and increasing seed yield.

Zeidan (2003) concluded that foliar application of urea at 50% flowering increased the yield and seed protein. In legumes, leaf senescence starts earlier before completion of maturity which break the source to sink relation, thereby reduces the yield. Nitrogen spray have been found to delay leaf senescence and improve yield.

Mallarino (2005) reported that foliar application could be used to avoid the depletion of these nutrients in the leaves and also the resulting reduction in

photosynthetic rate during this period, due to poor nutrient uptake from the soil and translocation of this element from the leaves to the developing seeds.

Ram and Punia (2007) have recorded at harvest stage, the highest plant height (30.92cm) was found in control treatment but the important yield contributing characters of lentil like number branches plant⁻¹ and number of pods plant⁻¹ were higher in foliar application of DAP and foliar application of TSP. Maximum number of branches plant⁻¹ was observed in application of DAP.

Ghosh and Joseph (2008) in green gram reported that foliar application of various nutrients had significant influence on the haulm yield. Among the treatments, foliar application of 2% DAP spray twice at flower initiation and pod formation stages of crop growth recorded significantly higher haulm yield of 4027 kg ha⁻¹ and was on par with 2% urea phosphate spray and TNAU pulse wonder spray twice at flower initiation and pod formation stage of crop growth. The haulm yield enhancement due to the different treatments might be due to continuous supply of nutrients which in turn increased the leaf area and dry matter production resulting in higher haulm yield. This is also attributed to the higher nutrient uptake throughout the crop growth period.

Shwetha (2008) reported that better growth and yield parameters of soybean were observed with the application of organic manures in combination with fermented organics *viz.*, *beejamrut*, *Jeevamrit*, *panchgavya* rather than application of only organics.

Kasbe *et al.* (2009) reported that the application of *jeevamrutha* formulation (10638 litre ha⁻¹) in rice-black gram cropping sequence recorded significantly higher total dry matter (163.05g plant⁻¹) over other treatments except *jeevamrutha* formulation 27777 litre ha⁻¹ which was onpar with *jeevamrutha* formulation 10638 litre ha⁻¹ (150.67 g).

Nileema *et al.* (2011) revealed that the soil treatment of RDF + *beejamruth* (seed treatment) + *jeevamruth* (soil application) + *panchagavya* (3% foliar spray) showed improvement in plant height (143.21 cm), root length (19.80 cm) and dry matter (7.94 g plant⁻¹), compared to other treatments and control. Further the plant nutrient concentrations (N, P and K) were the highest

with the application of liquid organic manures + RDF followed by beejamruth + jeevamruth + panchagavya.

Aliloo *et al.* (2012) conducted a field experiment under rain-fed conditions at Maragheh (Iran), the foliar spraying of urea was evaluated for two chickpea cultivars (Azad and ILC 482). The urea was applied as foliar spray of 2% and 4% at two stages (before and after flowering) and as soil application of 20 kg ha⁻¹. The interaction of urea application and cultivar for days to maturity and pods per plant was significant. The highest plant height and seed yield was obtained by application of 20 kg ha⁻¹ urea in soil. However, difference among 20 kg urea application, 2 % and 4 % urea spraying before flowering was not significant.

Khalilzadeh *et al.* 2012 was carried out a greenhouse experiment to determine the effect of foliar spraying of bio-organic fertilizers and urea on root and vegetative growth of mung bean (*Vigna radiate* L.) at Urmia University, Iran. The 1.0% spray concentration of urea, nitroxin, amino acid, green hum, Biocrop L-45, Nutriman N24 and Mas Raiz was evaluated against cattle manure, water spray and control. Results showed that foliar application of urea at 1% concentration recorded higher growth parameters like plant height (10.25cm), leaf area (9.84 cm²) and dry weight of shoot (1.24 g plant⁻¹).

Mondal *et al.* (2012) investigated the effect of foliar application of urea on soybean in a field experiment conducted at Bangladesh Institute of Nuclear Agriculture, Bangladesh. The results revealed that among four levels of urea spray (control, 1 spray of 1.5% urea, 2 sprays of 1.5% urea and 3 sprays of 1.5% urea), higher seed yield of soybean was recorded under foliar feeding of urea than control. The maximum yield were recorded for 3 sprays of 1.5% urea due to superiority in physiological characters (leaf area index, total dry mass per plant, absolute growth rate, chlorophyll and harvest index) and yield attributes (number of pods per plant, number of seeds per pod and 100-seed weight) over other treatments.

Kumar *et al.*, (2013) revealed that foliar spray of 2% DAP twice at flower initiation and pod formation stages of crop growth resulted in significantly higher number of pods⁻¹ (62.50), number of seeds pods⁻¹, seed index and higher grain yield (1460 kg ha⁻¹).

Dwivedi *et al.* (2014) reported that application of *jeevamrit* @ 5 % has increased plant height of Cape gooseberry besides enhanced physico-chemical properties of soil in comparison to application of *amritpani*, vermicompost and FYM.

Rahman *et al.* (2014) carried out a field experiment to evaluate different nutrients application on common bean at hazara University, Pakistan. The experiment was comprised of four treatments i.e. Control (water spray), poultry manure, DAP (Diammonium phosphate) and foliar spray of (NPK 20:20:20). The results showed that foliar spray of NPK fertilizer significantly increased number of pods per plant, number of seeds per pod, number of seeds per plant, biomass and grain yield.

Uma and Karthik (2017) had conducted a field experiment during *rabi* and revealed significant increase in growth attributes (plant height, dry matter production and number of pod plant⁻¹, number of seed plant⁻¹, test weight of grains) of pulses with foliar application of 2% DAP at 30 and 45 DAS.

Ganajaxi *et al.* (2018) reported that the spraying of 2% DAP supplies nutrients quickly (within 24 hours) through foliage and buds and helps the flower to retain and develop into pod and accumulates more food in seed and resulted into more number of pods/plant and higher test weight (100 seed weight).

2.2 Effect of foliar spray of nutrients on Yield of lentil

Ponnusamy *et al.* 1999 revealed that in black gram, foliar spraying of 2 per cent DAP at flower initiation and another 15 days later which was found to increase the grain yield of black gram.

Suresh (2000) experimented and came out with the suggestion that foliar application of nitrogen at later stages of crop growth is to be one of the possible ways of overcoming this problem. The reported that foliar application of urea 2 per cent twice (at flowering and pod development) significantly increased grain yield of green gram by 25.6 per cent.

Palta *et al.* (2005) reported enhanced productivity and total biomass in pulses due to foliar application of 2% urea spray at flowering and pod development stage.

Bhowmick (2006) reported that foliar spray of 2% urea twice at pre-flowering and 10 days thereafter significantly increased the grain yield of lentil. Yield increment due to 2% urea spray was 37.12 and 25.16% over no spray and water spray, respectively.

Selvi *et al.*, (2006) studied the effect of two per cent DAP as foliar spray at flowering and 15 days later on seed yield of green gram and obtained a seed yield 535 and 470 kg ha⁻¹ with DAP spray and basal application respectively, because during the floral and pod development stages, the demand for nitrogen is more (because of more competition between the sink organs) which could be met out by foliar application of the same during flowering and pod development stage.

Dixit and Elamathi (2007) revealed that the highest seed yield (1325 kg ha⁻¹) of pulses was recorded with application of 2% urea spray over basal dose of fertilizer application, though it was at par with 2% NPK (19-19-19) spray over basal dose of fertilizer application and 2% dap spray over basal dose of fertilizer application.

Manonmani and Srimathi (2009) found that foliar application of DAP at two per cent during flowering stage will give significantly produce higher number of pods plant⁻¹ and seed yield in black gram.

Verma *et al.*, (2009) conducted a field experiment at C.S. Azad University of Agriculture and Technology (Kanpur), to study the effect of foliar application of urea on the physiological traits and productivity of rainfed chickpea. The three concentrations of urea (0.25, 0.5 and 1.0%) as foliar spray were applied at 45 and 65 DAS in three chickpea genotypes (KDG-1168, Udai and Awarodhi) under rainfed condition. At 50% flowering stage, nitrate reductase activity (NRA), Relative Water Content (RWC) were found maximum in 1.0% urea spray. All the genotypes significantly improved their NRA, RWC and chlorophyll content in leaf with increase in urea concentration up to 1.0%. The number of branches per plant showed significant increase only up to 0.5% urea spray whereas seed yield of all genotypes increased up to 1.0% urea spray.

Kuttimani and Velayutham, (2011) revealed that foliar application of DAP increased 6% grain yield over control treatment in pulses. Increase in yield

and yield attributes might be due to fulfillment of the demand of the crop by higher assimilation and translocation of photosynthates from source to sink through adequate supply of nutrients by foliar application of fertilizers.

Venkatesh and Basu (2011) investigated the effect of foliar application of urea on chickpea in a field experiment conducted at Indian Institute of Pulses Research, Kanpur. Foliar application of urea apart from the basal application of recommended dose of fertilizers increased branching in chickpea by 8-23% over no spray or water spray. The highest grain yield and yield attributes were recorded with 2% urea spray at 75 days after sowing (DAS).

Venkatesh *et al.* (2012) carried out a field trial to study the effect of foliar application of nitrogenous fertilizers on chickpea under rain-fed conditions at Indian Institute of Pulses Research, Kanpur. Six treatments viz., i) control; ii) water spray; iii) urea (2%) spray at 75 DAS (days after sowing); iv) DAP (2%) spray at 75 DAS; v) urea spray at 105 DAS and vi) DAP spray at 105 DAS were evaluated and the results revealed that the highest pods per plant (45.3) were recorded in 2% urea spray at 75 DAS which was 23.7 and 21.3 per cent higher than control and water spray, respectively. The highest seed yield of 2437 kg ha⁻¹ was recorded with 2% urea spray at 75 DAS followed by 2% DAP spray at 75 DAS (2389 kg ha⁻¹).

Bhowmick *et al.*, (2014) reported in lathyrus irrespective of seed priming methods, foliar spray of 2% urea solution could significantly increase the seed yield to the tune of 1040 kg ha⁻¹ and it was closely followed by foliar spray of 2% DAP solution (983.75 kg ha⁻¹). Yield advantages were also discernible due to foliar spray of 2% urea (31.88 and 19.77%) and 2% DAP (24.75 and 13.29%), compared with no spray and water spray, respectively. Higher yields due to urea and DAP spray could be obtained because of the respective improvement in terms of growth and yield attributes). Similar results were earlier reported in chickpea (Bhowmick, 2006), lentil (Bhowmick, 2008; Gupta and Bhowmick, 2012) and lathyrus (Gupta and Bhowmick, 2013).

Patil *et al.* (2014) reported that application of FYM @ 20.5 t ha⁻¹ + *jeevamrit* @ 500 l ha⁻¹ (30 and 45 days after sowing) on pigeon pea significantly enhanced plant growth parameters (plant height, number of

branches per plant, number of compound leaves, leaf area per plant) and yield (seed and stock).

Singh *et al.* (2014) had conducted an experiment at university of agriculture and Technology, Kumarganj, Faizabad on lentil crop under different foliar application and result revealed that the highest yield obtained under two spray of 2% urea each at branching and pod formation stage applied to lentil crop.

Basavraj *et al.* (2015) reported that the soil application of *Jeevamrit* recorded significantly higher pod yield of French bean (141.7 q ha^{-1}) compared to without *Jeevamrit* application (117 q ha^{-1}).

Das and Jana (2015) studied the response of water soluble fertilizer spray on growth and yield of greengram, blackgram, lathyrus, lentil and chickpea in field experiments conducted at pulses and oilseeds research station, West Bengal. The seven levels of foliar spray of water soluble fertilizers at pre flowering stage [no spray, 0.5% NPK (19:19:19), 1% NPK (19:19:19), 2% NPK (19:19:19), 3% NPK (19:19:19), 2% DAP, 2% Urea] were evaluated under basal and no basal dose of fertilizers. The application of 2% urea spray recorded significantly higher seed yield of pulses over basal dose of fertilizer. Without basal fertilizer application, 3% NPK (19:19:19) spray recorded highest seed yield. Under basal dose of fertilizer application, the results showed a gradual increase in yield with the increase in concentration of NPK (19:19:19) fertilizer spray up to 2%.

Sengupta and Tamang (2015) reported that significant higher yield of green gram was obtained when the crop was sprayed with DAP (2% solution) at 25 and 45 DAS and Urea (2% solution) at 25 and 45 DAS.

Yogananda *et al.* (2015) reported that application of 100 per cent N equivalent compost along with recommended dose of FYM, *jeevamrutha* and *beejamrutha* has significantly increased the plant height (70.13 cm), number of leaves (63.53), number of branches (8.47), grain yield (1740 kg ha^{-1}) and stover yield (1864 kg ha^{-1}) of cowpea when compared to application of compost and liquid manures.

Devakumar *et al.* (2016) reported that application of N equivalent compost with *beejamruta* and *Jeevamruta* resulted in increasing the yield of

organic fieldbean compared to individual application of different N equivalent compost and *beejamruta*.

Bhosale *et al.* (2017) reported higher grain yield of chickpea when *Jeevamrit* @ 500 l ha⁻¹ applied (1969 kg ha⁻¹) as compare to without *Jeevamrit* applied (1601 kg ha⁻¹).

Hossain *et al.* (2018) reported that foliar spray of DAP (3%) increased 6% grain yield of lentil over control treatment. In drought prone areas, foliar spray of DAP (3%) treatment at flowering and pod formation stages was the most effective in terms of improving growth and yield of lentil in water stress environment where nutrient uptake is greatly limited.

Parmar and Vyas (2019) reported that maximum height, branches, root length was recorded in soil application of *Jeevamrit* (500 l ha⁻¹) followed by foliar application @ 5%(at 30 and 60 DAS) in rice. The lowest values of these parameters were observed in control.

Reshma *et al.* (2019) reported that combined application of *jeevamruta* (1000 litre ha⁻¹) and *panchagavya* (7.5 %) resulted in better growth, yield and yield attributing characters in cowpea besides conserving soil health. Similarly, application of *jeevamruta* (400 litre acre⁻¹) and *panchagavya* (7.5 %) resulted in multiplication of different beneficial microbers in fieldbean (Lavanya *et al.*).

2.3 Effect of foliar spray of nutrients on Economics of lentil cultivation

The report of Yakadri and Ramesh (2002) reported that foliar application of 2% DAP in black gram recorded the highest B:C ratio of 3.78 compared to control is concomitant to the present result.

Chandrasekhar and Bangarusamy, (2003) with respect of B:C ratio, foliar application of 2% DAP twice at flower initiation and pod formation stages of crop growth registered higher B:C ratio (2.22) followed by foliar application of TNAU pulse wonder twice at flower initiation and pod formation stages of crop growth (1.90) and the lowest B:C ratio (1.25) was recorded under the water spray treatment.

Kasbe *et al.* (2009) reported that application of *Jeevamrit* was found to be cost effective in rice when used at 2000 l ha⁻¹ in different combinations than *jeevamrit* used as N basis. It was observed that application of *Jeevamrit* is one of the cheap and efficient organic substitutes for other organic manures like

vermicompost in integrated approach for high crop yield and profitability, besides improving the nutrient status of soil.

Manjunatha *et al.* (2009) reported that application of FYM at 7.5 t ha⁻¹ + *Jeevamrit* application recorded the highest net returns (₹.27,384 ha⁻¹) which was on par with 100 per cent RDF (₹. 25,475 ha⁻¹) and significantly superior over the treatment FYM at 3.75 t ha⁻¹ + *Jeevamrit* application (₹.24, 405 ha⁻¹).

Amareswari and Sujathamma (2014) noticed that the cost of production, net return and B: C ratios were estimated using *Jeevamrit* and compared with those of chemical farming. In both the varieties B: C ratio was better with application of *Jeevamrit* method being 3.39 in masura variety 3.0, in hamsa as compared to 1.09 and 0.6 in chemical methods of rice production respectively.

Raksar *et al.* (2014) reported that application of organic manures (FYM, compost, green manure, vermicompost), biofertilizers (Azotobacter, Rhizobium, PSR), biopesticides and fungicides (trichoderma), trap crops rajgira, marigold, coriander, sorghum, castor and maize), biological pest control (*amrutpani*, *vermiwash*, neem ark) and soil health (*jeevamrit*) and INM has increased fruit yield and B:C ratio of tomato, brinjal and bulb yield and B:C ratio of onion in crop intensification system in comparison to control.

