

**PERFORMANCE OF *KHARIF* ONION UNDER ORGANIC  
AND INORGANIC FERTILIZER NUTRIENT LEVEL.**

**THESIS  
SUBMITTED TO THE**



**BANDA UNIVERSITY OF AGRICULTURE & TECHNOLOGY, BANDA**

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF**

**MASTER OF SCIENCE (HORTICULTURE)  
IN  
VEGETABLE SCIENCE**

**BY**

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BANDA- 210001, UTTAR PRADESH, INDIA**

**2023**



*Dedicated*  
*To*  
*My Beloved Parent's*  
*&*  
*Teachers*

*Km. Annapurnima.....* 



**Dr. R. K. Singh**  
Professor & Head



**Department of Vegetable Science,**  
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Dated - 22/01/2023

### ***Certificate – I***

This is to certify that the thesis entitled "**Performance of *kharif* onion under organic and inorganic fertilizer nutrient level**" submitted in partial fulfillment of the requirement for award of the degree of **Master of Science (Horticulture) in Vegetable Science, College of Horticulture**, Banda University of Agriculture and Technology Banda, is a genuine record of bonafide research work carried out by **Ms. Annapurnima, Id. No. 2059** under my guidance and supervision. The results of the investigation in this thesis have not so far been submitted for any other degree or diploma.

It is further certified that the help or information received during the course of investigation and preparation of the thesis have been duly acknowledged.

**(Dr. R. K. Singh)**  
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**(Advisory Committee)**

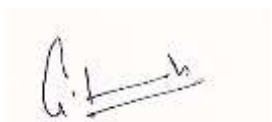
## ***Certificate – II***

We, the undersigned members of the Advisory Committee of **Ms. Annapurnima, Id. No. 2059** a candidate for the degree of **Master of Science (Horticulture) in Vegetable Science** have gone through the manuscript of the thesis and agreed that the thesis entitled **"Performance of kharif onion under organic and inorganic fertilizer nutrient level"** may be submitted in the partial fulfillment for award of the degree.



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## ***Certificate – III***

This is to certify that the thesis entitled "**Performance of *kharif* onion under organic and inorganic fertilizer nutrient level**" submitted by **Ms. Annapurnima, Id. No. 2059** in partial fulfillment of the requirement for award of the degree of **Master of Science (Horticulture) in Vegetable Science, College of Horticulture**, Banda University of Agriculture & Technology (Banda) was examined and approved on **16.08.2023**

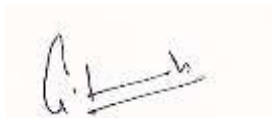


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**Place: Banda**

**Date: 22.07.2023**



**(Km. Annapurnima)**

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## LIST OF ABBREVIATIONS

Symbols		Description	Symbols		Description
@	:	At the rate	INM	:	<b>Integrated Nutrient Management</b>
&	:	And	kg	:	<b>Kilogram</b>
:	:	Colon	K	:	<b>Potassium</b>
°C	:	Degree Celsius	kg ha <sup>-1</sup>	:	<b>Kilogram per hectare</b>
-	:	Minus	M	:	<b>Meter</b>
x	:	Multiply	mm	:	<b>Millimeter</b>
%	:	Percentage	ml	:	<b>Milliliter</b>
+	:	Plus	mg	:	<b>milligram</b>
;	:	Semicolon	MT	:	<b>Million Tones</b>
<b>B: C</b>	:	Benefit-cost ratio	Max.	:	<b>Maximum</b>
<b>CV</b>	:	Co-efficient of variation	Min.	:	<b>Minimum</b>
<b>CD</b>	:	Critical difference	NS	:	<b>Non-significant</b>
<b>cm</b>	:	Centimeter	N	:	<b>Nitrogen</b>
<b>DAS</b>	:	Days after sowing	P	:	<b>Phosphorus</b>
<b>DSM<sup>-1</sup></b>	:	DeciSiemens per meter	Q ha <sup>-1</sup>	:	<b>Quintal per hectare</b>
<b>DAP</b>	:	Di ammonium phosphate	R.H.	:	<b>Relative humidity</b>
<b>EC</b>	:	Electrical conductivity	R.s	:	<b>Rupees</b>
<b>RDN</b>	:	Recommended Dose of Nutrient	<b>Hrs.</b>	:	<b>Hours</b>
<i>et.al</i>	:	And others	RH	:	<b>Relative humidity</b>
<b>fig.</b>	:	Figure	S	:	<b>Significant</b>
<b>g</b>	:	Gram	SEm±	:	<b>Standard error of the mean</b>
<b>Ha</b>	:	Hectare	<i>viz</i>	:	<b>Which is as follows</b>

## ABSTRACT


**Name** : Km. Annapurnima **Id. No.** : 2059  
**Semester** : IV **Degree** : M.Sc. Hort. (Veg. Sci.)  
**Year of admission** : 2021 **Department** : Vegetable Science  
**Major subject** : Vegetable Science **Minor subject** : Fruit Science  
**Thesis title** : **Performance of *kharif* onion under organic and inorganic fertilizer nutrient level**


Onion is one of the most important vegetable crops grown in India, having both the food and medicinal values. Due to its ability to flavour a variety of vegetable preparations, it is a necessary component of every kitchen and is referred to as the "**Queen of the Kitchen**". The experiment was conducted in a randomized block design with three replications at Vegetable Research Farm of BUAT, Banda, during the *Kharif* season of 2022. The holistic aim of this experiment was to search out the most suitable variety of *Kharif* onion that could easily produce the optimum yield with better profitability and also to standardize appropriate organic and inorganic nutrient management techniques that suit well to the crops and variety in the region. The experiment consisted of one-factor treatments. Therefore, a total of 09 treatments combination arrived to test, and every treatments were replicated thrice in an experimental unit i.e., T<sub>1</sub>. Farmer practice (NPKS): 70-40-40-0 kg/ha, T<sub>2</sub>. NPKS:100- 50-50-30 kg/ha, T<sub>3</sub>. NPKS: 120-50-50-40 kg/ha, T<sub>4</sub>. NPKS: 140-50-60-50 kg/ha, T<sub>5</sub>. NPKS: 150-50-60-70 kg/ha, T<sub>6</sub>. 20 tons enriched FYM, T<sub>7</sub>. 75% RDN + 5 tons enriched FYM, T<sub>8</sub>. 50 % RDN + 10 tons enriched FYM, T<sub>9</sub>. 25 % RDN + 15 tons enriched FYM and they were applied with an objective to study the effect of organic and inorganic nutrients on growth, yield, quality and economics of *kharif* onion.

In general, the weather condition was quite conducive resulting in harnessing good crop yields during the year of field experimentation. The soil of the experimental field was silt clay loam in texture having moderate basicity (pH-8.2, EC-0.31) and poor fertility. Overall, the soil holds organic carbon of 0.38 %, available nitrogen of 254 kg ha<sup>-1</sup>, available phosphorus of 17.3 kg ha<sup>-1</sup>, potassium of 259.3 kg ha<sup>-1</sup> and Sulphur of 13.96, respectively.

On the basis of result obtained and summarized from the present study, it can be concluded that all the observations taken for *kharif* onion were found to be superior with the application of organic and inorganic nutrients. In the study, it was observed that the application of T<sub>9</sub>-25 % RDN + 15 tons enriched FYM increased all growth and yield parameters such as plant height (cm), number leaves (cm), neck thickness (cm), bolting percentage, days to maturity (60-70%) neck fall followed by T<sub>7</sub>. 75% RDN + 15 tons enriched FYM and T<sub>8</sub>. 50% RDN + 10 tons enriched FYM. While the maximum B: C was recorded under T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha followed by T<sub>5</sub>. NPKS: 150-50-50-30 kg/ha, T<sub>4</sub>. NPKS: 140-50-60-50 kg/ha and T<sub>8</sub>. 50% RDN + 10 tons enriched FYM. There for among all the combinations of organic and inorganic nutrients applied 25 % RDN + 15 tons enriched FYM was found significantly most effective in increasing the yield and yield attributing traits.