Siddappa *et al.* (2016) reported that higher gross return, net return and B:C ratio were recorded with application of FYM @ 200 per cent N equivalent + *Jeevamrit* @ 500 l ha⁻¹ (₹56,635 ha⁻¹, ₹30,430 ha⁻¹ and 2.16, respectively) over FYM at 100 per cent N equivalent + no *Jeevamrit* application (₹.30745 ha⁻¹, ₹10055 ha⁻¹ and 1.49, respectively).

Hossain *et al.* (2018) reported that maximum grain yield was found when DAP was applied in both branching and pod initiation stages as spray. But in the present study urea was applied only either in branching stage or in pod initiation stage as lentil is a very sensitive to over fertilizer dose and two time spray will increase the production cost ultimately BCR value will be lesser than the recommended method of basal urea application in Bangladesh.

Gowthamch *et al.* (2019) experimental results revealed that, significantly higher growth, yield attributes, economics and nutrient uptake with good shelf-life and protein content of the French bean were found in the treatment which received *beejamrit* (seed treatment) + *Jeevamrit* (soil application @ 500 L ha⁻¹)

+ 100% RDN through vermicompost + Foliar spray of *Panchagavya* @ 3% and were on par with application of *Beejamrit*(seed treatment) + *Jeevamrit* (soil application @ 500 L ha⁻¹) + 50% RDN through FYM + 50% RDN through vermicompost + Foliar spray of *Panchagavya*@ 3% and (T₅) *Beejamrit* (seed treatment) + *Jeevamrit*(soil application @ 500 L ha⁻¹) + 100% RDN through FYM + Foliar spray of *Panchagavya*@ 3%. Similar trend of higher B:C ratio (4.17) and net return was (198794 Rs/ha) also recorded in the same set of treatment combination.

CHAPTER- III

MATERIAL AND METHODS

A field experiment is conducted “**Nutrient management through foliar application of nutrients in lentil (*lens culinaris* Medik) Under rainfed condition**” at the **Research farm, R.A.K. college of Agriculture, Sehore (M.P.)** in *rabi* season 202021. This chapter deals with the concise description of materials used and methods adopted during the course of investigation are presented.

3.1 Experimental site

The present study was conducted under All India Co-ordinated Research project on MULLaRP at R.A.K. College of Agriculture, Sehore (M.P.) during *rabi* season 2020-21 on 506.25 m² area having fairly uniform topography, normal fertility status and soil homogeneity.

3.2 Climate and Weather conditions

Sehore is situated in the Eastern part of Vindhyan Plateau in sub-tropical zone at the latitude of 23⁰ 12' North and longitude of 77⁰ 05' East at an altitude of 498.77 m from mean sea level (MSL) in Madhya Pradesh. The average annual rainfall varies from 1000 to 1200 mm concentrated mostly from June to September. The mean annual maximum and minimum temperatures are 31.16⁰ C and 18.5⁰ C, respectively. The summer months are hot and May is the hottest month having a maximum temperature up to 49.8⁰ C. December is the coldest month as temperature reaches down to 3.5⁰ C. The weekly meteorological data viz., rainfall, temperature, relative humidity and number of rainy days during crop season were recorded in meteorological observatory of R.A.K. College of Agriculture, Sehore.

Meteorological data recorded during the period of experimentation are given in Table 1. The total rainfall received during Nov 2020 to March 2021 was recorded at 48.5 mm with total 8 rainy days.

Table 3.1: Meteorological data during the *Rabi* crop season (2020-21)

Month	Standard Week	Week	Temperature (°C)		Rainfall in mm	No. of rainy days	Humidity In %
			Max.	Min.			
Nov.	45	05-11	30.11	10.61	00	00	66.53
	46	12-18	30.97	16.57	2.8	1	58.67
	47	19-25	27.54	12.51	00	00	61.42
	48	26-02 Dec	27.84	10.81	00	00	61.36
	Average		29.11	12.62			61.99
Dec.	49	03-09	29.87	10.57	00	00	63.21
	50	10-16	24.24	15.77	13.30	2	74.45
	51	17-23	22.55	6.3	00	00	78.63
	52	24-31	23.68	8.4	00	00	66.71
	Average		25.08	10.26			70.75
Jan.	01	01-07	25.77	14.75	0.5	00	74.62
	02	08-14	24.18	12.75	1.5	00	67.52
	03	15-21	26.52	13.02	00	00	48.28
	04	22-28	25.85	9.08	00	00	66.54
	05	29-04Feb	25.8	5.95	00	00	62.61
	Average		25.62	11.11			63.91
Feb.	06	05-11	26.08	8.31	00	00	59.13
	07	12-18	30.68	11.91	0.5	00	56.32
	08	19-25	32.48	11.42	00	00	53.26
	09	26-04Mar	35.31	14.75	00	00	51.12
	Average		31.13	11.59			54.95
March	10	05-11	35.57	15.42	00	00	46.94
	11	12-18	34.42	15.34	5.0	1	51.82
	12	19-25	35.28	16.92	24.9	4	42.25
	13	26-31	36.5	15.75	00	00	42.18
	Average		35.44	13.83			45.79

Source: Meteorological observatory, R.A.K. College of Agriculture, Sehore (M.P.)

3.3 Soil

The soil of the experiment field was medium black clay loam in texture fairly deep having a slight slope from west to east, which provides good drainage. To access the initial fertility status of the soil of experimental field, soil samples were collected randomly from different places of the field at 0 to 30 cm depth with the help of a screw type soil auger. After this a composite sample was prepared for the analysis of available nitrogen, phosphorous and potassium, pH and electrical conductivity. The analytical values are presented in Table 3.2,

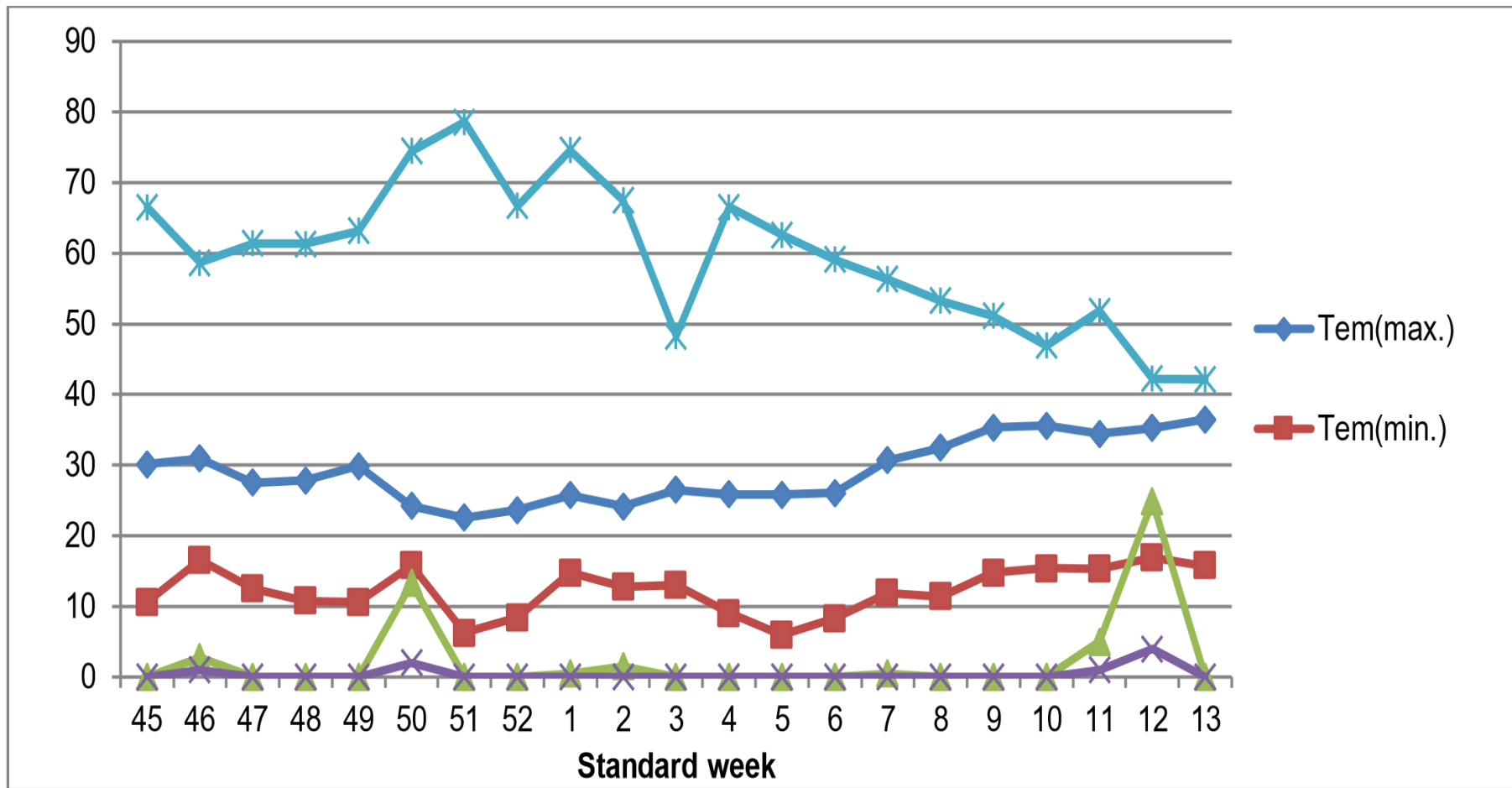


Table-3.2 Chemical composition of soil

S. No.	Particulars	Content	Level	Method adopted
1.	Available Nitrogen (N kg ha ⁻¹)	166	Low	Alkaline Permanganate method (Subbaih and Asija, 1956)
2.	Available Phosphorus (P ₂ O ₅ kg ha ⁻¹)	10.42	Low	Olson's Method (Olsen's et al., 1954)
3.	Available Potassium (K ₂ O kg ha ⁻¹)	311	High	Neutral Normal Ammonium Acetate (Hanway and Heidel, 1952)
4.	Available sulphur (ppm ha ⁻¹)	9.93	Medium	Turbidimetric Method (AOAC, 1984)
5.	Soil pH	7.2	Normal	Glass electrode pH meter using 1:2.5 soil water suspension (Piper, 1966)
6.	Electrical conductivity (m mhos/cm) (dsm ⁻¹)	0.6	Normal	By conductivity meter as described by (Jackson, 1973)

3.4 Previous history of the field

Following cropping system was followed in the experimental field during the preceding five years:

Table-3.3 Cropping history of the field

Year	Kharif season	Rabi season
2016-17	Urd bean	Lentil
2017-18	Urd bean	Lentil
2018-19	Urd bean	Lentil
2019-20	Urd bean	Lentil
2020-21	Urd bean	Present experiment

3.5 Experimental details and layout of the field

The experiment was laid out in randomized block design with six treatments, replicated four times. The details of experiment and treatments are given below and layout plan is illustrated in figure 2.

Location	: R.A.K. College of Agriculture, Sehore (M.P.)
Crop and Variety	: Lentil, RVL 13-7
Design	: Randomized Block Design (RBD)
Treatments	: 06
Replications	: 04
Total number of plots	: 24
Gross plot size	: 5.0 m × 3.0 m (15 m ²)
Net plot size	: 4.0 m × 2.4 m (9.6 m ²)
Distance between plots	: 0.75 m
Distance between replication	: 1 m
Row spacing	: 30 cm
Plant spacing	: 10 cm
Seed rate	: 40 kg ha ⁻¹
Recommended dose of fertilizer	: 20:40:20 kg ha ⁻¹ (At time of sowing)

3.5.1 Treatments details:

Details of treatments are presented in Table 3.3

Treatments	
T ₁	Control
T ₂	Water spray (Pre-flowering stage and 15 days after pre-flowering stage)
T ₃	2 % Spray of DAP (Pre-flowering stage and 15 days after pre-flowering stage)
T ₄	2 % Spray of Urea (Pre-flowering stage and 15 days after pre-flowering stage)
T ₅	2 % Spray of NPK (19:19:19) (Pre-flowering stage and 15 days after pre flowering stage)
T ₆	2 % Spray of <i>Jeevamrit</i> (Pre-flowering stage and 15 days after preflowering stage)

3.6 Characteristics of lentil variety RVL 13-7

RVL 13-7 (Raj Vijay Lentil 13-7) is released by RVSKVV, RAK College of Agriculture Sehore MP. It is mainly grown in Madhya Pradesh, Chhattisgarh and

Rajasthan. Its plant type is semi-erect, seed size is large, with medium height (36-40 cm) and branches having broad leaf, which makes it suitable for intercropping. This variety is suitable for timely sown conditions. Grain yields of this genotype 12-15 q/ha with 3.9 g/100 seed index. Maturity period of this variety is 100-110 days. It is also resistant to wilt disease.

3.7 Cultivation practices:

3.7.1 Preparation of field and layout of the experiment

The land was prepared with tractor-drawn rotavator to obtain a good seed bed condition for the rapid germination. After this, field was divided into four blocks equal to the number of replications. In each block, 6 plots were made equal to the number of treatments of size 15 m² (5 m × 3 m). The layout was made as illustrated in Fig. 3.2.

3.7.2 Organic liquid formulations *Jeevamrit* preparation

In the experiments 2 % foliar spray of *Jeevamrit* used those are prepared from different quantity of raw material in 200 liter of water.

Jeevamruth is made from mixing 10 kg local cow dung with 10 litres cow urine, add 2 kg jaggery, 2 kg pulse flour and 2 kg handful of garden soil and the volume made up to 200 litres. All these were put in 200L plastic drum and mixed thoroughly and volume was made up to 200L. The mixture was stirred well in clock wise direction and kept the plastic drum in shade covered with wet jute bag.

3.7.3 Seed rate and seed treatment

Before sowing, the seeds were treated with Bavistin @ 4g/kg seed. A recommended seed rate of lentil 40 kg/ha was used. Seed was drilled manually keeping distance of 30 cm in between rows. Seed was sown at the depth of 3 cm.

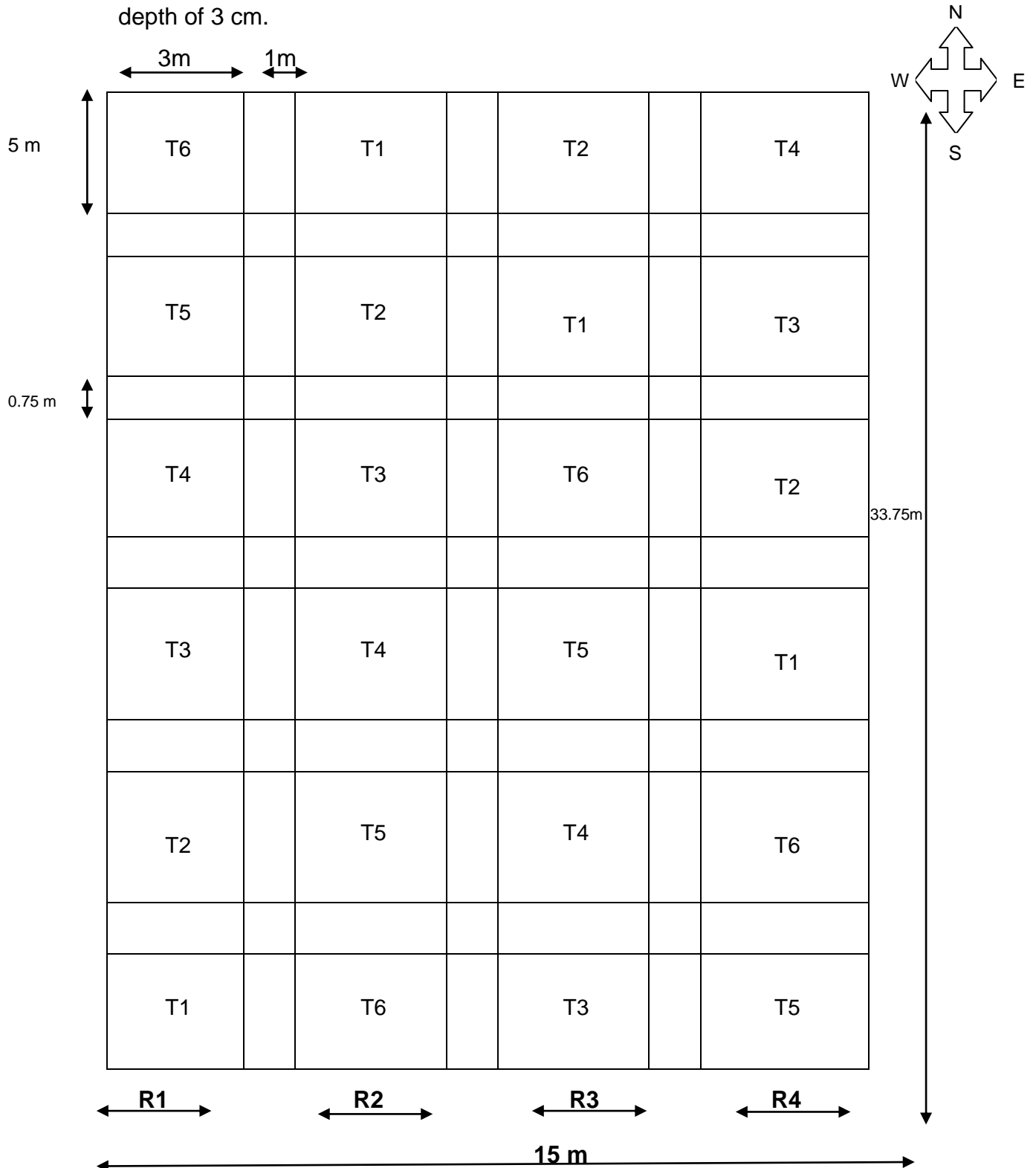


Fig 3.2:- Layout plan

3.7.4 Details of field operation

The schedule of field operations, crop management and post harvest operations are briefly presented in table 3.4.

Table 3.4: Schedule of the field operations:-

S. No.	Operation	Date	Remarks
1	Field preparation	14/11/2020	By Tractor
2	Lay out of the field	14/11/2020	Manually
3.	Sowing	15/11/2020	Manually
4	Intercultural practices Hoeing 2 times	21/12/2020 19/01/2021	Manually Manually
5	Foliar application of nutrients 2 times	02/01/2021 17/01/2021	Manually
6	Plant protection Imidacloprid 17.8% SL @ 2 %	08/01/2021	Manually
7	Harvesting	08/03/2021	Manually
8	Threshing	12/03/2021	Manually

3.7.5 Plant protection operations

The plant Protection measures were timely adapted as per necessary. Mainly infestation of aphid (*Aphis craccivora*) observed at flowering initiation stage of crop. Which was controlled by the spray of Imidacloprid 17.8% SL @ 2 %.

3.7.6 Harvesting and threshing

The crop was harvested at physiological maturity with the help of sickle. Two outer border rows of each plot were first removed and then, the net plot was harvested. Before harvesting, harvested produce was left in the respective plots for sun drying and weighed to record biological yield. The harvested produce was threshed by beating with sticks with the help of manual labour and finally seeds were winnowed by using 'Supas'. Threshed seeds were sundried for 2-3 days to reduce the moisture content and then the seed yield per plot was recorded.

3.8 Experimental observations

The experimental observations on lentil crop are presented under the following heads. For recording pre and post harvest observations, in each plot, three plants were tagged randomly with labels for various observations on growth parameters and yield attributes as followed: **3.8.1 Pre harvest studies:**

(A) Plant height (cm)

Plant height was measured in order to estimate the effect and extent on plant growth due to various treatments. Plant height of the three randomly selected plants was measured at 30, 45, 60 DAS and at harvest in each plot in cm from the soil surface to the main stem (apical).

(B) Branches per plant (no.)

The number of branches per plant was counted from randomly selected plants in each plot at 30, 45, 60 DAS and at harvest.

(C) Dry matter accumulation plant⁻¹ (g)

Dry matter was measured for estimate the effect of different treatments on dry matter accumulation. Dry matter was measured at 30, 45, 60 DAS and at harvest in each plot from three randomly selected plants are oven dried at 64±5°c degree centigrade for 24 to 48 hours drying.

(D) Number of nodules plant⁻¹

The plants were dugout safely and the total numbers of nodules from three randomly selected plants were counted and there after average number of nodules per plant were counted at 30, 60 DAS.

(E) Dry weight of nodules plant⁻¹ (mg)

The removed nodules were kept in oven for recording dry weight in milligram per plant at 30, 60 DAS.

3.8.2 Post harvest studies

At harvest, the earlier tagged plants were harvested for the purpose of recording observation on yield attributing parameters.

(A) Number of pods plant⁻¹

The numbers of pods per plant were counted from randomly selected plants after harvest of crop.

(B) Number of grain pod⁻¹

Per plant grains and pods were counted from each plant and divided by numbers of pod to obtain the grains per pods.

(C) Grains yield plant⁻¹ (g)

The grains obtained from three selected plants of lentil in each plot were weighted and mean weight of grain yield per plant was calculated.

(D) Seed index (g)

Random seed sample were taken from each yield of net plot. Hundred seeds from the produce of each plot were counted and weight accurately on electronic balance and expressed in grams.

(E) Seed and straw yield (kg ha⁻¹)

The harvested produce from each plot was tied in bundles separately sun dried and bundle weight (biological yield) was recorded with the help of spring balance. The weight of cleaned grains obtained from each net plot after threshing was recorded and thereafter converted into kilograms per hectare by using appropriate factor. Straw yield was calculated for each net plot by subtracting the grain yield from the bundle weight of the respective plot. **(F)**

Harvest index (%)

Harvest index was calculated by using the following formula given by Nichiporovich (1967) and expressed in per cent

$$\text{Harvest Index (HI)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Economical yield = Grain yield

Biological yield = Grain yield + straw yield

(G) Crop growth rate (g cm⁻² day⁻¹)

Crop growth rate (CGR) is the ratio of dry matter production per unit ground area per unit time, which was calculated by using the formula given by Watson (1952) and expressed as g m⁻² day⁻¹.

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

Where,

P is ground area (1m²);

W₁ and W₂ are plant dry weight at time t₁ and t₂, respectively.

(H) Relative growth rate (g g⁻¹ day⁻¹)

Relative growth rate (RGR) is the rate of increase in the dry weight per unit dry weight already accumulated and was calculated by using the formula of Blackman (1919) and expressed as g g⁻¹ day⁻¹.

$$\text{RGR} = \frac{\log W_2 - \log W_1}{(T_2 - T_1)}$$

Where, log W₂ and log W₁ are log of dry weight at time T₁ and T₂

3.9 Economics

The economics of various treatments was worked out taking into account the existing market rate of produce during the course of investigation.

i. Cost of cultivation (₹ ha⁻¹)

Cost of cultivation is an important factor for economic analysis. It can be calculated by considering prevailing market price of inputs, wages and actually cost involved on various aspects during the investigation.

ii. Gross monetary returns (₹ha⁻¹)

Gross monetary returns are the total earnings from crop produce in terms of ₹/ha. The gross monetary return was calculated by considering the prevailing price of the produce at the time of harvesting.

iii. Net monetary returns (₹ha⁻¹)

The net monetary returns (₹ha⁻¹) were calculated after deducting all the expenditure (₹ha⁻¹) from gross return. It was obtained by subtracting cost of cultivation from gross return. This represents the actual income of farmer. The net monetary returns (₹ha⁻¹) for different treatments were calculated with the following formula-

$$\text{Net monetary returns (₹ha}^{-1}\text{)} = \text{Gross returns (₹ha}^{-1}\text{)} - \text{Cost of cultivation (₹ha}^{-1}\text{)}.$$

iv. Benefit Cost ratio

Benefit Cost Ratio is the ratio of the benefits of an activity or production, relative to its costs, both expressed in monetary terms. Mehmood *et al.* (2011).

$$\text{BCR} = \text{Gross return} / \text{Cost of cultivation}$$

3.10 Statistical analysis and interpretation of data

The experimental data was analyzed by Fishers method of analysis of variance (Panse and Sukhatme 1967). Critical differences were calculated at probability of 5 per cent wherever F value was significant.

Table 3.5: The skeleton of analysis of variance

Sources	D.F.	SS	MSS	F-ratio
Replications	r-1			
Treatments	t-1			
Errors	(r-1)(t-1)			

The following formulae were used for standard error, critical difference and coefficient of variance estimations.

$$\begin{aligned} \text{a) S.Em}\pm &= \sqrt{\text{EMS}/r} \\ &= \frac{\text{S.Em}\pm}{\sqrt{2}} \times t_{5\% \text{ at error df}} \\ \text{b) C.D.} &= \frac{\sqrt{\text{EaMS}}}{\text{GM}} \times 100 \\ \text{c) C.V.} &= \frac{\text{S.Em}\pm}{\text{GM}} \times 100 \end{aligned}$$

Where;

r	:	Replication
t	:	Treatment
D.f	:	Degree of freedom
SS	:	Sum of square
MSS	:	Mean sum of square
EMS	:	Error mean sum of square
S.Em±	:	Standard error of mean
CD	:	Critical difference
CV	:	Coefficient of variation

CHAPTER – IV RESULT

A field experiment on “**Nutrient Management Through Foliar Application of Nutrients in Lentil (*Lens culinaris* Medik) Under Rainfed Conditions**” were conducted in *rabi* season 2020-21. The results pertaining to growth performance, yield attributes and yield analysis are presented in this chapter under following heads:

4.1 Plant growth parameters

4.2 Yield and yield attributes

4.3 Economics

4.1 Plant growth parameters

4.1.1 Plant height (cm)

The data of plant height (cm) of lentil presented in Table 4.1 and appendix (I). The data indicates that increase in plant height of lentil was up to at harvest stage. The plant height recorded at 30 and 45 DAS was found non-significant. However, the maximum plant height (15.51 cm) was recorded in control (T₁) and foliar application of *NPK (19:19:19)*@ 2% (T₅). At 45 DAS maximum plant height was recorded in treatment foliar application of *DAP*@ 2% (T₃), (23.38 cm) followed by foliar application of *Jeevamrit*@ 2%(T₆), (22.07 cm).

Table 4.1:- Effect of different treatments on plant height at successive stages of growth of lentil crop.

	Treatments	30 DAS	45 DAS	60 DAS	At harvest
1	Control	15.51	20.99	29.44	34.95
2	Foliar application of Water	14.74	21.24	32.21	36.55
3	Foliar application of <i>DAP</i> @ 2%	15.46	23.38	33.38	41.46
4	Foliar application of <i>Urea</i> @ 2%	15.37	21.05	33.75	42.91
5	Foliar application of <i>NPK (19:19:19)</i> @ 2%	15.51	21.6	32.68	40.39
6	Foliar application of <i>Jeevamrit</i> @ 2%	15.1	22.07	32.49	40.35
	S. Em. (±)	0.81	0.92	0.70	1.28
	CD	NS	NS	1.72	3.11

The plant height was found significant at 60 DAS and at harvest. The maximum plant height was recorded in treatment foliar application of *Urea*@ 2% (T₄), (33.75 cm and 42.91 cm) respectively at 60 DAS and at harvest. It was at par with treatments foliar application of *DAP*@ 2% (T₃), (33.38 cm) and

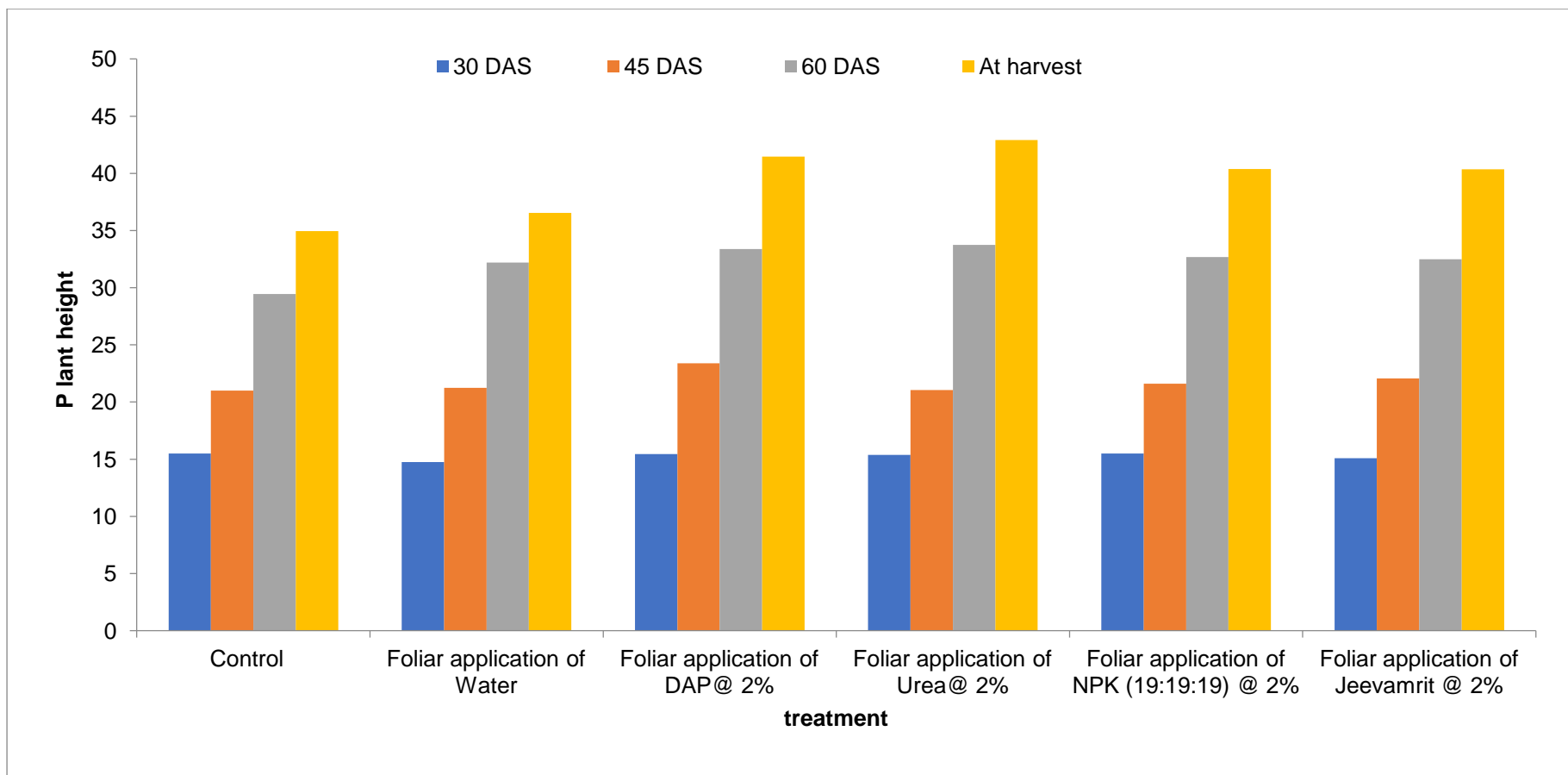


Fig 4.1 Effect of different treatments on plant height at successive stages of growth of lentil crop

(T₃), (41.46 cm), foliar application of *NPK (19:19:19)*@ 2% (T₅), (32.68) and (40.39 cm), foliar application of *Jeevamrit*@ 2%(T₆), (32.49 cm) and (T₆), (40.35 cm) and lowest plant height was found in Control (T₁), (29.44 cm) and (34.95 cm) respectively at 60 DAS and at harvest.

4.1.2 Number of Branches plant⁻¹

The data on number of branches observed at various successive growth stages are presented in Table 4.2 and appendix (II). The branches plant⁻¹ were recorded at 30, 45, 60 DAS and at harvest stage. The effect of different treatments on number of branches plant⁻¹ were found non significant at 30 and 45 days after sowing. However, It was found significant at 60 DAS and at harvest of crop.

Table:-4.2. Effect of different treatments on number of branches plant⁻¹ at successive stages of growth of lentil crop

	Treatments	30 DAS	45 DAS	60 DAS	At harvest
1	Control	2.41	3.41	4.99	5.5
2	Foliar application of Water	2.66	3.24	5.58	6.16
3	Foliar application of <i>DAP</i> @ 2%	3.25	3.16	5.99	6.58
4	Foliar application of <i>Urea</i> @ 2%	2.91	3.67	6.08	6.33
5	Foliar application of <i>NPK (19:19:19)</i> @ 2%	2.75	3.16	6.66	7.58
6	Foliar application of <i>Jeevamrit</i> @ 2%	2.75	3.42	5.82	6.5
	S. Em. (±)	0.32	0.41	0.49	0.33
	CD	NS	NS	1.20	0.80

The maximum number of branches (6.66 and 7.58) were recorded in foliar application of *NPK (19:19:19)*@ 2% (T₅) respectively at 60 DAS and at harvest. It was found at par with foliar application of *Urea*@ 2% (T₄), (6.08), foliar application of *DAP*@

2% (T₃), (5.99), foliar application of *Jeevamrit*@ 2%(T₆), (5.82), foliar application of water (T₂), (5.58) at 60 DAS. The lowest number of branches plant⁻¹ were recorded in control (T₁), (4.99 and 5.50) at 60 DAS and at harvest respectively.