Hence, application of T<sub>9</sub>-25 % RDN + 15 tons enriched FYM recorded higher yield (232.22 q/ha) and excellent quality bulbs may be suggested for cultivation in *kharif* onion as well as the maximum net return per hectare but maximum B: C ratio observed in Treatment T<sub>5</sub>. NPKS: 150-50-50-30 kg/ha due to low cost of cultivation. However, we can see the soil status in treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM, that is significantly improve the soil health and fertility under Bundelkhand region.

  
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## सारांश

नाम	: कु0 अन्नपूर्णिमा	पहचान संख्या	: २०५६
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थीसिस शीर्षक : कार्बनिक एवं अकार्बनिक पोषक तत्व उर्वरक के अन्तर्गत खरीफ प्याज का मूल्यांकन


प्याज भारत में उगाई जाने वाली सबसे महत्वपूर्ण सब्जी फसलों में से एक है, जिससे खाद्य और औषधीय दोनों गुण हैं। विभिन्न प्राकर की सब्जियों को स्वादिष्ट बनाने की अपनी क्षमा के कारण, यह हर रसोई का एक आवश्यक घटक है और इसे रसोई की रानी कहा जाता है। यह प्रयोग २०२२ के खरीफ सीजन के दौरान बीयूएटी, बाँदा के सब्जी अनुसंधान प्रक्षेत्र में तीन प्रतिकृति के साथ एक रन्डोमाइज्ड ब्लॉक डिजाइन में लगाया गया था। इस प्रयोग का समग्र उद्देश्य खरीफ की सबसे उपयुक्त किस्म जो कि इस प्रक्षेत्र के लिए अनुमोदित है उसका प्रयोग अनुसंधान में करना जो कि आसानी से अच्छा उत्पादन कर सके। बेहतर लाभप्रदता के साथ इष्टतम उपज और उचित कार्बनिक और अकार्बनिक पोषक तत्व प्रबंधन तकनीकों का मानकीकरण करना जो क्षेत्र में फसलों और विविधता के लिए उपयुक्त हों। प्रयोग में एक-कारक उपचार शामिल था। इसलिए परीक्षण के लिए कुल ०६ उपचार संयोजन लिये गये और प्रत्येक उपचार को एक प्रायोगिक इकाई में तीन बार दोहराया गया, यानी टी १- किसान अभ्यास एनपीकेएस : ७०-४०-४०-० किग्रा/हेक्टेयर, टी २ - एनपीकेएस : १००-५०-५०-३० किग्रा/हेक्टेयर, टी ३- एनपीकेएस : १२०-५०-५०-४० किग्रा/हेक्टेयर, टी ४- एनपीकेएस : १४०-५०-६०-५० किग्रा/हेक्टेयर, टी ५- एनपीकेएस : १५०-५०-६०-७० किग्रा/हेक्टेयर, टी ६- २० टन समृद्ध गोबर खाद टी ७- ७५ % आरडीएन + ५ टन समृद्ध गोबर खाद टी ८- ५० % आरडीएन + १० टन समृद्ध गोबर खाद टी ९- २५ % आरडीएन + १५ टन समृद्ध गोबर खाद और इन्हें इस उद्देश्य से प्रयोग किया गया था कि खरीफ प्याज की वृद्धि, उपज, गुणवत्ता और अर्थव्यवस्था पर कार्बनिक और अकार्बनिक पोषक तत्वों के प्रभाव का अध्ययन किया जा सके।

सामान्य तौर पर, मौसम की स्थिति काफी अनुकूल थी जिसके परिणामस्वरूप क्षेत्र प्रयोग के वर्ष के दौरान अच्छी फसल की पैदावार हुई। प्रायोगिक क्षेत्र की मिट्टी की बनावट गादयुक्त दोमट थी, जिसमें मध्यम आधारभूतता (पीएच- ८.२, ईसी ०.३१) और खराब उर्वरता थी। कुल मिलाकर, मिट्टी में क्रमशः ०.३८ % कार्बनिक कार्बन, २५४ किलोग्राम हेक्टेयर-१ उपलब्ध नाइट्रोजन, १७.३ किलोग्राम हेक्टेयर-१ उपलब्ध फास्फोरस, २५६.३ किलोग्राम हेक्टेयर-१ पोटेशियम और १३.६६ किलोग्राम सल्फर होता है।

वर्तमान अध्ययन से प्राप्त परिणाम और सरांश के आधार पर यह निष्कर्ष निकाला जा सकता है कि खरीफ प्याज के लिए गए सभी अवलोकन कार्बनिक कार्बनिक और अकार्बनिक पोषक तत्वों के अनुप्रयोग से बेहतर पाए गए। अध्ययन में यह देखा गया कि टी ९ -२५ % आरडीएन + १५ टन समृद्ध गोबर खाद के अनुप्रयोग से सभी विकास और उपज मापदंडों में वृद्धि हुई जैसे कि पौधे की ऊंचाई (सेमी), पत्तियों की संख्या (सेमी), गर्दन की मोटाई (सेमी), बोल्टिंग प्रतिषत, परिपक्वता के दिनों में (६०-७० %) गर्दन गिरने के बाद टी ७- ७५ % आरडीएन + १५ टन समृद्ध गोबर खाद और टी ८- ५० % आरडीएन + १० टन समृद्ध गोबर खाद। जबकि अधिकतम बी सी टी ५-एनपीकेएस के तहत दर्ज किया गया था : १५०-५०-६०-७० किग्रा/हेक्टेयर, इसके बार टी ५-एनपीकेएस: १५०-५०-५०-३० किग्रा/हेक्टेयर, टी ४- एनपीकेएस : १४०-५०-६० था। ५० किग्रा/हेक्टेयर और टी ८-५० % आरडीएन + १० टन समृद्ध गोबर खाद। कार्बनिक और अकार्बनिक पोषक तत्वों के सभी संयोजन में से २५% आरडीएन + १५ टन समृद्ध गोबर खाद को उपज और उपज बढ़ाने वाले गुणों को बढ़ाने में काफी प्रभावी पाया गया।

इसलिए, टी ९-२५ % आरडीएन + १५ टन समृद्ध गोबर खाद के उपयोग से उच्च उपज (२३२.२२ कु०/हेक्टेयर) दर्ज की गई और उत्कृष्ट गुणवत्ता वाले कन्दों का सुझाव खरीफ प्याज की खेती के साथ- साथ प्रति हेक्टेयर अधिकतम शुद्ध रिटर्न के लिए दिया जा सकता है, लेकिन अधिकतम बी: सी अनुपात उपचार में देखा गया टी ५-एनपीकेएस : खेती की कम लागत के कारण १५०-५०-५०-३० किग्रा/हेक्टेयर। हालाँकि, हम टी ९-२५ % आरडीएन + १५ टन समृद्ध गोबर खाद उपचार में मिट्टी की स्थिति देख सकते हैं, जिससे बन्देलखंड क्षेत्र के अन्तर्गत मिट्टी के स्वास्थ्य और उर्वरता में काफी सुधार हुआ है।

  
(राजेश कुमार सिंह)  
मुख्य सलाहकार

  
(कु० अन्नपूर्णिमा)  
लेखक

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## INTRODUCTION

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During last five decades vegetable genetic diversity has been eroding all over the world. Major region of declining of genetic diversity are the commercial markets and economic social pressure that have influenced breeding practices that promote uniformity, encouraging extensive cultivation of preferred improved and hybrid vegetable cultivars with insufficient diversity. Globally, India rank second in vegetable production and contributed 15.8 and 14 % to global vegetable area and production, respectively. The cultivated area and production of vegetable in India 204.84 million metric tons and 11.35 million hectares (source- NHB 2021-2022). Onion is one of the most important vegetable crops grown in India, having both the food and medicinal values. This crop is known to the mankind since prehistoric times and found in the religious books like Bible, Koran and the inscriptions of ancient civilizations of Egypt, Greece and China. The onion, scientifically known as *Allium cepa* L., is a bulbous, biennial herb that is a member of the *Alliaceae* family of the genus *Allium*. It is a significant vegetable bulb crop that is significant on both a national and international scale. It is prized for the peculiar pungent flavour that allyl propyl disulphide gives it and is a crucial component of food in many different places. It serves both vegetable and spice purposes. Due to its ability to flavour a variety of vegetable preparations, it is a necessary component of every kitchen and is referred to as the "Queen of the Kitchen" (Selvaraj, 1976). Onion is the rich source of minerals like phosphors, calcium and carbohydrates and also contains protein and vitamin-C. Onion is being used in several ways as frozen dehydrated bulbs and also has medicinal value & contains several anticancer properties.