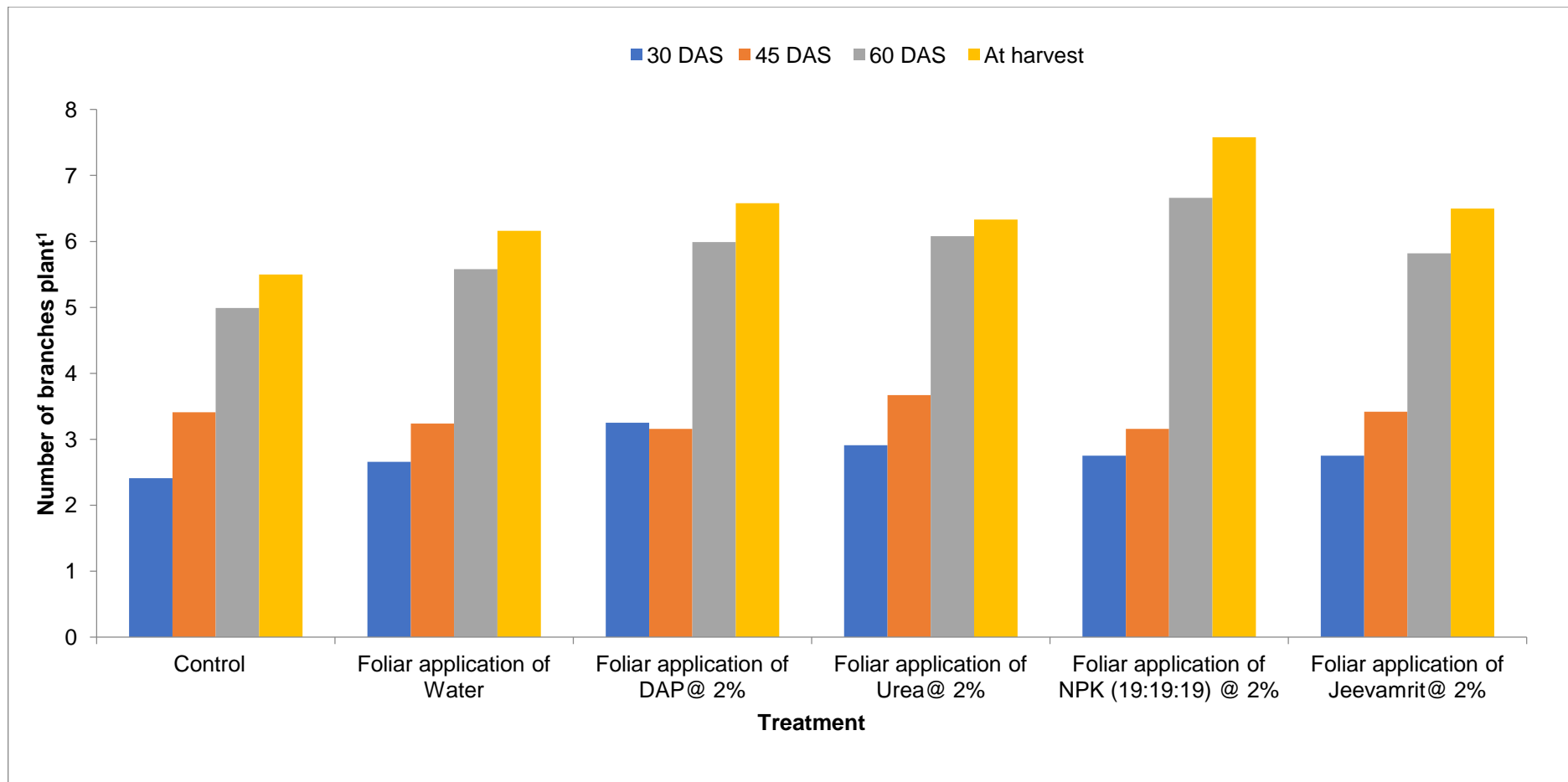


Fig 4.2 Effect of different treatments on number of branches plant¹ at successive stages of growth of lentil crop

4.1.3 Dry weight plant⁻¹ (g)

The dry weight plant⁻¹ was recorded at different stages of crop growth 30, 45, 60 DAS and at harvest stage was statistically analyzed and presented in Table 4.3 and appendix (III). The effect of different treatments on dry weight plant⁻¹ was found non significant at 30 and 45 days after sowing, However, It was found significant at 60 DAS and at harvest stage of crop.

The maximum dry weight plant⁻¹ was recorded in foliar application of *Urea@ 2%* (T₄), (0.89 g and 1.23 g) respectively at 30 DAS and 45 DAS followed by foliar application of water (T₂).

The dry weight plant⁻¹ was found significant at 60 DAS and at harvest. The maximum dry weight plant⁻¹ was recorded in foliar application of *NPK (19:19:19)@ 2%* (T₅), (3.81g and 20.08g) respectively at 60 DAS and at harvest. It was found at par with foliar application of *DAP@ 2%* (T₃), (3.42 g and 18.66 g) at 60 DAS and harvest stage respectively. The lowest dry weight plant⁻¹ was found in Control (T₁), (2.40 g and 13.75 g).

Table: - 4.3 Effect of different treatments on dry weight (g) plant⁻¹ at successive stages of growth of lentil crop.

	Treatments	30 DAS	45 DAS	60 DAS	At harvest
1	Control	0.67	1.08	2.40	13.75
2	Foliar application of Water	0.81	1.16	2.78	15.37
3	Foliar application of <i>DAP@ 2%</i>	0.62	1.10	3.42	18.66
4	Foliar application of <i>Urea@ 2%</i>	0.89	1.23	3.16	16.62
5	Foliar application of <i>NPK (19:19:19)@ 2%</i>	0.73	1.05	3.81	20.08
6	Foliar application of <i>Jeevamrit@ 2%</i>	0.61	1.10	3.24	17.00
	S. Em. (±)	0.05	0.07	0.17	0.84
	CD	NS	NS	0.42	2.05

4.1.4 Number of root nodules plant⁻¹

The number of root nodules plant⁻¹ recorded at different stages of crop growth viz. 30 and 60 DAS was statistically analyzed and presented in Table 4.4 and appendix (IV). It was found non significant at 30 DAS, However, it was found significant at 60 DAS.

The maximum number of root nodules plant⁻¹ were recorded in foliar application of *Urea@ 2%* (T₄), (10.58) at 30 DAS followed by foliar application of *DAP@ 2%* (T₃), (9.83).

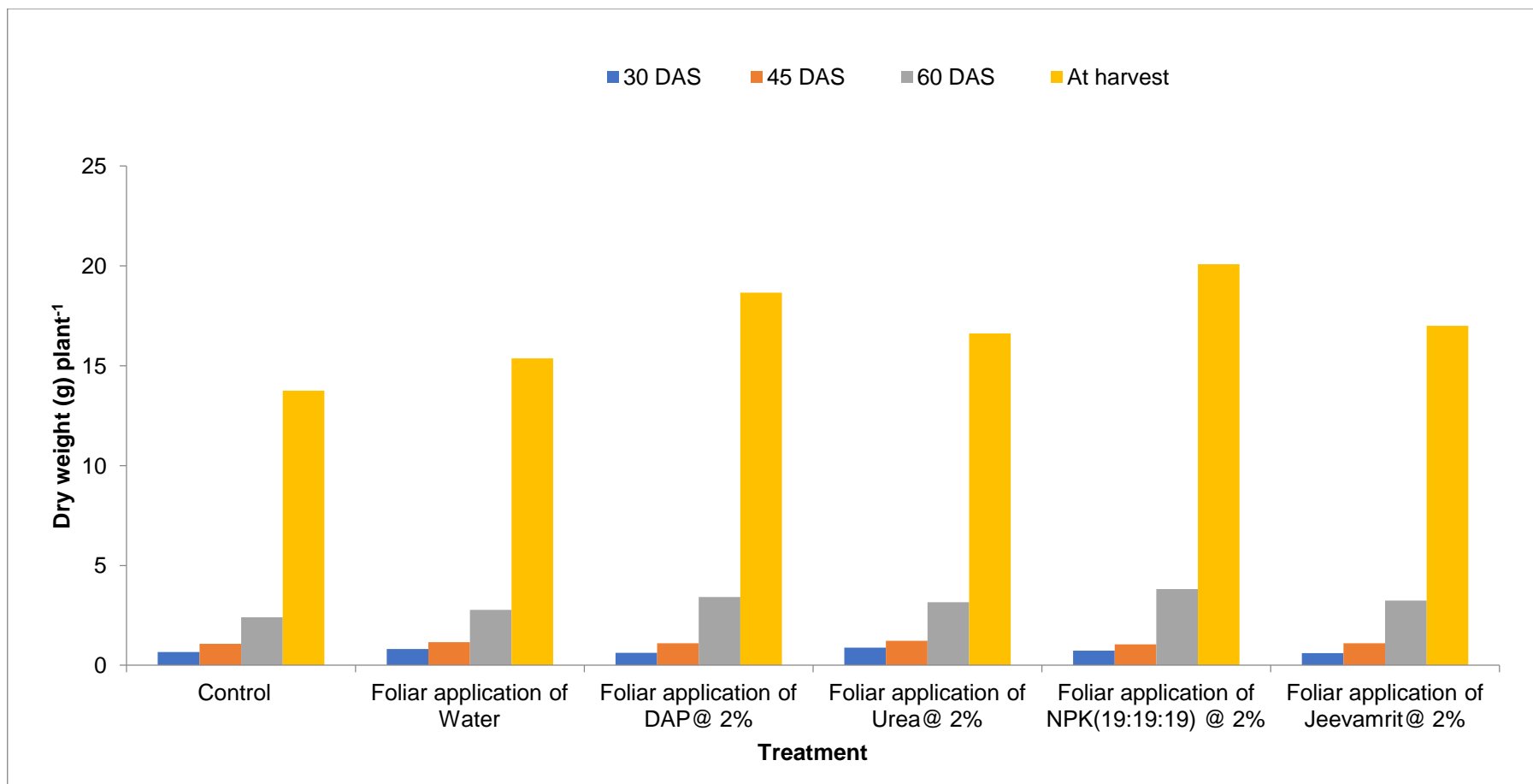


Fig 4.3 Effect of different treatments on dry weight (g) plant⁻¹ at successive stages of growth of lentil crop

Table:- 4.4 Effect of different treatments on number of root nodules plant⁻¹ at successive stages of growth of lentil crop.

	Treatments	30 DAS	60 DAS
1	Control	9.24	11.66
2	Foliar application of Water	8.58	12.33
3	Foliar application of <i>DAP@ 2%</i>	9.83	16.16
4	Foliar application of <i>Urea@ 2%</i>	10.58	13.58
5	Foliar application of <i>NPK (19:19:19)@ 2%</i>	9.49	18.49
6	Foliar application of <i>Jeevamrit@ 2%</i>	8.49	14.41
	S. Em. (±)	1.14	1.36
	CD	NS	3.31

The maximum number of root nodules plant⁻¹ were recorded in foliar application of *NPK (19:19:19)@ 2%* (T₅), (18.49) at 60 DAS. It was found at par with foliar application of *DAP@ 2%* (T₃), (16.16). The lowest number of root nodules plant⁻¹ was recorded in control (T₁), (11.66).

4.1.5 Dry weight of root nodules plant⁻¹ (mg)

The dry weight of root nodules plant⁻¹ at different stages of crop growth viz. 30 and 60 DAS was statistically analyzed and presented in Table 4.5 and appendix (V). It was found non significant at 30 DAS, However, It was found significant at 60 DAS.

The maximum dry weight of root nodules plant⁻¹ was recorded in treatment foliar application of *NPK (19:19:19)@ 2%* (T₅), (13.92 mg) at 60 DAS, The lowest dry weight of root nodules plant⁻¹ was recorded in Control (T₁), (5.67 mg).

Table:- 4.5 Effect of different treatments on dry weight of root nodule plant⁻¹ at successive stages of growth of lentil crop.

	Treatments	30 DAS	60 DAS
1	Control	1.83	5.67
2	Foliar application of Water	1.66	6.25
3	Foliar application of <i>DAP@ 2%</i>	2.00	12.58
4	Foliar application of <i>Urea@ 2%</i>	2.08	8.33
5	Foliar application of <i>NPK (19:19:19)@ 2%</i>	1.91	13.92
6	Foliar application of <i>Jeevamrit@ 2%</i>	1.58	9.83
	S. Em. (±)	0.49	0.46
	CD	NS	1.13

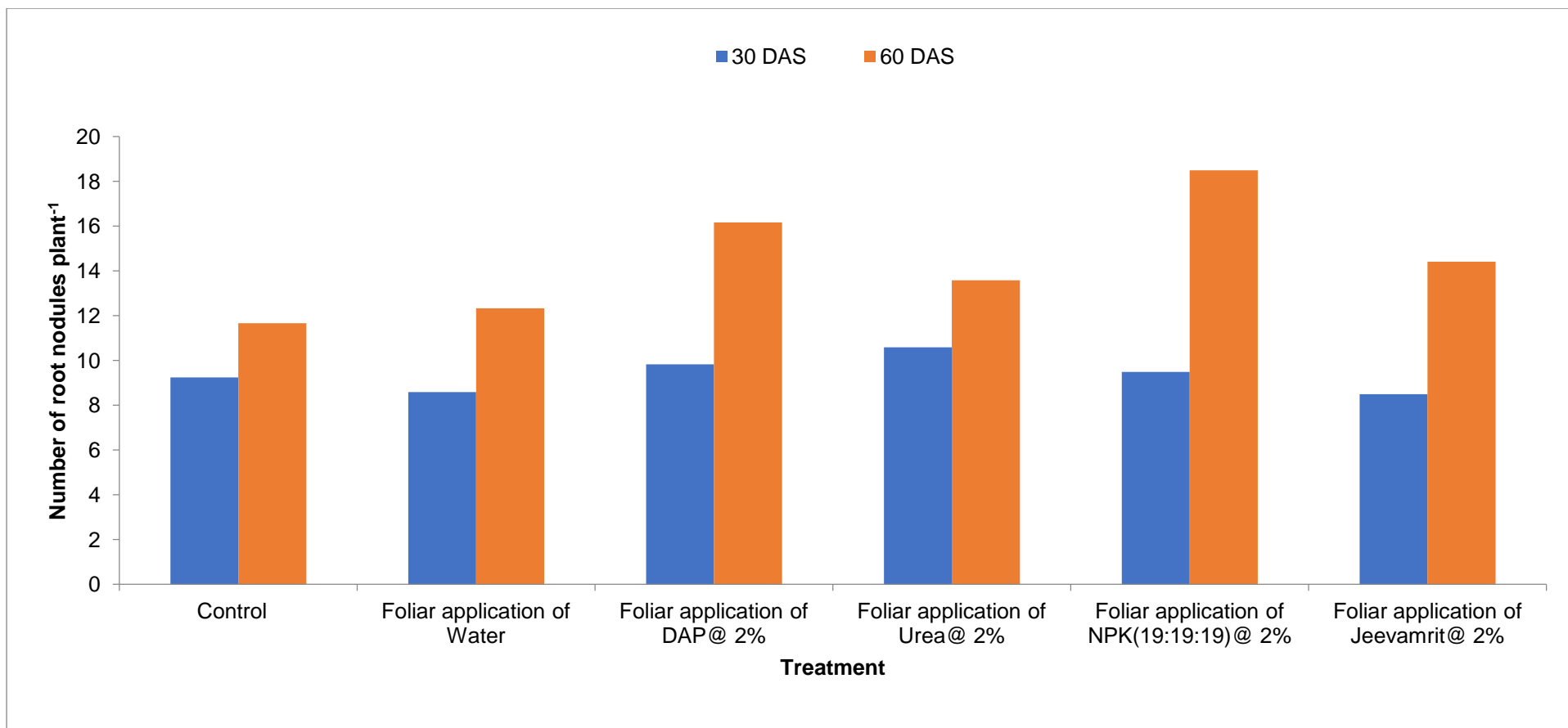


Fig 4.4 Effect of different treatments on number of root nodules plant⁻¹ at successive stages of growth of lentil crop