Onion has been cultivated since more than 5000 years on the earth and thought to have been first domesticated in the mountainous region of *North West India, Afghanistan, Pakistan, Tajikistan* and *Uzbekistan*. *Western Asia* and the areas around the Mediterranean Sea seem to be the secondary centres of origin. The closest among them are *Allium vavilovii* Popor from Turkmenistan and northern Iran and *A. asarense* from Iran, *A. oschaninii*. Fedstch from Uzbekistan and neighbouring countries is considered ancestor of *A. cepa*. The *alliums* are distributed widely through temperate, warm temperate and boreal zone of the northern hemisphere. It is supposed that from Central Asia, the onion ancestor probably migrated first towards Mesopotamia, where onion is mentioned in Sumerian

literature (2500 B.C.), then to Egypt (1600 B.C.), India and South East Asia. From Egypt *A. cepa* was introduced into Mediterranean area and from there to all Roman Empire. According to Vavilov (1926) Southwest Asian gene centre is proposed as primary centre of domestication and variability of onion. Further, Vavilov and Burkinich (1929) confirmed that Afghanistan and adjacent countries is the genetic centre of origin of the cultivated forms of onion and garlic.

India is one of the leading onion producers after China, with production of 2362.33 thousand MT per year from an area of 1284.99 thousand hectare, with the productivity of 18.10 MT/ha (Horticulture Statistics Department, 2018-19). The cultivation area available for the production of onion across India during the year 2021-22 was approximately 1.94 million hectares and the production is 31.7 million metric tons. (Source- Directorate of Economics and Statistics, Govt. of India 2021-22). It is grown in the states of Maharashtra, Madhya Pradesh, Karnataka, Bihar, Rajasthan, Gujarat, Andhra Pradesh, Haryana, West Bengal, Uttar Pradesh and Chhattisgarh in the country. Among these states, Maharashtra is the leading onion producing state which has production of around (8047.14 thousand tonnes) followed by Madhya Pradesh (3187.73 thousand tonnes) and Karnataka (2804.85 thousand tonnes) (Horticulture Statistics Department, 2018-19).

There are 1120 hectares and 20280 metric tonnes of production in the seven districts of the Bundelkhand region of Uttar Pradesh (Chitrakoot, Banda, Hamirpur, Mahoba, Jalaun, Jhansi, and Lalitpur). Onion productivity is extremely low (18.1 tons/ha) both nationally and regionally. Lack of region-specific high-yielding varieties, improved production methods, and low-quality seeds are only a few of the factors that may contribute to this crop's low productivity. The Directorate of Onion and Garlic Research, IIHR, NHRDF, IARI, and state agricultural universities like MPKV, among others, have generated a significant number of varieties and hybrids in recent years to be grown throughout the nation in a variety of agro-climatic settings during various seasons. The Bundelkhand region has not significant onion varieties for local cultivation for higher yield. In these situations, a variety of suitable genotypes in connection to yield and variability factors must be evaluated in order to choose the best one for direct adoption in the farmer's field or for use as a parent in subsequent breeding programmes. During the *Rabi*, late *Kharif*, and *Kharif* seasons, the Bundelkhand region of Uttar Pradesh is favourable for onion production, just like Andhra, Telangana, Karnataka, Maharashtra, and

a large portion of Madhya Pradesh. It boosts annual total production and satisfies market demand for fresh onions, among other benefits, when *kharif* onions are produced. In comparison to the *Rabi* growing season, *Kharif* onions growing are more difficult and also more expensive. Only a small number of onion cultivars are recognised by local growers as *kharif* varieties.

Onion is one of the important vegetables grown for its shoot and bulbs. It has prominent position among the bulb vegetables due to its multiple virtues like high nutritive and medicinal value, ease of cultivation, wide adaptability, *Rabi* and *Kharif* cultivation, good portability, export potential and bountiful returns. It is rich in major Minerals Ca (47 mg), P (50 mg), and Fe (0.7 mg), carbohydrates (11.1 %), protein (1.2 %), dietary fibre (0.4 %), and fat (0.1 %) in per 100 gm. Onions secretes a lot of phytoncides killing pathogenic microbes, this is why it is widely used as remedy for catarrhal diseases: flu, angina, suppurative lung inflammation, catarrh and cough. It prevents from prostatic hypertrophy. Even in ancient Egypt onion decoction was considered an aphrodisiac. Onion prevents atherosclerotic plaques. It also reduces blood coagulation, prevents atherosclerosis and other cardiovascular diseases. One onion bulb can have the same effect as cardio aspirin. This vegetable improves kidney function and absorbs nitrogen from blood. Onion also has an anti-carcinogenic effect. It stimulates digestion and regulated bowel's function removing active microorganisms. As we see, onion is very beneficial to human health. Medical properties of onion exceed those in many drugs, which normally have side effects. Several parts of the plant have a place in traditional medicines. The seeds of onion relieve dental worms and urinary diseases. They are used in both tender and mature stages (Kumar *et al.*, 2010). The production of *kharif* onion has several advantages i.e., increases total production per annum and fulfils the demand of fresh onion in the market. *Kharif* onion provides high price as compared to *Rabi* raising season onion.

Organic manure and inorganic fertilizers have paramount importance in ameliorating the yield. Inorganic fertilizers now a day is costly affair and increases of cost cultivation. Secondly the sole application of inorganic fertilizers deteriorates soil fertility level day by day, that affect the production, economics of production and human health, where organic manure and bio-fertilizers are cheap, easily available and eco-friendly, giving quality produce, improving keeping quality, T.S.S. and pungency. Unbalanced nutrition and the produce's ability to be stored are two of the crop's main limiting issues,

which contribute to onions' low output. Utilizing organic fertiliser either separately or in conjunction with inorganic fertiliser has the potential to significantly increase the productivity, quality, and shelf life of onions. (Gupta *et al.*, 1999).

The overuse of chemical fertilisers, particularly nitrogenous ones, causes onions to rot quickly in storage (Anon., 2009). Studying the effects of various nitrogen and potash sources on the yield and shelf life of onions during the *kharif* season is crucial in this regard. Numerous variables, including as cultivars, bulb weight, spacing, date of planting, soil, climate, and fertiliser application, affect onion seed output and quality. Nitrogen (N) is applied to onions to increase vegetative growth, produce high-quality foliage, and encourage the synthesis of carbohydrates. However, phosphorus (P) is not a component of chlorophyll II and has no direct impact on photosynthesis. In addition, it is mostly found in the reproductive sections of plants, which aid in the growth of the roots. Potassium (K) is necessary for a leaf's photosynthesis since it aids in the movement of food. Additionally, potassium enhances the leaf's capacity to produce starch and sugar. It is necessary for the movement of sugar. This component is crucial for the development of grains and is definitely necessary for the growth of tubers. The use of potassium generally increases the responsiveness of all root/bulb crops. Potassium is crucial in the application of nutritional fertilisers because it has a role in buffering the effects of both nitrogen and phosphorus (Brady, 1995).

In recent years, it has become clear that careful nutrient administration is necessary for a higher yield and improved onion quality. The primary component that significantly affects onion growth and output under favourable agro-climatic conditions is mineral nutrition. In modern agriculture, fertilisers make up a large part of the cost of producing onions. With the cautious delivery of nutrients, it is feasible to create higher yields of high-quality bulbs. Nitrogen is typically the scarcest nutrient in Indian soils. According to reports, applying different types of nitrogen at the right time significantly improved onion growth and bulb yield. Onion is a bulbous herb having distinctive and pungent odour due to a sulphurous volatile oil known as allyl propyl disulphide (C<sub>6</sub>H<sub>12</sub>S<sub>2</sub>). (Peterson, 1979) showed that sulphur increased bulb size, hastened maturity, increased of the pungency of the bulbs. In addition to N, P and K, sulphur has been found to be very beneficial for onion (Balasubramanian *et al.*, 1979). Although the requirement of micronutrients is very small

but its deficiency can limit the growth and production. It is clear that the efficiency of macronutrients increases by the use of micronutrients.

Use of vermicompost as an excellent organic manure for field crops and vegetable crops has been promoted. Vermicompost is recommended for use as an organic fertiliser and as a replacement for chemical fertilisers in organic agriculture. Organic waste is digested by earthworms, elements that are finally split and referred to as "vermicompost." It has a lot of pores, aeration, drainage, and water-holding capacity. Vermicompost has nutrients that are easily accessible from outside sources. Inoculating microorganisms with the ability to mobilise nutrients from inert to useful forms through biological processes is what makes up bio-fertilizers. They are an affordable and efficient source of plant nutrients, don't use non-renewable energy sources during production, produce plant hormones that enhance crop growth and product quality, and support sustainable crop production by preserving soil productivity. Acetic chemicals secreted by phosphate solubilizing bacteria (PSB) help to dissolve soil phosphorus that would otherwise be insoluble and unavailable. Following inoculation with PSB bio-fertilizer, crop output is improved by 10% to 30%. (Tilak and Annapurna, 1993).

The most widely utilised organic manure is FYM, but it is in short supply. It has a low and inconsistent concentration of nutrients. Under intensive cropping systems, the combined use of FYM and inorganic fertilisers is especially important because they are both necessary for maintaining crop yields and soil productivity. By encouraging the synthesis of polysaccharides and other substances that favour the aggregation of fine soil particles, organic manures like FYM help to increase tilth, structure, aeration, moisture transport, and moisture retention (Bose *et al.*, 2001). The present investigation intitled **“Performance of *kharif* onion under organic and inorganic fertilizer nutrient level.”** Has been planned with following objectives:

1. To find out the best organic nutrient fertilizer for good quality bulb production of *kharif* onion.
2. To assess the best inorganic fertilizer nutrient for *kharif* onion productivity.
3. To assess the quality of *kharif* onion under different organic and inorganic applied.
4. To study the economics possibility of treatment variables.

## REVIEW OF LITERATURE

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A review of literature pertinent to present study is presented in this chapter; an attempt has been made to cite the relevant literature on “**Performance of *kharif* onion under organic and inorganic fertilizer nutrient level**”. The available literature strongly conveys that work has been done on response of *kharif* onion levels of NPKS, FYM and bio- fertilizers. The similar work on other bulb crop is also being reviewed in this chapter.

**2.1** To find out the best organic nutrient fertilizer for good quality bulb production of *kharif* onion.

**2.2** To assess the best inorganic fertilizer nutrient for *kharif* onion productivity.

**2.3** To assess the quality of *kharif* onion under different organic and inorganic applied.

**2.4** To study the economics possibility of treatment variables.

**2.1 To find out the best organic nutrient fertilizer for good quality bulb production of *Kharif* onion.**

**Abbey (2000)** studied that application of 3 tonnes/hectare FYM 100 kg NPK fertilizer combination gave the highest bulb yield of (12.4 t /ha) onion. The application of dairy cattle waste and poultry waste compost released about 31.5 and 51.3% nitrogen, respectively and also had decreased  $\text{NO}_3^-$  leaching to deeper soil layer in Kyushu area.

**Singh *et al.* (2001)** found that application of FYM @ 10 t/hectare to sandy loam soil of Rajasthan significantly increased the bulb yield of onion; the % increase completed the control was 14.2 per cent and the per cent increase completed FYM @ 5 t/ha. Was 5.2 per cent. Again, they considered the response of onion cv. N- 53 to the integrated application of nitrogen and farmyard manure. The average weight of bulb and bulb yield increased significantly with farmyard manure at 10 tonne/ hectare and N at 120 kg per hectare.

**Khalil *et al.* (2002)** recorded the average bulb weight, marketable crop bulb yield with 25 m<sup>2</sup> manure resulted in the highest bulb percentage. When, FYM (40, 50 and 60 m<sup>3</sup> / feddan) and chicken manure on onion cv. Shandweel. N (100 kg / feddan as urea, 30 kg / feddan as calcium super phosphate) and K (24 kg / feddan as potassium sulphate) were applied.

**Lal et al. (2002)** used the significant effect on all the plant growth parameters- plant height, number of leaves, diameter of bulb in onion cv. Hisar-2 with the application of FYM.

**Chandramohan (2002)** studied the effect of farmyard manure seems to act directly by increasing the crop or seed yield either by accelerating the respiration process through cell permeability or by hormone growth action. It provisions nitrogen, phosphorus and sulphur in presented forms to the plants through biological decomposition. Indirectly, it improves the physical properties of soil such as aggregate formation, aeration, permeability and water holding capacity.

**Jayathilake et al. (2003)** observed that application of bio-fertilizers (Azotobacter, Trichoderma or Azospirillum @ 2 kg ha<sup>-1</sup>) in combination with 50 % N through organic manure (VC or FYM) while the other 50% of recommended N and 100 per cent PK supplied through chemical fertilizer gave significantly greater result in dry matter production of onion when compared to control.

**Katung et al. (2005)** found two field trials and recorded significantly higher marketable number and yield of onion bulbs by the application of poultry manure @ 5 or 10 tonne / hectare and they also studied a significant response of bulb yield with increasing FYM manure levels.

**Reddy and Reddy (2005)** studied the effects of different levels of farmyard manure (0, 10, 20 and 30 t ha<sup>-1</sup>) on the growth and yield of onion (cv. N-53) and their residual effect on succeeding radish in onion-radish (Cv. Sel-7) cropping system. The plant height, number of leaves per plant, leaf area, bulb length, diameter and weight and yield of onion increased significantly increasing with levels of farmyard manure (from 10 to 30 t ha<sup>-1</sup>). The treatment of farmyard manure at 30 tonne/ ha<sup>-1</sup> recorded the maximum plant height and number of leaves per plant in onion.

**Shashidhar et al. (2005)** observed that yield/ hectare of garlic (73.48, 68.15 and 70.82 q per hectare, respectively during *khariif*, *rabi* and over two seasons) was maximum with the application of sun hemp @ 20 tonne/ hectare. It was on par with the application of poultry manure (2.5 tonne/hectare) and FYM (5.0 tonne/hectare).

**Arguello et al. (2006)** used the FYM effects on bulbing dynamics, non-structural carbohydrate content, yield, and quality of 'Rosado Paraguayo' garlic bulbs and found that farmyard manure treatment increased scorodite growth, which was directly related to the

harvest index, resulting in greater yield and bulb quality. Bulb quality was not modified in terms of bulb pungency and soluble solids content by the use of farmyard manure.

**Mamatha (2006)** studied that significantly higher neck diameter in onion with the application of FYM and vermicompost @ 100% RDN when compared to urea. Also observed neck diameter of 1.38 cm with FYM and 1.30 cm with vermicompost whereas, urea recorded 0.70 cm neck diameter at harvest.