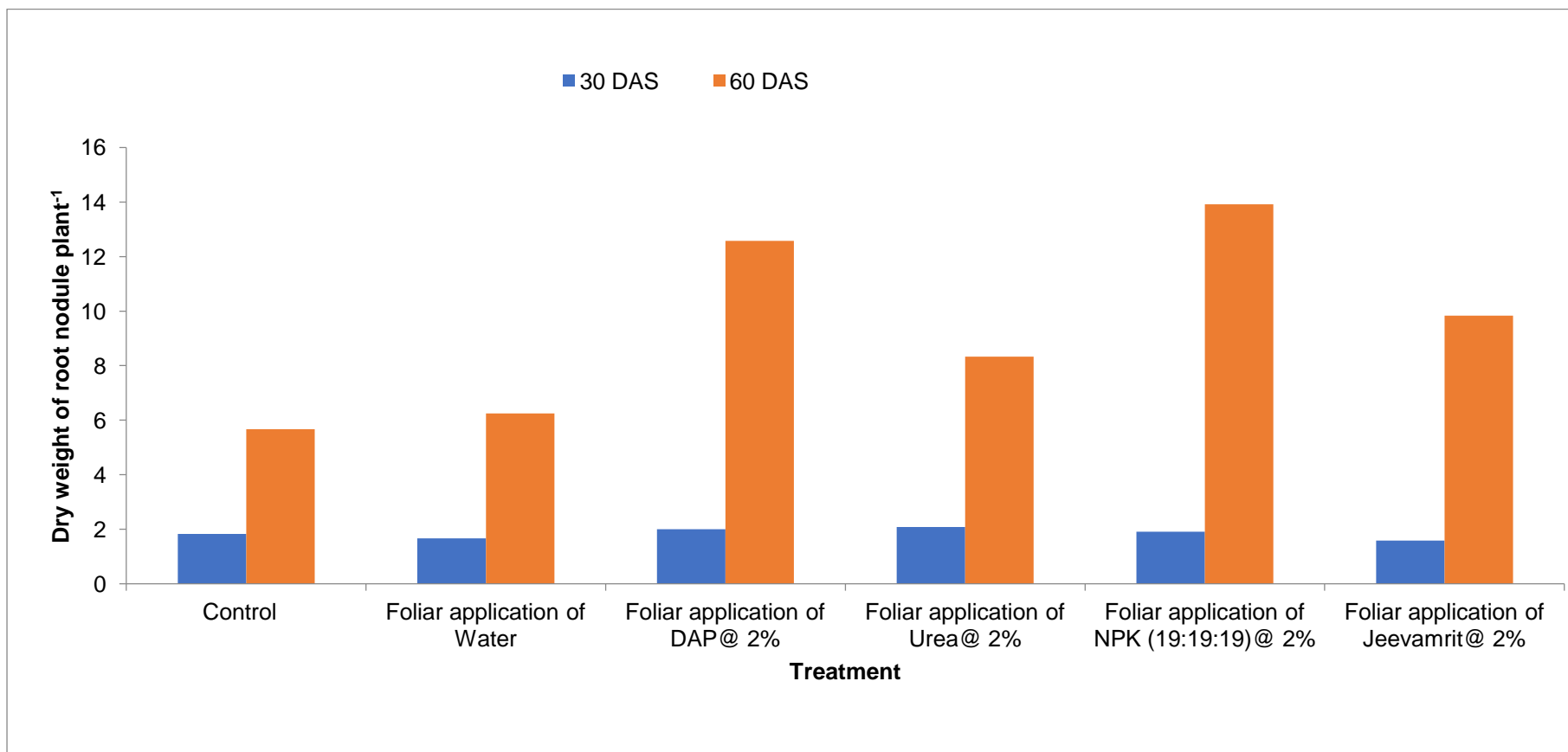


Fig 4.5 Effect of different treatments on dry weight of root nodule plant⁻¹ at successive stages of growth of lentil crop

4.2 Yield and yield attributes

4.2.1 Number of Pods plant⁻¹

The number of pods per plant is one of the important yield attributes which have direct correlation with grain yield. The observation on this attribute was recorded at harvest of crop. The data on average numbers of pods per plant are presented in Table 4.6, appendix (VI) and illustrated in Fig. 8

The data indicated that the significant difference was observed in pods plant⁻¹ due to various treatments. The pods plant⁻¹ ranged from 103.98 to 116.55 pods plant⁻¹. The maximum number of pods per plant obtained in foliar application of *NPK (19:19:19)*@ 2% (T₅), (116.55). It was found at par with foliar application of *DAP*@ 2% (T₃), (113.50) and foliar application of *Jeevamrit*@ 2%(T₆), (111.73). The lowest number of pods per plant was observed in Control (T₁), (103.98).

4.2.2 Number of Grains pod⁻¹

The data on average numbers of grains pod⁻¹ are presented in Table 4.6, appendix (VI) and illustrated in Fig.8

The data indicated that the significant difference was observed in grains pod⁻¹ due to various treatments. The grains pod⁻¹ ranged from 1.29 to 1.77 grains pod⁻¹. The foliar application of *NPK (19:19:19)*@ 2% (T₅) gave maximum number of grains per pod, (1.77) followed by foliar application of *DAP*@ 2% (T₃), (1.55). The lowest numbers of grains per pod were observed in control (T₁), (1.29).

Table: - 4.6 Effect of different treatments on pod plant⁻¹, seed pod⁻¹ and seed index of lentil

	Treatments	Number of Pods plant ⁻¹	Number of grains Pod ⁻¹	Seed index (g)
1	Control	103.98	1.29	2.37
2	Foliar application of Water	110.00	1.30	2.41
3	Foliar application of <i>DAP</i> @ 2%	113.50	1.55	2.50
4	Foliar application of <i>Urea</i> @ 2%	111.18	1.33	2.47
5	Foliar application of <i>NPK (19:19:19)</i> @ 2%	116.55	1.77	2.81
6	Foliar application of <i>Jeevamrit</i> @ 2%	111.73	1.51	2.51
	S. Em. (±)	2.12	0.05	0.07
	CD	5.17	0.12	0.19

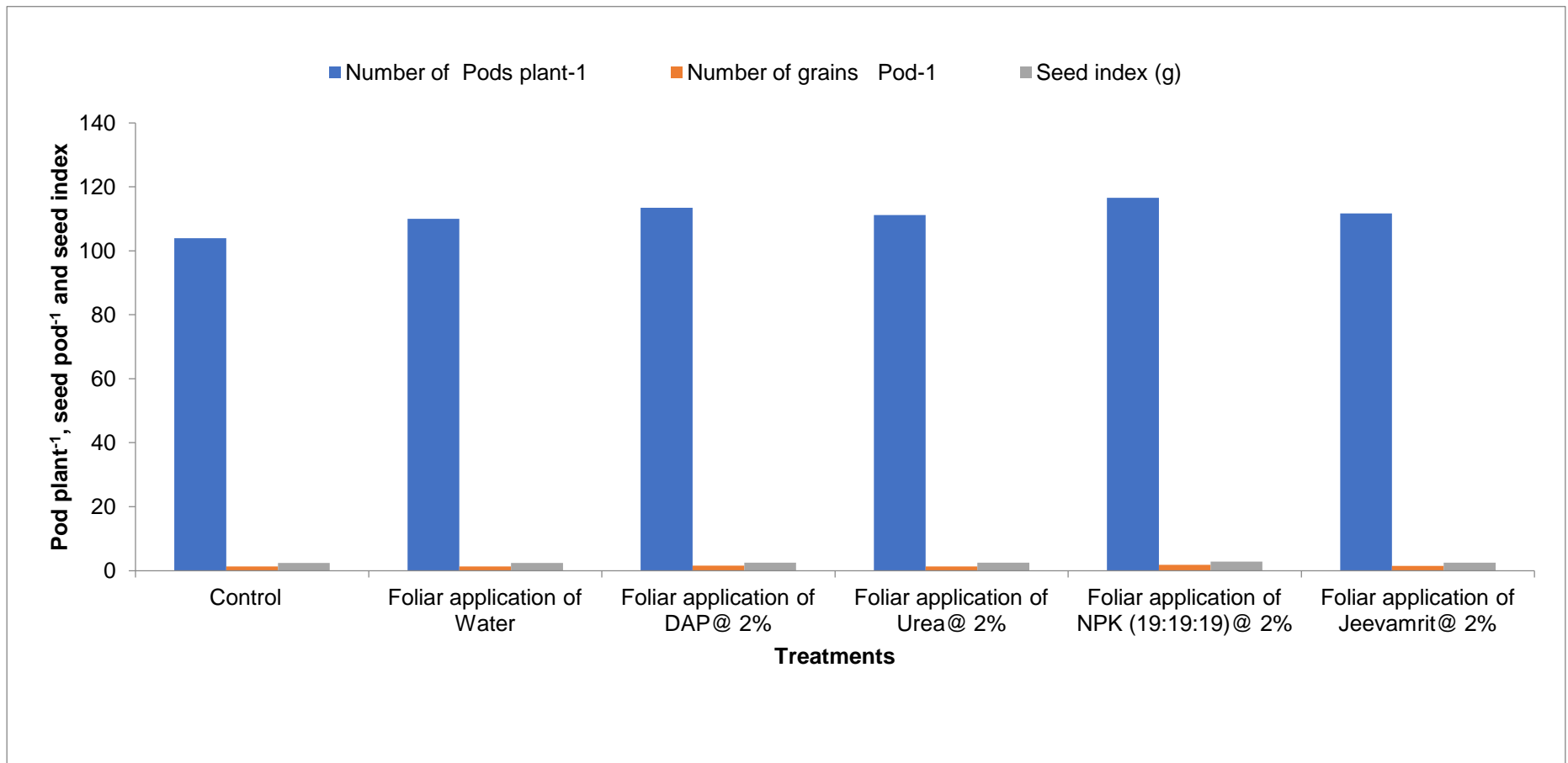


Fig 4.6 Effect of different treatments on pod plant⁻¹, seed pod⁻¹ and seed index of lentil

4.2.3 Seed index (g)

It is evident from the Table 4.6 and illustrated in Fig.8 shows that there were significant differences observed in seed index due to various treatments.

The seed index ranged from 2.37 to 2.81 g. The maximum seed index was recorded in foliar application of *NPK (19:19:19)*@ 2% (T₅), (2.81 g) followed by foliar application of *Jeevamrit*@ 2%(T₆), (2.51 g). The lowest seed index was recorded in control (T₁), (2.37 g).

4.2.4 Grain yield plant⁻¹ (g)

The grain yield per plant is an important character and directly related with the economic yield of plant. The observation on grain yield plant⁻¹ was recorded at harvest stage of crop. The data on grain yield per plant presented in Table 4.7 and illustrated in Fig.9

The data indicated that the significant difference was observed in grain yield plant⁻¹ due to various treatments. The grain yield plant⁻¹ ranged from 3.16 to 5.43 g. The maximum grain yield plant⁻¹ was recorded in foliar application of *NPK (19:19:19)*@ 2%

(T₅), (5.43 g) followed by foliar application of *DAP*@ 2% (T₃), (4.42 g). The lowest grain yield per plant was recorded in control (T₁), (3.16 g).

4.2.5 Grain yield (kg ha⁻¹)

The grain yield is the most important character and superiority of the treatment is judged by its capacity to produce more grain yield. The data on grain yield were statistically analyzed and presented in Table 4.7 and illustrated in Fig.9

The data indicated that the significant difference was observed in grain yield due to various treatments. The grain yield ha⁻¹ ranged from 1299 to 1512 kg. The foliar application of *NPK (19:19:19)*@ 2% recorded maximum grain yield ha⁻¹ (1512 kg). It was found at par with foliar application of *DAP*@ 2% (T₃), (1464 kg), foliar application of *Jeevamrit*@ 2%(T₆), (1450 kg), foliar application of *Urea*@ 2% (T₄), (1435 kg). The lowest grain yield kg ha⁻¹ was recorded in control (T₁), (1299 kg).

4.2.6 Straw yield (kg ha⁻¹)

Increase in straw yield is directly related with increase in vegetative growth of the plant and subsequently its mass. The data on straw yield

(kg ha⁻¹) was influenced by different treatment are presented in Table 4.7, illustrated in Figure 9 and Appendix (VII). The data indicates significant increase in straw yield due to different treatments.

The straw yield ha⁻¹ ranged from 2246 to 2496 kg. The maximum straw yield ha⁻¹ was recorded in treatment foliar application of *NPK (19:19:19)*@ 2% (T₅), (2496 kg). It was found at par with foliar application of *DAP*@ 2% (T₃), (2473 kg). The lowest straw yield kg ha⁻¹ was recorded in control (T₁), (2246 kg).

Table:-4.7 Effect of different treatments on Grain yield plant⁻¹ (g), Grain yield kg ha⁻¹, straw yield kg ha⁻¹ and harvest index (%) of lentil crop.

	Treatments	Grain yield Plant ⁻¹ (g)	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	H .I. (%)
1	Control	3.16	1299	2246	36.76
2	Foliar application of Water	3.43	1421	2292	38.27
3	Foliar application of <i>DAP</i> @ 2%	4.42	1464	2473	37.27
4	Foliar application of <i>Urea</i> @ 2%	3.75	1435	2308	38.34
5	Foliar application of <i>NPK (19:19:19)</i> @ 2%	5.43	1512	2496	37.73
6	Foliar application of <i>Jeevamrit</i> @ 2%	4.22	1450	2339	38.27
	S. Em. (±)	0.23	32.05	26.44	0.61
	CD	0.56	77.53	64.26	NS

4.2.7 Harvest index (%)

The harvest index is found non significant difference under various treatments are presented in Table 4.7 and illustrated in Fig. 9.

The maximum harvest index was recorded in foliar application of *Urea*@ 2% (T₄), (38.34%) followed by foliar application of *Jeevamrit*@ 2%(T₆) and foliar application of Water (T₂), (38.27%).