**Aisha et al. (2007)** found that application of advanced rates of town refuse (as organic nitrogen) along with rock phosphate (as natural P) and potassium sulphate recorded the highest values for the yield and various bulb quality parameters studied in onion.

**Bybordi and Malakouti (2007)** conducted the field trial in Iran and obtained highest bulb yield (71.1 t/ ha) by the application of vermicompost and farmyard manure @ 6 tonne/hectare in red onion cv. Azarshahr. They discoursed that the organic fertilizers such as animal manure, municipal solid waste composts, farmyard manure and vermicompost are quite rich in plant nutrients and their application for agricultural resolves leads to sustainable food production.

**Gowda et al. (2007)** observed the effect of organic manure and fertilizers in garlic cv. G-282. Application of 100% NPK + bio-fertilizer + FYM recorded significantly maximum plant height, a higher number of leaves and maximum bulb yield. Similarly, the quality of bulbs was good with same treatment combination.

**Gambo et al. (2008)** studied the highest bulb yield of onion (4.67 tonne/hectare) when farmyard manure @ 30 tonne/ hectare was applied.

**Suresh et al. (2008)** obtained that maximum number leaves of onion per plant at 30 DAT (7.4), higher bulb length (8.6 cm), maximum bulb diameter (22.0 cm), higher bulb weight (133.6 g) and also numerically higher bulb yield (40.01 q/ha), umbel diameter (15.10 cm), seed weight per umbel (5.3 g), seed weight per plant (15.43 g), seed yield per plot and per hectare (16.14 q/ha), respectively and also 1000- seed weight (15.43 g) was observed maximum with application of FYM@ 4.2 tonne/ hectare (100%) alone and FYM@ 4.2 tonne/ hectare (100%) + PSB @ 5 kg/ha + Azospirillum @ 5 kg/ha. Whereas, lowest bulb and seed yield was obtained in poultry manure @ 4.2 tonne/hectare (22.58 q/ha).

**Yassen and Khalid (2009)** evaluated that, the highest fresh mass (138.4 g/plant), dry mass (82.3 g/plant) and diameter of onion bulbs (8.96 cm) was obtained with application of 23.8 m<sup>3</sup> FYM/ hectare + 47.6 m<sup>3</sup> chicken manure/ hectare.

**Islah (2010)** observed that the maximum plant height, number of leaves per plant, neck diameter, as well as, yield and its components like, bulbing ratio, fresh weight of bulbs and bulb diameter, in addition to minerals content, except dry weight and dry matter per cent of bulb of garlic, with application of farmyard manure at higher rate as compared to control treatment (NPK).

**Abo-Baker Basha (2011)** found the application of bio-fertilizers onion plants improved nutrients and produced best quality exportable organic onion through enhancement in vegetative plant growth. Application of bio-fertilizer (10 tonne/acre) induced highly significant increase in most growth parameters and resulted in a significant increase in total and exportable bulb yield under newly cultivated land at south valley area'.

**Dahaeriya et al. (2011)** observed the cv. G-182 variety of Garlic Observation 50% sprouting, plant height (cm), no of leaves per plant neck girth (cm), , clove weight (gm), fresh weight of root (gm), dry weight root (gm), fresh weight of leaf (gm), fresh weight of bulb (gm), dry weight of bulb (gm) biomass yield per plant, dry matter content (gm+), bulb yield (t/ha<sup>-1</sup>) .It take in the interaction between N levels and bio-fertilizers 100% recommended dose of Nitrogen Azospirillum ,PSB significantly recorded the minimum time (4.33 days), the maximum plant height also observed that is (65.60cm) the interaction between Nitrogen levels and bio fertilizers 100% recommended dose of Nitrogen +Azospirillum+ PSB, no of leaves shield maximum that is 12.76, Neck girth 1.31 cm, leaf area per leaf 52.04 cm<sup>2</sup>,no of cloves per bulb 26.27, fresh weight of root 0.63 gm, dry weight of root 045 gm, fresh weight of bulb 32. 79 gm, dry weight of bulb 14.40 gm.

**Dubey et al. (2011)** evaluated the experiment on performance of recommended dose of farmyard manure with the different biofertilizers viz. Azotobacter, Azospirillum and PSB. The maximum height of plant was increased (50.83cm) using Azospirillum + PSB. While other characters were also showed superiority among number of leaves per plant (7.13), and length of leaves (40.80 cm) with the application of FYM with Azotobacter + Azospirillum + PSB. The maximum fresh weight of ten bulbs (905 g), neck thickness (0.965 cm), bulb diameter-polar (5.22 cm), equatorial (5.12 cm), TSS (13.630

Brix) and bulb yield (237.0 q/ha). The effect of bio-fertilizers (Azotobacter, Azospirillum and PSB) increased the height of plant, number of leaves, length of leaves, size of bulb (polar & equatorial), neck thickness and TSS

**Reddy *et al.* (2011)** found the effects of vermicompost and farmyard manure (0, 5 or 10 tonne/ ha<sup>-1</sup>) on the performance of onion - radish cropping system. The performance of both crops was significantly improved by the use of both vermicompost and farmyard manure doses. The application of 10 tonne/hectare vermicompost and farmyard manure resulted in the highest bulb yields of onion.

**Filippini *et al.* (2012)** studied that garlic yield and possible health risks as resulting from the organic amendments and the waste water use. Result found that crop yields were quite similar in all treatments, only treatments with 8 mg/hectare of both nine amendments (chicken manure, farmyard manure and vermicompost).

**Rodriguez *et al.* (2012)** observed the three organic fertilizations on garlic production and to determine the macronutrient content in leaves of garlic during the crop cycle. The treatments were: T0, with inorganic fertilization (100 kg ha<sup>-1</sup> of diamonic phosphate+100 kg ha<sup>-1</sup> of urea), T1, 16.07 kg ha<sup>-1</sup> of bovine manure-Onion compost (+50 kg ha<sup>-1</sup> of phosphate rock); T2, 2000 kg ha<sup>-1</sup> of Bio Organutsa Nitro Plus a commercial organic fertilizer, (+50 kg ha<sup>-1</sup> of phosphate rock) and T3, Bio Organutsa Nitro Plus + FYM (same as T2+1,25 L FYM). The number of leaves, maximum and dry weight along the cycle increased in all treatments. T2 and T3 showed the maximum values compared to T1. Nitrogen and potassium content in leaves decreased gradually in all treatments after the beginning of bulb formation. At harvest, T2 and T3 presented the maximum yield, weight and diameter of bulbs.

**Singh *et al.* (2012)** evaluated that 50% (RDF) + 25 tonne FYM ha<sup>-1</sup> was found to be superior in respect to bulb yield, quality and benefit cost ratio for the garlic var. Yamuna Safed-2 (G-50).

**Gwari, Ezekiel Yakubu (2014)** conducted the treatments consisted of factorial combination of four organic manures (FYM at rate of 20 tonne/ha, goat dung at rate of 20 tonne/ha, poultry litter at rate of 15 tonne/ha and no manure) and five levels of irrigation intervals (3, 6, 9, 12 and 15 days). Organic manure was allocated to the main plot and irrigation intervals to sub-plots. Parameters studied includes bulb diameter, cured bulb weight, percentage of marketable yield/non-marketable bulb and total yield in tons/ha.

**Banjare et al. (2015)** observed the effect of organic substances on yield and quality of onion, *Allium cepa* L. variety Agrifound Light Red. The experiment was laid out in randomized block design with 3 replications and 8 treatments with combination or individual application of organic manures, bio-fertilizer and inorganic fertilizers. After analysis of performance of different treatments, the results shown that 100% recommended doses of fertilizers (RDF) resulted into maximum polar diameter, equatorial diameter, neck thickness, maximum A+ grade bulbs and average weight of bulb. also showed beneficial effect in increasing marketable yield, total yield and total soluble solids which was at par with the treatment containing RDF (75%) + vermicompost (3 tons/ha) + PSB (2 kg/ha) + Azotobacter (2 kg/ha).