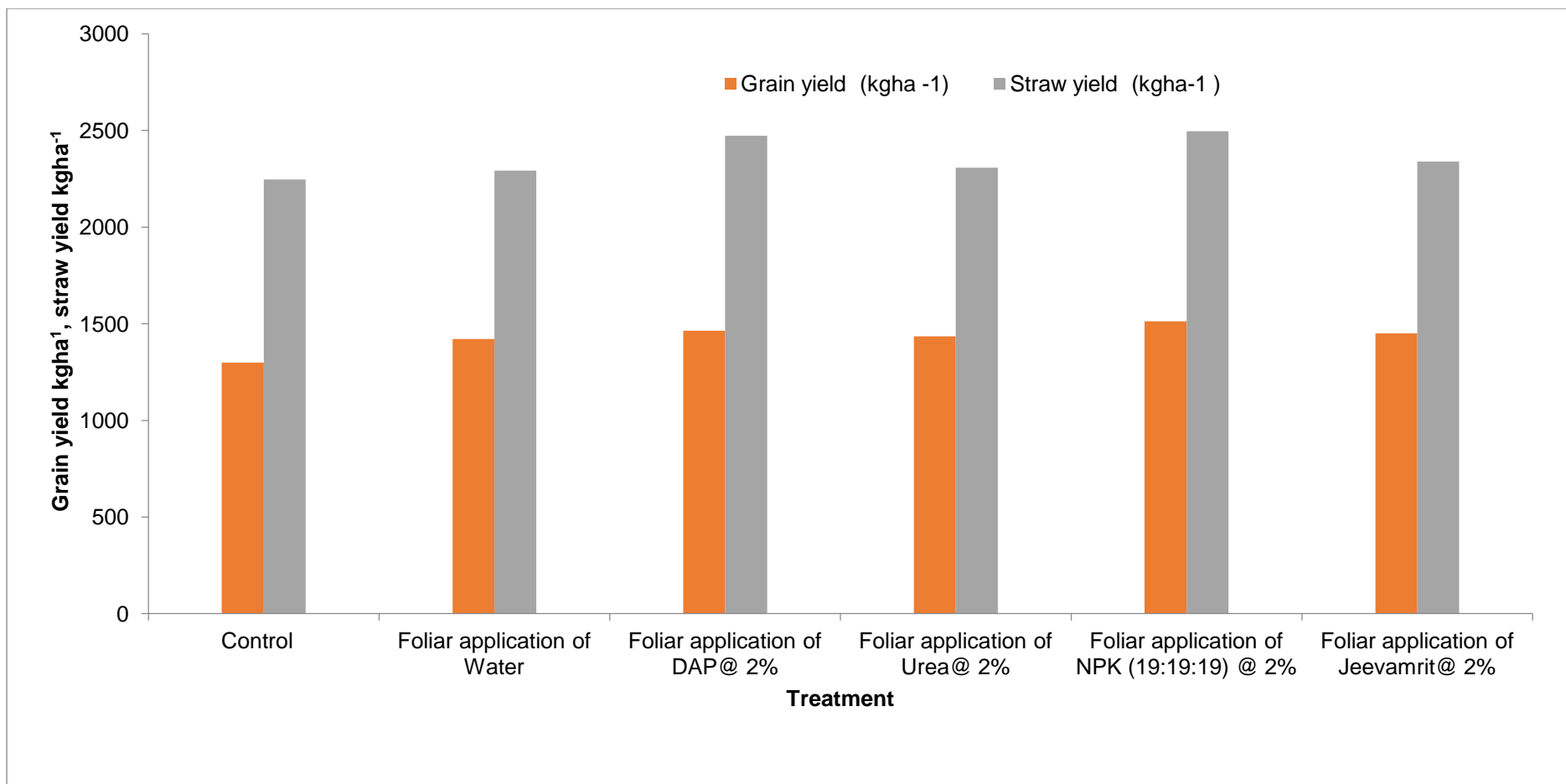


Fig 4.7 (a) Effect of different treatments on Grain yield kg ha¹ and straw yield kg ha⁻¹ of lentil crop

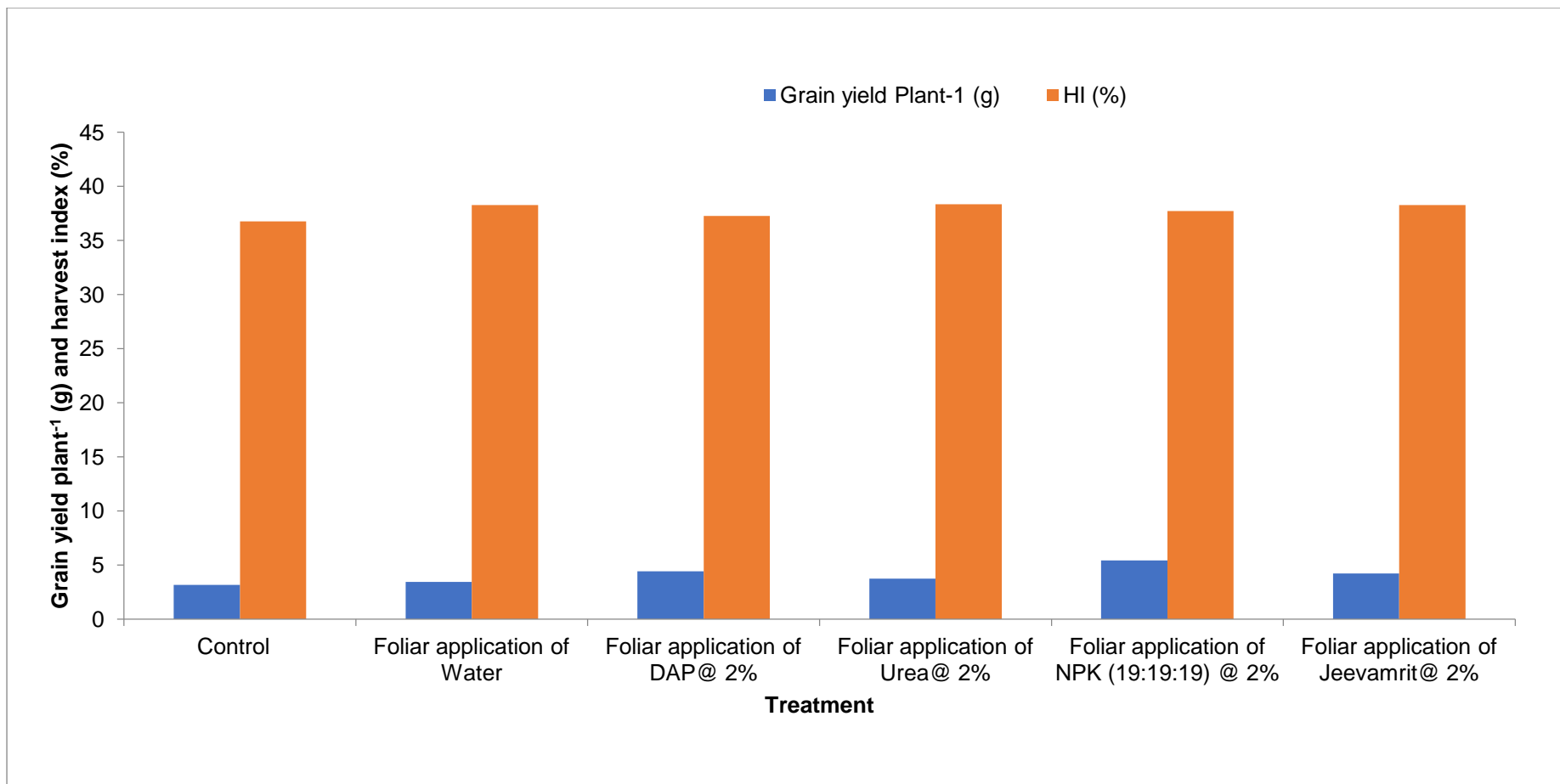


Fig 4.7 (b) Effect of different treatments on Grain yield plant⁻¹ (g) and harvest index (%) of lentil crop.

4.3 Growth analytical observation

4.3.1 Crop Growth Rate (CGR) ($\text{g m}^{-2} \text{day}^{-1}$)

The data on CGR computed at 30-45 and 45-60 days interval of crop growth periods are presented in Table 4.8 and illustrated by Fig. 10. The perusal of data in Table 4.8 indicated that CGR, in general, increased with the advancement in growth period up to 45-60 DAS in all the treatments while the CGR found non significant at 30-45 and 45-60 days interval.

Table:-4.8 Effect of different treatments on Crop Growth Rate (CGR) ($\text{g m}^{-2} \text{day}^{-1}$) of lentil crop at successive Crop Growth Stage.

	Treatments	30-45 Days interval	45-60 Days interval
1	Control	0.90	2.94
2	Foliar application of Water	1.07	3.60
3	Foliar application of <i>DAP</i> @ 2%	0.78	5.16
4	Foliar application of <i>Urea</i> @ 2%	0.74	4.30
5	Foliar application of <i>NPK (19:19:19)</i> @2%	0.70	6.12
6	Foliar application of <i>Jeevamrit</i> @ 2%	1.08	4.74
	S. Em. (\pm)	0.20	0.44
	CD	NS	NS

At 30-45 days interval, the results of the data indicates that the highest value of CGR was recorded with foliar application of *Jeevamrit*@ 2%(T_6), (1.08) followed by treatment foliar application of Water (T_2), (1.07). The results obtained at 45-60days interval indicated that the highest value of CGR was recorded with foliar application of *NPK (19:19:19)*@ 2% (T_5), (6.12) followed by foliar application of *DAP*@ 2% (T_3), (5.16).

4.3.2 Relative Growth Rate (RGR) ($\text{g g}^{-1} \text{day}^{-1}$)

The data on RGR computed at 30-45 and 45-60 days interval of crop growth periods are presented in Table 4.9 and illustrated by Fig. 11.

Table:-4.9 Effect of different treatments on Relative Growth Rate (RGR) ($\text{g g}^{-1} \text{day}^{-1}$) of lentil crop at successive Crop Growth Stage.

	Treatments	30-45 Days interval	45-60 Days interval
1	Control	0.05	0.38
2	Foliar application of Water	0.07	0.42
3	Foliar application of <i>DAP</i> @ 2%	0.07	0.52
4	Foliar application of <i>Urea</i> @ 2%	0.09	0.49
5	Foliar application of <i>NPK (19:19:19)</i> @2%	0.04	0.58
6	Foliar application of <i>Jeevamrit</i> @ 2%	0.07	0.47
	S. Em. (\pm)	0.03	0.03
	CD	NS	0.09

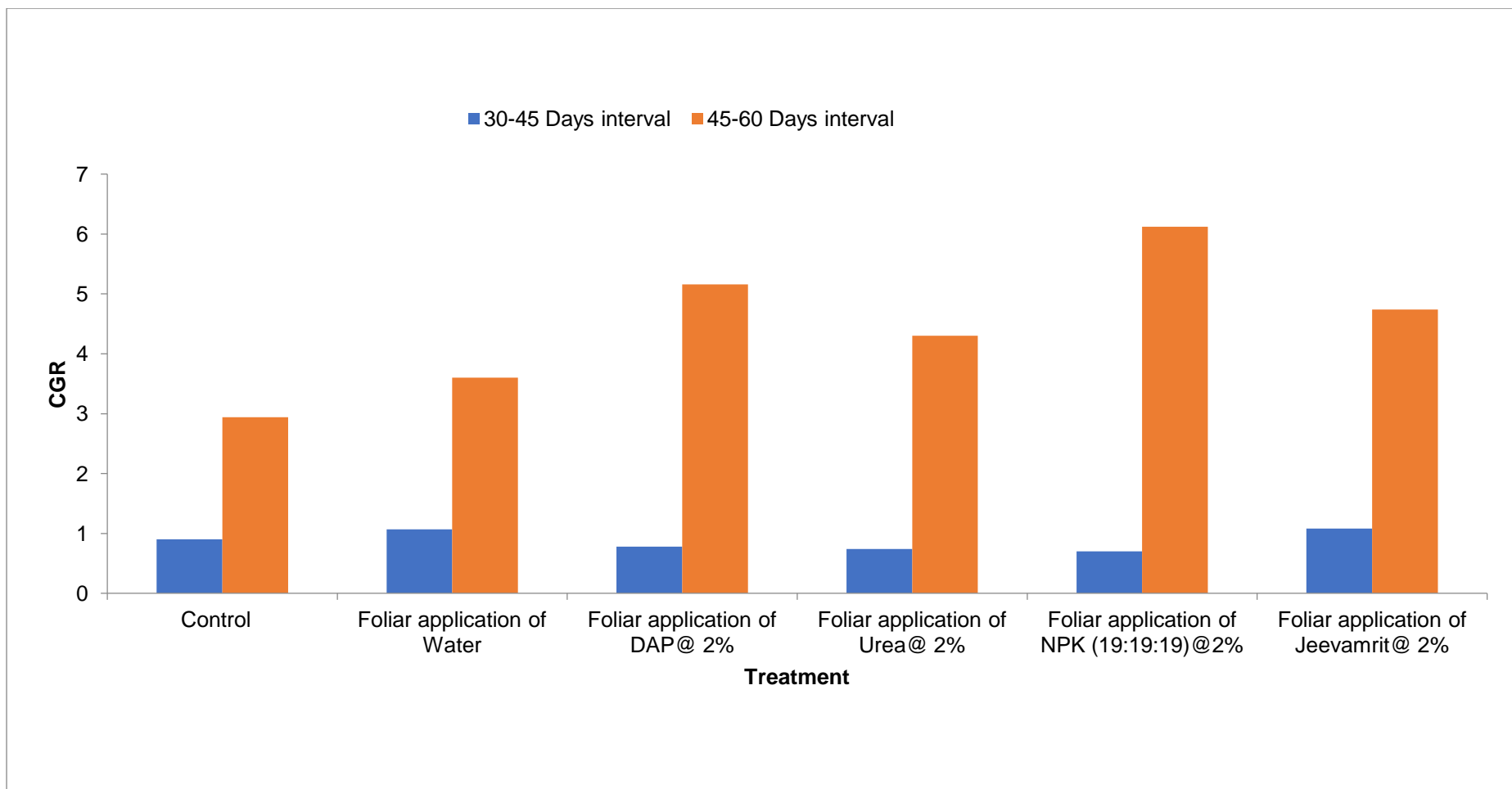


Fig 4.8 Effect of different treatments on Crop Growth Rate (CGR) ($\text{g m}^{-2} \text{ day}^{-1}$) of lentil crop at successive Crop Growth Stage

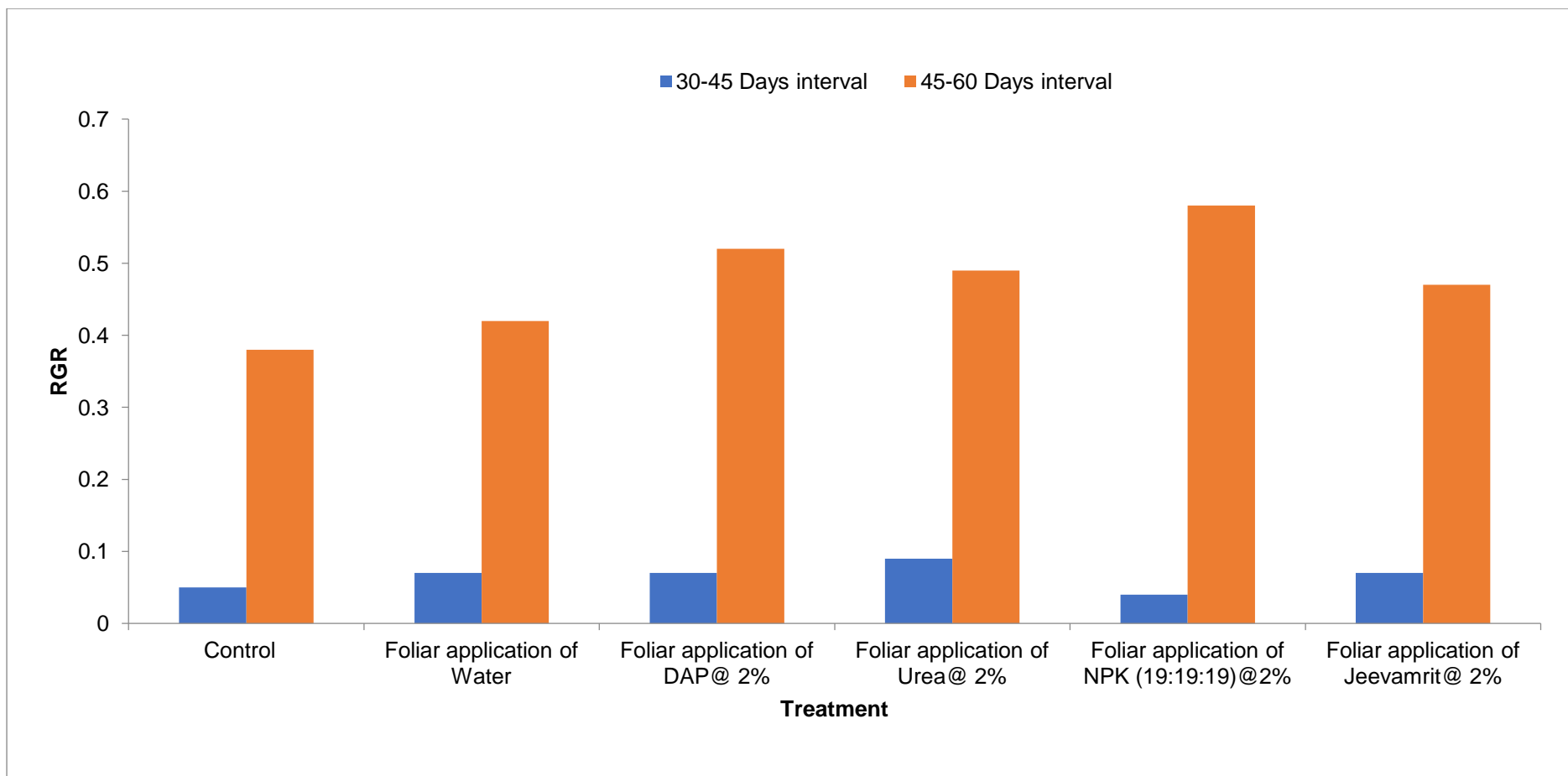


Fig 4.9 Effect of different treatments on Relative Growth Rate (RGR) ($\text{g g}^{-1}\text{day}^{-1}$) of lentil crop at successive Crop Growth Stage

The perusal of data in Table 4.9 indicated that RGR, in general, increased with the advancement in growth period up to 45-60 DAS in all the treatments. It was found non significant at 30-45 days interval, However, It was found significant at 45-60days interval.