**Gurjar et al. (2017)** studied the effect of planting methods, organic nutrient sources and bio-fertilizers on quality and economics of *Kharif* onion in Gwalior conditions. The results of the experiment were exposed that the ridge method of planting resulted in significantly highest protein content (6.34%) over furrow and flat method of planting and maximum TSS (12.52%) was also recorded with ridge method, which was at par with rest of both sowing methods. The connections were found not significant response with these parameters. Seedlings inoculated with PSB transplanted on ridges with 25.0 tonne FYM/ha and PSB 5 kg/ha.

**Kaur et al. (2019)** evaluated the organic manures and azotobacter (bio-fertilizer) on the performance of *kharif* onion (*Allium cepa* L.) cv. Agrifound Dark Red. Results of the study revealed that the combined application of organic manures and biofertilizers had significant effect on the physical and biochemical characteristics of *kharif* onion. Maximum plant height (56.61 cm), leaf number (11.52), neck thickness (2.69 cm), bulb diameter (2.49 cm) and bulb weight (79.35 cm). Increase in yield (256.80 q/ha) and TSS (14.30 Brix).

**Kumar et al. (2019)** took the twelve treatments viz. control, FYM (100%), V.C. (100%), FYM (50%) + Neemcake (50%), Rhizobium (50%) + V.C (50%), Azotobactor (50%) + Neemcake (50%), PSB(50%) + Trichodarma + Azotobactor (25%), Trichodarma (100%), PSB (25%) + Rhizobium (25%) + Trichodarma (50%), V.C (25%)+ Neemcake (50%) + Trichodarma (25%), FYM (25%) + V C(25%) + Trichodarma (50%), V.C (50%) + Neemcake (25%) + Trichodarma (25%). The results revealed that combined application of PSB (25%) + Rhizobium (25%) + Trichodarma (50%) increase the maximum height of

plant, number of leaves per plant, bulb diameters, neck thickness of bulb, length of bulb, number of scales, fresh weight of bulb, total soluble solid (T.S.S.) except weight of bulb and yield in treatments Trichodarma (100%) under Lucknow conditions.

**Kumar et al. (2021)** observed that viz. Pusa Riddhi, Pusa Madhavi, NHRDF Red, Pusa Red and AGLR were conducted for yield potential. Three organic formulations were applied as pre-harvest spray viz., neem-based formulation (Besara, Panchgavya). Panchgavya, FYM, Azotobacter applications resulted in maximum plant height, number of leaves, and bulb diameter and bulb weight of onion varieties.

## **2.2 To assess the best inorganic fertilizer nutrient for *kharif* onion productivity.**

**Bhatia and Pandey (1991)** studied that NPK fertilizer application at three rates i.e., 50+20+10; 100+40+15 and 150+60+20 kg/ha to onion, highest seed yield (20.39/plant and 10.27/ha) was obtained with the 150+60+20 kg NPK/hectare.

**Pawar et al. (1992)** observed the effect of different levels of nitrogen (0, 40, 80 and 120 kg/ha) on seed yield of N-53 onion. The data indicated that the number of umbels were found to increase up to 40 kg N/ha. While the height and diameter of umbels increased progressively with increase in the level of nitrogen.

**Singh et al. (1994)** studied the field experiment to study the effect of various levels of nitrogen on growth and seed yield of *kharif* onion var. Agrifound Dark Red. They showed that the total number of umbels per plant and size of umbel were increased significantly with increasing levels of nitrogen from 80 to 120 kg/ha. The value obtained at 160 kg/ha was at par. The higher levels of nitrogen (200 kg/ha) had non-significant effect.

**Bhonde et al. (1995)** found on onion cv. Agrifound Dark Red grown during the *kharif* season under Nasik, India conditions. It was revealed that the trace elements zinc, copper and boron and macro nutrient had a significant effect on bulb development and yield as well as bulb quality when applied in combination instead of single. Foliar application of three ppm Zinc + 1 ppm Copper + 0.5 ppm Boron at 30 and 45 days after transplanting gave the highest net return to the onion growers.

**Alam et al. (1999)** studied that sulphur fertilizer @ 40 kg S ha<sup>-1</sup> increased yield by increasing the number of leaves per plant, plant height, number of cloves per bulb and fresh and dry weight of garlic bulb.

**Amjad *et al.* (1999)** observed that all phosphorus and half Nitrogen at sowing, while rest of Nitrogen applied at top dress at flowering fertilizer doses showed significant effect on number of flowers per umbel and diameter of umbel.

**Kumar *et al.* (2001)** found that the increase in potassium application significantly increased the dry weight of tops and bulbs up to 40 kg K<sub>2</sub>O/hectare.

**Ashok Kumar *et al.* (2001)** observed higher dry weight of leaf (2.9 g/plant) and bulb + (4.3g/plant) with 120 kg N/ha as compared to control (2.01 and 2.2 g/plant in leaf and bulb dry weight, correspondingly).

**Khandkar *et al.* (2002)** studied an experiment on effect of added sulphur on growth and yield of garlic and sulphur utilization and found that number of cloves per bulb, bulb girth and bulb yield increase with the application of sulphur up to 60 kg/hectare.

**Sharma *et al.* (2002)** evaluated that plant height, bulb diameter and bulb yield, increased with the increase in sulphur fertilization up to 30 kg /ha<sup>-1</sup> in heavy textured soils and up to 45 kg ha<sup>-1</sup> in light textured soils.

**Majumdar *et al.* (2003)** reported the effect of P (0, 50 and 100 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and S (0, 10, 15 and 20 kg S ha<sup>-1</sup>) levels on yield, nutrient uptake, Phosphorus and Sulphur use efficiency and build-up of Phosphorus and Sulphur in the soil, bulb and straw yield. Nutrient uptake and protein content of garlic increased significantly with increasing levels of Phosphorus and Sulphur application. The available Phosphorus and Sulphur content in postharvest soil increased significantly with Phosphorus and Sulphur application. The interaction effects of Phosphorus and Sulphur were significant for bulb yield, N, P and S uptake and available Phosphorus and Sulphur in postharvest soil and their highest values were recorded with P100S20 treatment combination.

**Hariyappa (2003)** studied that, the application of potassium @ 125 kg/ha recorded significantly highest plant height over control, but was on par with 150 kg/ha, and also increase the bulb weight.

**Nasreen *et al.* (2003)** evaluated a field experiment to study the effect of 7 levels of sulphur (0,15,30,45,60,75 and 90 kg ha<sup>-1</sup>) on yield of onion and the results revealed that, the highest bulb yield (18.92 t ha<sup>-1</sup>) of onion was recorded in treatment receiving 60 kg S ha<sup>-1</sup>.

**Singh *et al.* (2004)** reported that the maximum plant height at 45 and 90 DAS were noticed with application of potassium @ 120 kg/hectare.

**Singh and Singh (2005)** conducted a field experiment to investigate the effect of different levels and sources of sulphur on productivity, nutrient content and their utilization by onion. The result revealed that each successive increase in level of sulphur up to 80 kg ha<sup>-1</sup> significantly increased bulb yield (4106.52 q ha<sup>-1</sup>) and Nitrogen, Phosphorus and Sulphur content in bulb as well as their uptake by the crop during both the years. Amongst the source of sulphur, gypsum proved significantly superior to other sources with respect to bulb yield of onion. Whereas, the value of Nitrogen, Phosphorus and Sulphur content and their uptake in the onion were significantly greater with sulphur as ammonium sulphate. Application of 80 kg S ha<sup>-1</sup> as gypsum is economical for onion crop production.

**Sankaran *et al.* (2005)** noticed that, the effect of sulphur application through SSP @ 45 kg ha<sup>-1</sup> significantly increased the yield by 9.6% over control and it was at par with S @ 30 kg ha<sup>-1</sup>.

**Wani (2005)** observed the effect of sources (gypsum and elemental Sulphur) and levels (0, 25, 50 and 100 kg ha<sup>-1</sup>) of S on garlic cv. Local. The bulb yield was highest (169.94 q ha<sup>-1</sup>) at 50 kg S ha<sup>-1</sup>. The contents of N, P and S (1.36, 0.64 and 1.08, respectively) were highest at 100 kg Sulphur ha<sup>-1</sup>.

**El-Bassiony (2006)** reported the effect of soil application of potassium sulphate (50, 100, 150 and 200 kg fed<sup>-1</sup>) and foliar application of potassium oxide (1g L<sup>-1</sup>) as a stimulated dose on onion and observed that, the maximum yield (15.23 and 15.17 t ha<sup>-1</sup>) and TSS (13.25 and 12.92 Brix) with soil application of 200 kg ha<sup>-1</sup> of potassium sulphate and foliar application of potassium oxide (1 g L<sup>-1</sup>) was observed.

**Khan *et al.* (2007)** observed that the application of 100kg nitrogen/hectare and 10kg Zink/hectare in onion produce highest leaf length (41.81 cm), plant height (56.33 cm), bulb weight (136.5g) and yield (22.80q/ha).

**Kumar and Khajuria (2007)** noticed the effect of sulphur on bulb yield of onion in relation to phosphorus addition. They found that the onion crop responds significantly to sulphur application. The interaction effect of S x P on the bulb yield of onion was found to be non-significant.

**Mozumder et al. (2007)** conducted the transplanted onion production performs profitable in the hilly areas with the best fertilizer combination of Nitrogen-125, potassium-175 and Sulphur-24 kg/hectare. The maximum plant height (41.8 cm) length of bulb (4.49cm), diameter of bulb (3.85cm), single bulb weight (41.4g/ha) and fresh yield (10.33t/ha) were obtained with the same treatment.

**Paul et al. (2007)** reported that the combined application of boron and Sulphur (1 kg/ha Boron + 30 kg Sulphur/ha) produced higher yield in onion than boron and sulphur alone.

**Thakare et al. (2007)** found the field experiment stated that growth parameters such as plant height, number of bulbs, fresh weight of bulb per plant, total dry matter, yield of bulb per plot and bulb yield/ha. were recorded as the highest under the application of 30 kg ZnSO<sub>4</sub> and 15 kg FeSO<sub>4</sub> per hectare.

**Aisha and Taalab (2008)** studied the experiment to study the response of onion productivity to the application of potassium at different forms and rates. The found results showed that the maximum leaves numbers were detected with using chemical form of potassium as potassium sulphate.

**Jaggi and Raina (2008)** noticed the effects of sulphur in garlic (*Allium sativum* L.) - maize (*Zea mays*) cropping sequence. Garlic bulb and foliage yield (6.3 and 0.8 tonne/ha<sup>-1</sup> respectively) obtained at 30 kg ha<sup>-1</sup> of sulphur dose and was significantly higher over without sulphur (3.7 and 0.5 tonne/ha<sup>-1</sup> respectively). An optimum sulphur dose of 44.3 kg ha<sup>-1</sup> produced an improved bulb yield.

**Ullah et al. (2008)** observed that the application of sulphur @ 60 and 75 kg/hectare in two consecutive years produce highest bulb yield 19.75 and 19.88t/ha

**Farooqui et al. (2009)** evaluated the effect of nitrogen and sulphur levels on growth and yield of garlic (*Allium sativum* L.). The experiment containing of four levels of nitrogen (50,100, 150 and 200 kg ha<sup>-1</sup>) and four levels of sulphur (0, 20, 40 and 60 kg ha<sup>-1</sup>). Among the various levels of sulphur tried 60 kg ha<sup>-1</sup> exhibited the greatest growth and yield attributes. Significantly highest yield of garlic was obtained with the treatment combination of 200 kg N ha<sup>-1</sup> + 60 kg S ha<sup>-1</sup>.

**Fraihat (2009)** reported the effect of 3 levels of nitrogen (100, 150 and 200 kg ha<sup>-1</sup>) and 3 levels of sulphur (0, 50 and 100 kg ha<sup>-1</sup>) on growth and productivity of onion

bulbs Giza 20 cultivar. The results presented that increasing nitrogen and sulphur application rates significantly enhanced plant height, number of green leaves per plant-1 and weight of plant and bulb at different stages of onion growth.

**Singh *et al.* (2009)** found that each successive increase in level of Sulphur up to 40 kg ha<sup>-1</sup> significantly increased bulb yield. The Sand farmyard manure application showed synergistic interaction effect on the uptake of S and ultimately on the bulb yield of garlic. Maximum bulb yield was obtained in the treatment where Sulphur was applied @ 40 kg ha<sup>-1</sup>.

**Alam *et al.* (2010)** noticed in the onion crop that the number of leaves per plant (14.63), plant height (61.30 cm), diameter of bulb (14.97mm), fresh weight of leaves (31.42 g), fresh weight of bulb (9.21 g), diameter of bulb (4.36 cm) and bulb yield (13.38 t/ha) were highest in Zinc +Boron+ Nitrogen treatment combination.

**Rohidas *et al.* (2010)** studied an experiment on micronutrients in the garlic crop and revealed that the plant height (71.87cm), number of leaves per plant, neck thickness and bulb yield (155.39 q/ha) were obtained in the treatment zinc applied @ 4ppm which was statistically at par with the treatment boron @ 0.75 ppm.

**Shaheen *et al.* (2010)** conducted a field experiment to study the effect of nitrogen application as soil dressing @ 90- and 120-units N fed-1 and supplying amino mix compound and sugar as foliar spray on onion plant and results showed that, the highest nutritional value of Nitrogen, Phosphorus, potassium, Fe, Mn, Zn and Cu was obtained with the application of 120 units Nitrogen fed-1 and foliar spray of amino mix compound with sugar.

**Umamaheswarapa P. and Chandrappa D. (2011)** observed the response of onion Cv. Bellary Red to varying levels of Nitrogen, Phosphorous and Potassium. Application of Nitrogen at 120kg/ha improved plant height, number of leaves, neck thickness, bulb diameter, bulb weight and bulb yield over its lower levels. Application of Phosphorous at 60kg/ha recorded maximum plant height, number of leaves, neck thickness, bulb diameter, bulb weight and bulb yield over rest of the doses. Application of Potassium at 120kg/ha recorded maximum plant height, number of leaves, neck thickness, bulb diameter, bulb weight and bulb yield over of the doses. Interaction effects of NPK at 120:60:120 kg/ha gave maximum plant height, number of leaves, neck thickness, bulb diameter, bulb weight and bulb yield (24.8 t/ha) in Central Dry Zone of Karnataka.

**Gasti et al. (2011)** evaluated the effect of integrated nutrient management on growth and yield of onion revealed that the treatments differed significantly during 75 and 90 days after sowing, bulb diameter, average weight of bulb, bulb yield and nutrient uptake. Significantly maximum plant height (39.20cm and 62.50cm), number of leaves per plant (6.97 and 9.07) and neck thickness (1.17cm and 1.36cm) during both the stages, while control recorded minimum values for all the parameters. Highest bulb diameter (6.43cm), average weight of bulb (59.23g) and total yields per hectare (12.27 t/ha.). The major nutrients nitrogen, phosphorus and potassium uptake was maximum in the treatment receiving 50% RDF, while uptake of these nutrients was least in control.

**Puttaraju et al. (2011)** reported the nutrients levels imposed on garlic cultivation application of 150:100:100kg Nitrogen, Phosphorus and potassium/ha. recorded the highest growth parameters viz, plant height (64.68cm and 50.46 cm during *rabi* and *kharif* season), number of leaves, stem girth, fresh and dry weight of bulbs, number of cloves per bulb to eight of cloves, equatorial diameter of bulbs and received maximum garlic yield of 104.15 and 60.43 q/ha during *rabi* and *kharif* seasons, respectively.