At 30-45 days interval, the results of the data indicates that the highest value of RGR was recorded with foliar application of *Urea@ 2%* (T₄), (0.09) followed by foliar application of

Water (T₂), foliar application of *Jeevamrit@ 2%*(T₆) and foliar application of *DAP@ 2%* (T₃), (0.07). At 45-60days interval, the results of the data indicates that at this stage RGR was significantly by different treatments. The highest value of RGR was recorded with treatment foliar application of *NPK (19:19:19)@ 2%* (T₅), (0.58). It was found at par with foliar application of *DAP@ 2%* (T₃), (0.52), foliar application of *Urea@ 2%*(T₄), (0.49). The lowest RGR was recorded in control (T₁), (0.38).

4.4 Economic Analysis

4.4.1 Cost of Cultivation (₹ha⁻¹)

The data on cost of cultivation, gross return, net return and BC ratio are presented in Table 4.9 Figure 12 and Appendix (IX).

The higher cost of cultivation was recorded with foliar application of *NPK (19:19:19) @ 2%* (T₅), (₹ 21026 ha⁻¹) followed by treatment foliar application of *DAP@ 2%* (T₃), (₹ 19506 ha⁻¹) and lower cost of cultivation was recorded in control, (T₁), (₹18526 ha⁻¹).

4.4.2 Gross return (₹ha⁻¹)

The maximum gross return was recorded with treatment foliar application of *NPK (19:19:19)@ 2%* (T₅), (₹ 82119 ha⁻¹) followed by foliar application of *DAP@ 2%* (T₃), (₹ 79597 ha⁻¹) and lower in gross return was recorded in Control (T₁), (₹ 70755 ha⁻¹).

4.4.3 Net Return (₹ ha⁻¹)

The higher net return was recorded with treatment foliar application of *NPK (19:19:19)@ 2%* (T₅), (₹ 61093 ha⁻¹) followed by foliar application of *DAP@ 2%* (T₃), (₹ 60091 ha⁻¹) and lower in net return was recorded in Control (T₁), (₹ 52229 ha⁻¹).

4.4.4 Benefit Cost Ratio (per ₹ invest)

The higher BC Ratio was recorded with treatment foliar application of *Jeevamrit@ 2%*(T₆), (4.12) followed by foliar application of *DAP@ 2%* (T₃), (4.08) and lower in BC Ratio was recorded in control (T₁), (3.82).

Table:-4.10 Cost of cultivation, gross return, net return and B:C ratio of lentil influenced by different treatments.

	Treatments	Grain yield (Kg ha ⁻¹)	Straw yield (Kg ha ⁻¹)	Gross return (₹ ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Net profit (₹)	B:C ratio
1	Control	1299	2246	70755	18526	52229	3.82
2	Foliar application of Water	1421	2292	77061	19026	58035	4.05
3	Foliar application of <i>DAP</i> @ 2%	1465	2473	79597	19506	60091	4.08
4	Foliar application of <i>Urea</i> @ 2%	1435	2308	77822	19146	58676	4.06
5	Foliar application of <i>NPK (19:19:19)</i> @ 2%	1512	2496	82119	21026	61093	3.92
6	Foliar application of <i>Jeevamrit</i> @ 2%	1450	2339	78659	19074	59554	4.12
	S. Em. (±)	32.05	26.44	1644	-	-	0.08
	CD	77.53	64.26	3995	-	-	0.21

CHAPTER V

DISCUSSION

The results obtained in the present studies and showed previous chapter are discussed in this chapter. Effects have been made to assist the elaborated results with appropriate results findings cited in the literature in India and abroad. The findings are also compared with the work done in order to provide suitable and possible explanations.

5.1 Weather condition

The metrological condition are during the crop season was favorable for lentil crop. At the time of sowing temperature was favorable (16.57 to 30.97 °C) for seed germination and also received rains (2.8 mm) at seed sowing week. December month was also favorable for crop because two rainy days was observed. However during the month of January temperature was decreased (10.26 to 25.08 °C) however no harmful effect was noticed on crop because of lentil is a cool season hardy crop. It can tolerate temperature upto 16-30 °C.

5.2 Effect of *NPK(19:19:19)* on growth parameters of lentil

Foliar application of *NPK (19:19:19)*@ 2% has recorded higher plant height, number of branches, dry weight plant⁻¹, number of root nodules plant⁻¹ and dry weight of root nodules plant⁻¹ (198.11 mg) as compare to Control. Increase in growth parameter and nodule might be attributed due to balance supply of macro nutrient. Similar result was recorded by Rahman *et al.* (2014) carried out a field experiment to evaluate different nutrients application on common bean at hazara University, Pakistan. The experiment was comprised of four treatments i.e. Control (water spray), poultry manure, DAP (Diammonium phosphate) and foliar spray of (NPK 19:19:19). The results showed that foliar spray of NPK fertilizer significantly increased number of pods per plant, number of seeds per pod, number of seeds per plant, biomass and grain yield.

5.3 Effect of *NPK(19:19:19)* on yield and yield attributes of lentil

NPK(19:19:19) contain Nitrogen, Phosphorus and Potassium in equal quantity. Due to balance supply of nutrients which help in improving plant growth and yield attributes.

In the present investigation, foliar application of *NPK (19:19:19)*@ 2% recorded significantly higher grain yield (1512 kg ha⁻¹) with an increase of

16.39 percent over control. Similarly, significantly higher straw yield was also recorded with foliar application of *NPK (19:19:19)*@ 2% (2496 kg ha⁻¹) with an increase of 11.13 percent over Control (Table 4.7 and Fig. 9). The increase in grain yield and straw yield of lentil due to foliar application of *NPK (19:19:19)*@ 2% balanced supply of Nitrogen, Phosphorus and Potassium. Das and Jana (2015) studied the response of water soluble fertilizer spray on growth and yield of greengram, blackgram, lathyrus, lentil and chickpea in field experiments conducted at pulses and oilseeds research station, west bengal. The seven levels of foliar spray of water soluble fertilizers at pre flowering stage [no spray, 0.5% *NPK (19:19:19)*, 1% *NPK (19:19:19)*, 2% *NPK (19:19:19)*, 3% *NPK (19:19:19)*, 2% DAP, 2% Urea] were evaluated under basal and no basal dose of fertilizers. The application of 2% urea spray recorded significantly higher seed yield of pulses over basal dose of fertilizer. Without basal fertilizer application, 3% *NPK (19:19:19)* spray recorded highest seed yield. Under basal dose of fertilizer application, the results showed a gradual increase in yield with the increase in concentration of *NPK (19:19:19)* fertilizer spray up to 2%.

The grain yield recorded significantly higher with foliar application of *NPK (19:19:19)*@ 2% due to better yield attributing traits like number pods per plant (116.55), number of seeds per pod (1.77), grain weight per plant (5.43 g) and seed index (2.81 g) (Table 4.6 and 4.7). Increased yield attributes might be due to beneficial effect of *NPK (19:19:19)* which reflected in the form of higher plant height (42.91 cm) with more number of branches per plant (7.58) and higher straw yield per plant (14.65 g) and also due to higher number of effective nodules (18.49) and nodule dry weight per plant (13.92 mg) due to application of *NPK (19:19:19)*@ 2% at pre-flowering stage and 15 days after the first spray (Table 4.4 and 4.5). In the present study, all the yield attributing parameters were significantly higher due to foliar application of *NPK (19:19:19)*@ 2% which might be due to favorable effects of *NPK (19:19:19)* are applied at regular intervals (pre-flowering stage and 15 days after the first spray).

5.4 Effect on Economics

Cost of cultivation higher in foliar spray of *NPK (19:19:19)*@ 2% due to high price of *NPK (19:19:19)* in market as compared with other treatments and minimum in control. The treatment foliar spray of *NPK (19:19:19)*@ 2% (T_5) was recorded highest gross monetary return (₹.82119 ha⁻¹) followed by treatment foliar application of *DAP*@ 2% (T_3), (₹.79597 ha⁻¹). Higher gross monetary return was mainly due to high grain and straw yield of lentil. The lower gross monetary return (₹.70755 ha⁻¹) was recorded in Control. The lower gross monetary return was mainly due to low grain and straw yield of lentil. Kasbeet *al.* (2009) reported that application of *Jeevamrit* was found to be cost effective in rice when used at 2000 l ha⁻¹ in different combinations than *jeevamrit* used as N basis. It was observed that application of *Jeevamrit* is one of the cheap and efficient organic substitutes for other organic manures like vermicompost in integrated approach for high crop yield and profitability, besides improving the nutrient status of soil.

The treatment foliar spray of *NPK (19:19:19)*@ 2% (T_5) was recorded highest net return (₹.61093 ha⁻¹) followed by treatment foliar application of *DAP*@ 2% (T_3), (₹.60091 ha⁻¹) and the lower net return (₹.52229 ha⁻¹) was recorded in control. Amareswari and Sujathamma (2014) noticed that the cost of production, net return and B: C ratios were estimated using *Jeevamrit* and compared with those of chemical farming. In both the varieties B: C ratio was better with application of *Jeevamrit* method being 3.39 in masura variety 3.0, in hamsa as compared to 1.09 and 0.6 in chemical methods of rice production respectively.

The benefit cost ratio was higher in with treatment foliar application of *Jeevamrit*@ 2% (T_6), (4.12) due to low cost of treatment and high gross and net return.

CHAPTER - VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH WORK

6.1 Summary

The agronomic investigation entitled “**Nutrient Management Through Foliar Application of Nutrients in Lentil (*Lens culinaris* M.) Under Rainfed Condition**” was carried out in the field of R.A.K. college of Agriculture, Sehore (M.P.), during *Rabi* 2020 on 506.25 m².

The field experiment was carried out in a randomized block design with 6 treatments viz. (T₁), Water spray (T₂), 2% foliar spray of DAP (T₃), 2% foliar spray of Urea (T₄), 2% foliar spray of *NPK (19:19:19)* (T₅), 2% foliar spray of *Jeevamrit*(T₆) and 4 replications. The gross and net plot size was 5 m x 3 m and 4.0 m x 2.4 m. Treatments Control. All application applied at Pre-flowering stage and 15 days after the first spray.

The soil of experimental field was medium black clay loam in texture (vertisol). Sowing of lentil was done on 15 November, 2020 with spacing of 30 x 10 cm and harvested on 8th of March, 2021. Recommended dose of N:P₂O₅:k₂O were applied as basal dose. All treatments were applied at Pre-flowering stage and 15 days after first spray. Effect of various treatments was studied on growth development, yield attributes and yield of lentil.

The results emanated from the experimentation are summarized here as under:

6.1.1 Effect on crop

- The effect of foliar application of *NPK (19:19:19)*@ 2% on plant height, branches, dry matter accumulation at all stages of crop was found significant. Treatments differed significantly number of root nodules and dry weight of nodules per plant at 30 and 60 DAS.
- In pods per plants, number of seeds per pod, seed yield per plant, seed index foliar application of *NPK (19:19:19)*@ 2% was found significantly higher than othertreatments.
- Seed yield was significantly influenced by foliar application of *NPK (19:19:19)*@ 2%, (1512 kgha⁻¹) at par with 2% foliar spray of DAP (T₃), (1464 kgha⁻¹), 2% foliar spray of *Jeevamrit*(T₆), (1450 kgha⁻¹)and 2% foliar spray of Urea (T₄), (1435 kgha⁻¹). Harvest index was found non-significant and higher

values obtained in 2% foliar spray of Urea (T₄), (38.34 %) followed by 2% foliar spray of *Jeevamrit* (T₆), (38.27%).

6.1.2 Effect on Economics

- Cost of cultivation higher in foliar spray of *NPK (19:19:19)*@ 2% due to high price of *NPK (19:19:19)* in market at compare with other treatment and minimum in control.
- Treatment foliar spray of *NPK (19:19:19)*@ 2% was recorded highest net return of ₹.61093 ha⁻¹ followed by treatment foliar application of *DAP*@ 2% (T₃), which has net return (₹.60091 ha⁻¹).
- The benefit cost ratio was higher in with treatment foliar application of *Jeevamrit*@ 2%(T₆), (4.12) followed by treatment foliar application of *DAP*@ 2% (T₃), (4.08). However, the lowest benefit cost ratio was observed in control (T₁) (3.82).

Conclusion

In the present study, foliar application of *NPK (19:19:19)*@ 2% (T₅) and foliar application of *Jeevamrit*@ 2% (T₆) recorded equal yield statistically. Only numerical difference found under both treatments. The B:C ratio was found significantly higher (4.12) in foliar application of *Jeevamrit*@ 2%(T₆) than (3.92) foliar application of *NPK (19:19:19)*@ 2% (T₅). While the gross and net monetary return was found maximum under foliar application of *NPK (19:19:19)*@ 2% (T₅) in comparison with foliar application of *Jeevamrit*@ 2% (T₆). But it was not worthy to harvest rupees 1539 more on cost of investing rupees 1952 under foliar application of *NPK (19:19:19)*@ 2% (T₅) in comparison with foliar application of *Jeevamrit*@ 2% (T₆). Therefore we can say that the foliar application of *Jeevamrit*@ 2% (T₆) is more beneficial and may be sustainable due to less chemical applied.

6.3 Suggestions for future work

- Without applied of recommended dose of N:P₂O₅:k₂O as basal dose need to be studied.
- Combine effect of foliar spray of *Jeevamrit*@ 2% and *NPK (19:19:19)*@ 2% dose need to be studied.

BIBLIOGRAPHY

- Anonymous; (2019). FAOSTAT data, updated using national statistics.
- Anonymous; (2019). Kisan Kalyan and Krishivikash Vibhag Madhya Pradesh.
- Anonymous; (2019). Department of Economics and Statistics, DAC and FW.
- Aliloo, A. A.; Khorsandy, H. and Mustafavi, S. H. (2012). Response of chickpea (*Cicer arietinum* L.) cultivars to nitrogen applications at vegetative and reproductive stages. *Cercetariagronomice in Moldova* **45** (4) : 49-55.
- Amareswari, P. U. and Sujathamma, P. (2014). *Jeevamrit* as an alternative of chemical fertilizers in rice production. *Agric.Sci.Digest.*; **34**(3): 240-242.
- Bhowmick, M. K. (2006). Foliar nutrition and basal fertilization in chickpea under rainfed condition. *Environ. and Ecol.* **24** S (4):1028-1030.
- Bhowmick, M. K. (2008). Effect of foliar nutrition and basal fertilization in lentil under rainfed conditions. *J. Food Legumes*, **21**: 115-16.
- Bhowmick, M. K., Duary, B., Biswas, P. K., Rakshit, A. and Adhikari, B. (2013). Seed priming, row spacing and foliar nutrition in relation to growth and yield of chickpea under rainfed condition. SATSA Mukhapatra - Annual Technical Issue, **17**: 114-19.
- Bhowmick, M. K., Duary, B. and Biswas, P. K. (2014). Promoting grasspea (*Lathyrussativus*L.) cultivation in rice-fallows of West Bengal. In. Some Empirical Aspects of Economic Growth and Diversification in India's Emerging Economy (Ed., Chattopadhyay, P. K.). New Delhi Publishers, New Delhi. pp. 367-73.
- Basavraj, K.; Devkumar, N.; Latha, B and Somanthaa, A. C. (2015). Effect of organic liquid manure, *Jeevamrit* and panchagavya on yield of Frenchbean (*Phaseolus vulgaris* L.). *Proceeding of National Symposium on Organic Agric.*, Tamil Nadu, p. 111.
- Bhosale, prerana, Gaikwad, D. D.; Getbe, R. M. and Anarse, S. A. (2017). Effect of organic sources of nutrients on grain straw and soil fertility status after harvest of chickpea (*Ciceraritinum*). *Contemporary Research in India.* **7**(3): 2231-2237.
- Chandrasekhar, C. N. and Bangarusamy, U. (2003). Maximizing the yield of mungbean by foliar application of growth regulating chemicals and nutrients. *Madras Agril J.*; **90** (1-3): 142-145.
- Dixit, P. M. and Elamathi, S. (2007). Effect of foliar application of DAP, micronutrients and NAA on growth and yield of green gram (*Vigna radiate* L.). *Legume Res.*, **30**: 305307.
- Dwivedi, D. H., Yadav, A. K., Kumar, P. and Gautam, S. K. (2014). Integrated nutrient management in cape gooseberry (*Physalis peruviana*) for peri urban horticulture. *Ind. J. of App. Res.*; **4**(12): 2249- 555X.
- Devakumar, N.; Ramesh Kumar, C.; Latha, R. and Nveenkumar, G. S. (2016) Effect of different levels of compost, *beejamrutha* and *jeevimeruta* on Field of organic field bean (*Lablab purpureus* var. *lignosus*).

- Nar.Conference on Sustainable and Self Sufficient Production of Pulses through an Integrated Approach. *Univ.ofAgric.Sci.*, Bengalura. P-92.
- Das, S. K. and Jana, K. (2015) effect of foliar spray of water soluble fertilizer at pre flowering stage on yield of pulses. *Agric. Sci. Digest.*, **35**(4): 275-279.
- El-Kramany, M. F., Magda Mohamed, H., and Nofal, O. A. (2003). Effect of late foliar application with urea and Potasium fertilization on yield, yield components and chemical composition of two mungbean varieties. *Egypt J. Appl. Sci.*,**18**: 177-188.
- Growada, S. T. and Growada, K. T. K. (1980) influence of fertilizer on yield component of green Gram. *Indian J. Agron.*, **23**(4): 374.
- Ghosh, M. K. and Joseph, S. A. (2008). Influence of biofertilizers, foliar application of DAP and sulphur sources on yield and yield attributes of summer greengram (*Vigna radiate* L. Wilczek). *Legume Res.*, **31**: 232-233.
- Garcia, L. R. and Hanway, J. J. (1976). Foliar fertilization of soybean during the seed filling period, *Agron. J.*,**68**, 658-657.
- Ganapathy, M.; Baradhan, G. and Ramesh, N. (2008). Effect of foliar nutrition on reproductive efficiency and grain yield of rice fallow pulses. *Leg. Res.;* **31** (2):142-144.
- Gupta, S. and Bhowmick, M. K. (2012). Enhancing lentil productivity under riceutera system in West Bengal, India. *J. Lentil Res.*,**5**: 23-32.
- Ganajaxi, M.; Gurupad, B. and Lalita, J. (2018). Integrated nutrient management in lentil *Int. J. Che. Stu.* ; **6**(6): 201-202.
- Gowthamchand, N. J.; Ganapathi, and Soumya, T. M. (2019). Effect of Bulky Manures and Fermented Liquid Organics on Growth, Yield, Nutrient Uptake and Economics of FrenchBean (*Phaseolus vulgaris* L.) Under Rainfed Condition. *Int. J. of Agric., Envir. and Biotec.*; **13**(1): 51-58.
- Hossain, M. B.; Roy, S. and Alam, A. B. M. S. (2018). Foliar application of diammonium phosphate and triple super phosphate on lentil at drought prone area of banglades. *J. Bangladesh Acad. Sci.*, **42**(2), 211-214.
- Kolota, E. and Osinska, M. (2001) Efficiency of foliar nutrition of field vegetables grown at different nitrogen rates. *ActaHort (ISHS)*.;563:87-91.
- Kerin, V. and Berova, M. (2003) Foliar fertilization in plants. Videnov& Son, Sofia.; Bulgarian.
- Kasbe, S. S.; Mukund, J., and Bhaskar, S.,(2009). Characterization of farmers *jeevamrutha* formulations with respect to Aerobic rice. *Mysore J. Agric. Sd.*,**43**:(3) 570573.
- Kuttimani, R. and Velayutham, A. (2011). Foliar application of nutrients enhances the yield attributes and nutrient uptake of greengram. *Agril. Sci. Digest.*;**31**(3): 202-205.
- Khalilzadeh, R.; Mehdi, T. and Jalal, J. (2012). Growth characteristics of mungbean (*Vigna radiate* L.) affected by foliar application of urea and bio-organic fertilizers. *Int. J. Agric. and Crop Sci.*; **4**(10): 637-642

- Kumar, C. V.; Vaiyapuri, K.; Amanullah, M. M. and Gopaldaswamy, G. (2013) influence of foliar spray of nutrients on yield and economics of soybean (*Glycine max* L. Merill). *J. of Bio. Sci.*; **13**: 563-565.
- Muehlbauer, F. J.; Ladizinsky, G. and Cohen, D. (1985) hybridization in the genus *Lens* by means of embryo culture. *Theor. Appl. Genet.* **70**: 97–101.
- Mallarino, A. P. (2005). Foliar fertilization of soybean: Is it useful to supplement primary fertilization? In: Integrated Crop Management, IC-494, 15, 125-126,
- Manjunatha, G. S.; Upeeri, S. N.; Pujari, B. T.; Yeledahalli, N. A. and Kuligoda, V. B. (2009), Effect of farm yard manure treated with *jeevamrit* on yield attributes and economics of sunflower (*Helianthus annuus* L.). *Karnataka J. Agric. Sci.*, **22**(1) 342-348.
- Mondal, M. M.; Puteh, A. B.; Malek, M. A. and Roy, S. (2012). Effect of foliar application of urea on physiological characters and yield of soybean. *Leg. Res.*; **35**(3): 202-206.
- Maheswari, U. and Karthik (2017). Effect of foliar nutrition on growth, yield attributes and seed yield of pulse crops. *Adv. Crop Sci. Tech.* **5**:3.
- Natarajan, K. (2007). Panchagavya for plant. *Proc. Nation. Conf. Glory Gomatha, S. V. Veterinary Univ., Tirupati*, **72-75**.
- Nileema, S. Gore, and Sreenivasa, M. N. (2011) Influence of liquid organic manures on growth, nutrient content and yield of tomato (*Lycopersicon esculentum* Mill.) in the sterilized soil. *Kar. J Agric. Sci.*, **24**(2):153-157.
- Ponnusamy, K. and Harer, P. N. (1999). Heterosis and combining ability in soybean. *J. of Maharashtra Agric. U.*; **23**: 115-117.
- Palta, J. A., Nandwal, A. S., Kumari, S. and Turner, N. C. (2005). Foliar nitrogen applications increase the seed yield and protein content in chickpea (*Cicer arietinum* L.) subject to terminal drought. *Aus. J. Agric. Res.*; **56** (2): 105-112.
- Palekar, S. (2006). Shoonyab and ovaladanai sargika krushi pub. Swamy Anand, Agri Prakashana, Bangalore.
- Patil, D. B., Murade, N. B., Dhavan, S. P., Jagtap, H.D. and Chopade, M. B. (2014). Effect of organic inputs on growth and quality of pigeonpea (*Cajanus cajan*). *Bioinfolet* **11**: 421-424.
- Parmar, R. and Vyas, M. D. (2019). Effect of organic liquid manure (*jeevamrit*) on growth and yield of soybean [*Glycine max* L. Merrill] in black soil; M.Sc.(Ag) Agronomy Thesis *RVSKVV Gwalior*.
- Rajesh, N. and Paulpandi, V. K. (2013) review of foliar nutrition in red gram enhancing the growth and yield characters. *Am. Int. J. Res. Formal, Appl. Natural Sci.* **13**142: 9-14.
- Rahman, U. R.; Aftab, I. A.; Jafar, I.; Liazfarhana, Shafiul, M. and Sohail (2014). Growth and yield of *Phaseolus vulgaris* as influenced by different nutrient treatments. *International J of Agron. and Agri. Res.*; **4**(3):20-26.
- Raksar, S. S.; Wani, A. G.; Zhagade, A. L., and Gagare, P. A. (2014). Integrated system of crop intensification of vegetables with relation to

- climate change in Pathar area of Sangamner. *Int. J. of Soc. relevance and Con.* **2**:1-5.
- Ram, B. and Punia, S. S. (2007). Effect of seed priming and urea spray on growth yield attributes and yield of lentil (*Lens culinaris* Medik). Abst. of papers, National Symposium of NLS held at IIPR, Kanpur on Nov. **3-5**: 80.
- Ram, B. and Punia, S. S. (2018) effect of seed priming and foliar urea spray on yield and economics in lentil (*lens culinaris*) under rainfed condition. *Int. J. Agric. Sci.* **10**(8):5801-5803.
- Salisbury, F.B. and Ross, C.W. (1985) plant physiology. 3rd ed. Wadsworth, Belmont, CA. 540 pp.
- Suresh, V. V. (2000). Effect of nitrogen and potassium on yield and quality parameters of Byadagichilli (*Capsicum annum* L.). *M.Sc. (Agri.) Thesis, Univ. Agric., Sci., Dharwad* (India).
- Solaiappan, U., Paulpandi, V. K. and Chellaiah, N. (2002). Effect of graded levels of phosphorus and foliar fertilization on short duration redgram in rainfedvertisol. *Madras Agric. J.*,**87**: 451-454.
- Selvi, R., Muthiah, A. R., Manivannan, N., Raveendran, T.S., Manickam, A. and Samiyappan R. (2006). Tagging of RAPD for MYMV resistance in mungbean (*Vignaradiata* (L.) Wilcz.k). *Asian J. Plant Sci.*,**5**:227–280.
- Shwetha, B. N. (2008). Effect of nutrient management through organics in soybean - wheat cropping system. M. Sc. (Agri) Thesis, University of Agricultural Sciences, Dharwad.
- Sreenivasa, M. N., Nagaraj Naik, M. and Bhat, S. N. (2010). Beejamruth: A source for beneficial bacteria. *Karnataka J Agric. Sci.*,**17**(3):72-77.
- Singh, V.; Sharma, V.; Deepak; Ahamed, A.; Meena B. L. and Paswan S. K. (2014) genetic divergence analysis in lentil (*Lens Culinaris* M.) Germplasm. *Agric. Sci. Res. J.* **4**(3); pp. 59- 62.
- Senguptaand, K. and Tamang, D. (2015) response of green gram to foliar application of nutrients and brassinolide. *J. Crop and Weed.*, **11**(1):43-45.
- Siddappa. (2015). Use of *jeevamrit* and farmyard manure on growth and yield of Fieldbean (*Dolichos lablab* L.) M Sc (Agri.) Thesis Univ. Agric. Sci. Bengaluru.
- Sutar, R., G.M., Sujith, and Devakumar, N. (2019) Growth and yield of Cowpea [*Vigna unguiculata* (L.) Walp] as influenced by *jeevamrutha* and *panchagavya* application. *Legume Res.-An Int. J.*,**42**:824-828.
- Vasanthkumar, H. H. R., (2006). *Jeevamrut* slurry preparation. *Siri Samruddhi*, **4-5**.
- Venkatesh, M. S. and Basu, P. S. (2011). Effect of foliar application of urea on growth, yield and quality of chickpea under rainfed conditions. *J. of Food Leg.*; **24**(2):110112.
- Venkatesh, M. S., Basu P. S. and Vedram (2012). Foliar application of nitrogenous fertilizers for improved productivity of chickpea under rainfed conditions. *Legume Res.*,**35**(3): 231-234

- Verma, C. B., Yadav, R. S., Singh, I. J. and Singh, A. K. (2009). Physiological traits and productivity of rainfed chickpea in relation to urea spray and genotypes. *Leg. Res.*, **32**(2): 103-107.
- Yakadri, M. and Ramesh, T. (2002). Effect of soil application of potassium and DAP spray in blackgram (*Vigna mungo* L.). *Madras Agric. J.*, **89**: 147-149.
- Yogananda, S. B.; Devakumar, N.; Shruti, M. K., and Ningaraju (2015). Growth and yield of cowpea as influenced by different sources of organic manures Nation Symp Organic Agriculture for Sustainable Food Security: Challenges and opportunities, Tamilnadu, India. p. 113.
- Zeidan, M.S. (2003). Effect of sowing dates and urea foliar application on growth and seed yield of determinate faba bean (*Vicia faba* L.) under Egyptian conditions. *Egypt J. Agron.*, **24**: 93-102.

APPENDIX - I
ANALYSIS OF VARIANCE

Particular of character	D.F.	Mean sum of square				
		30 DAS	45 DAS	60DAS	AT Harvest	
I. Analysis of variance for Plant height (cm)						
Replication	3	2.12	19.58	10.69	20.69	
Treatment	5	1.88	16.40	46.54	185.42	
Error	15	39.59	51.09	30.23	98.80	
II. Analysis of variance for branches plant⁻¹						
Replication	3	2.45	3.25	0.35	2.77	
Treatment	5	1.54	0.75	6.13	9.19	
Error	15	6.16	10.53	14.62	6.60	
III. Analysis of variance for dry weight plant⁻¹ (g)						
Replication	3	0.01	0.13	1.09	6.56	
Treatment	5	0.24	0.07	4.84	102.29	
Error	15	0.16	0.35	1.82	42.88	
IV. Analysis of variance for number of nodules plant⁻¹						
Replication	3	1.38	-	-	22.05	
Treatment	5	12.37	-	-	129.27	
Error	15	78.31	-	-	111.46	
V. Analysis of variance for dry weight of nodules plant⁻¹ (mg)						
Replication	3	2.68	-	-	14.20	
Treatment	5	9.16	-	-	222.86	
Error	15	14.64	-	-	13.05	
VI. Analysis of variance for pods/plant, seeds/pod, seed index, yield/plant and straw yield/plot						
		Pods plant⁻¹	Seeds pod⁻¹	Seed index	Yield plant⁻¹	Straw yield plot⁻¹
Replication	3	181.14	0.76	0.07	4.43	76292.2 5
Treatment	5	147.43	0.87	0.48	14.03	290387. 2
Error	15	225.36	0.96	0.37	5.11	60421.8 8
VII. Analysis of variance for grain yield kg ha⁻¹, straw yield kg ha⁻¹, biological yield kg ha⁻¹ and harvest index (%)						
		Grain yield kgha⁻¹	Straw yield kgha⁻¹	Harvest index		
Replication	3	5428.02	52980.31	4.625627		
Treatment	5	102194.1	201656.2	8.432199		
Error	15	61648.7	41959.3	22.37746		
VIII. Analysis of variance for CGR(g m⁻²day⁻¹)						
		30-45 DI		45-60 DI		
Replication	3	0.40		2.77		
Treatment	5	0.55		25.51		
Error	15	2.48		12.14		
IX. Analysis of variance for RGR(g g⁻¹day⁻¹)						
		30-45 DI		45-60 DI		
Replication	3	0.01		2.49		
Treatment	5	0.006		0.05		
Error	15	0.05		0.08		

APPENDIX -II Basic cost of cultivation

S.No.	Particular	Quantity/Time	Cost(/ha)
1.	Field preparation and sowing		
	Harrowing	2.5 hr	1875
	Ploughing	2.5 hr	1875
	Sowing	2.5 hr	1875
2.	Cost of fertilizer		
	Urea	9 kg	54
	DAP	87 kg	2088
	MOP	33 kg	533
3.	Cost of seed	40 Kg	2800
4.	Cost of seed treatment		
	Bavistin	100 g	126
5.	Cost of Treatment		
	Foliar spray of Urea	20 kg	120
	Foliar spray of DAP	20 kg	480
	Foliar spray of NPK (19:19:19)	20 kg	2500
	Foliar spray of <i>Jeevamrit</i>	20 liter	48
	labour charge for spray	10 labour	2500
6.	Plant protection		
	Imidacloprid @ 17.8 SL	100 ml	300
	Spraying	2 labour	500
7.	Intercultural operation	6 labour	1500
8.	Harvesting	10 labour	2500
9.	Threshing	10 labour	2500
		Total	24174

Prevailing rate input and others operational charges

Rate of tractor @	₹750/hr
Labour charge @	₹250/day
Rate of certified seed @	₹ 7000/q
Rate of Urea @	₹6/kg
Rate of DAP @	₹ 24/kg
Rate of NPK (19:19:19) @	₹125/kg
Rate of <i>Jeevamrit</i> @	₹2.4/l
Rate of cow urine @	₹2/l
Rate of cow dung @	₹2/kg
Rate of pulse flour @	₹ 65/kg
Rate of jiggery @	₹ 40/kg
Rate of imidacloprid @ 17.8 SL	₹ 3/ml
Rate of lentil for sell @	₹ 5100/q
Rate of lentil straw @	₹ 200/q

VITA

The author of this thesis Mr. NavinMaibara S/o Shri Ramesh Chandra Mewada was born on 12th November 1996 at Village-Gopalpura, Tehsil-Shyampur, District-Sehore(M.P.).

He completed his primary education from S.V.M. High School, Shyampur and High School (10th) & Higher Secondari School from GayatriVidhyaMandir H.S. School Charnal, in 2012 & 2014 respectively. He joined College of Agriculture, Rewa (M.P.), affiliated to Jawaharlal Nehru KrishiVishwaVidyalaya (JNKVV), Jabalpur in 2015-16 and completed B.Sc. (Agri.) degree in 2019 with first division (7.40 OGPA).

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