**Rizk et al. (2012)** found that the application of Nitrogen +Phosphorus fertilizer @ 90+45 unit/fed and 400 kg Sulphur/fed, Sulphur was advisable for better growth of onion plant and to ensure high yield and good quality of onion bulbs in Giza 20 cultivar in reclaimed sandy soil.

**Abedin et al. (2012)** studied the experiment conducted on the effect of micronutrients on growth and yield of onion of cultivar Taherpuri that the maximum yield and yield contributing parameters i.e., leaves per plant, plant height, diameter of bulb, fresh weight of leaves, diameter of bulb, fresh weight of bulb, and bulb yield obtained from Zinc + Boron with the combination of macro nutrient.

**Assefa et al. (2013)** conducted an experiment to investigate the effect different combination of fertilizer and compost on yield and growth parameters of onion. Result of the experiment revealed that almost all yield and yield parameters studied significantly affected by different combination of Nitrogen, Phosphorus, Sulphur and Zinc fertilizers and compost. Maximum yield was obtained from plots that received combined fertilizers of Nitrogen, Phosphorus, Sulphur and Zinc. Thus, combined application of Nitrogen, Phosphorus, Sulphur and Zinc together @ 130, 20, 21 and 15 kg/ha, respectively was

found to be the most suitable combination and dose of a maximum growth and yield of onion and suggested for farmer's use in the field.

**Beg *et al.* (2013)** noticed that, the foliar application of potassium on moong bean and urd bean at the time of flowering at half and full basal fertilizer doses in different concentrations was applied and results revealed that, the treatment where 1 kg. Potassium ha<sup>-1</sup> was applied as foliar spray gave the best results.

**Mishu *et al.* (2013)** carried out an experiment to study the effect of different doses of sulphur on growth and yield performances of onion. The maximum sulphur content (0.49%) of onion bulb was observed in 40 kg Sulphur ha<sup>-1</sup> followed by 20 kg S ha<sup>-1</sup> (0.45 %), 60 kg Sulphur ha<sup>-1</sup> (0.45%) and 80 kg Sulphur ha<sup>-1</sup> (0.44%) at average of 45 and 85 days after transplanting. Though, number of splitted bulb, bulb diameter, neck diameter, and neck bulb ratio were not significantly affected by different doses of sulphur application. Application of 40 kg S ha<sup>-1</sup> resulted in the highest yield (10.65 t ha<sup>-1</sup>) among the different doses of sulphur.

**Tripathy *et al.* (2013)** noticed that the irrespective of sources sulphur @ 30 kg/hectare produced significantly higher plant height (54.51 cm), number of leaves per plant (14.80), polar diameter (5.17cm), average bulb weight (60.83 g) and total bulb yield (211.23 q/ha).

**Trivedi and Dhumal (2013)** studied a field experiment at Pune during *Kharif* season to access the effect of application of Zinc and Sulphur on growth, yield and quality parameters of onion. Result revealed that the application of Sulphur significantly increases the bulb weight (73.9g) and bulb yield 45 t/ha as foliar spray.

**Verma *et al.* (2014)** conducted an experiment to check the response of different levels of Zinc and sulphur on onion. Data revealed that both zinc and sulphur significantly affected the growth parameters. The maximum leaf length (66.39cm), plant height (79.33cm), bulb weight (297.87g), yield (70.36t/ha) and benefit cost ratio (2.73) were recorded in the application of sulphur @45 kg/ha + zinc @ 30 kg/ha in the soil.

**Rai *et al.* (2014)** studied the effect of integrated application of organic manures (FYM and vermicompost), inorganic fertilizers and bio-fertilizers (PSB and Azotobacter) on physico-chemical properties, available NPKS content of soil and nutrient concentration of onion (*Allium cepa L.*). There were six treatments comprised varied levels of FYM, vermicompost, chemical fertilizers, PSB and Azotobacter. The experiment was laid out

under randomized block design (RBD) and the treatments were triplicate during the experiment. Significantly improvement in physico-chemical properties viz. pH, electrical conductivity, bulk density and water holding capacity of soil under onion crop were recorded at all three growth stages i.e., 30 DAT, 60 DAT and at harvest observed in the plots received 50% N through vermicompost + 25% N through urea + PSB + Azotobacter (T6) as compared to other treatments.

**Acharya *et al.* (2015)** observed that the plant height (50.30cm), number of leaves per plant (51.3), fresh weight of leaf (22.7 g), total dry matter production (5.31 t/ha), fresh weight of bulb (85.4 g), bulb yield (16.9 t/ha) were higher in Zinc sulphate @ 0.5percent foliar spray while 10kg/ha borax soil application showed highest polar diameter (26.0 mm) and equatorial diameter (27.2 mm) and borax @ 5 kg/ha soil+ 0.25percent foliar showed maximum number of bulblets per clump.

**Chattopadhyay *et al.* (2015)** conducted an experiment on onion cv. Sukhsagar at BCKVV, West Bengal to assess the influence of sulphur on growth and yield parameters. Pooled result of two-year data revealed that significantly higher total yield (298.81 q/ha) and marketable yield (272.13 q/ha) were recorded in the element sulphur applied @ 30 kg/ha.

**Sayed *et al.* (2015)** assessed in the experiment conducted on garlic crop that increasing the applied sulphur levels from 200 to 400 kg Sulphur/ha significantly increased plant height, number of leaves, plant dry weight, total yield, bulb weight and diameter.

**Fouda (2016)** noticed that the highest values of vegetative growth parameters in onion bulb recorded with using 50% NPK as soil application and foliar application of Iron + Zinc + Copper in the ratio of 300:100:50 mg/lit.

**Khan *et al.* (2019)** observed the effect of different levels of fertilizers application on Onion (*Allium cepa*). Total 9 treatments were replicated three times both under shade and open conditions. Plant height (cm), Neck thickness (cm), Fresh weight of bulb (g), Number of leaves/ plant, Dry weight of bulb (g), Bulb size in diameter (cm) and Bulb yield (tonne/hectare) in both open and under Jatropha were found to be maximum in T4 (NPK 165:100:110 kg/ha) and minimum in T9 (NPK 190:125:135kg /ha).

**Taha *et al.* (2019)** studied the garlic yield and enhancing bulb quality are essential aims for requirements of the market and the consumers. The experiment finds out the

influence of combination of nitrogen level and sulphur. Results indicated that the combination of the recommended nitrogen level with foliar application of sulphur gave the highest values of plant growth, bulb weight and total yield for cultivar.

### **2.3 To work out the quality of *Kharif* onion under different organic and inorganic applied.**

**Birajdr (1991)** found that application of 40 tonne FYM coupled with 50:50:50 NPK kg/ha and biofertilizers in onion bulb crop resulted in significantly increased plant height (76.62 cm).

**Serrano *et al.* (1995)** evaluated the response of onions (cv. Crystal wax) to LEDA (liquid effluent from an anaerobic digester) biofertilizer (obtained from cow dung). Results exposed that a mixture of LEDA and chemical fertilizer gave the best results in terms of leaf number.

**Dixit (1996)** conducted the field experiment at Himachal Pradesh and revealed that increasing Nitrogen application rates increased bulb yield up to 120 kg N/ha. Higher yields were also obtained with higher FYM rates. Application of 120 kg Nitrogen with 20 tonne FYM/ha increased yields by 42.79% compared with control.

**Varu *et al* (1997)** worked that the application of farmyard manure (95 tonne/ha) + NPK (50 kg N, 25 kg P<sub>2</sub>O<sub>5</sub>, 25 kg K<sub>2</sub>O /ha) + Dharatidhara 4 t/ha gave maximum bulb diameter weight and volume in onion

**Mandhare *et al.* (1998)** carried out an experiment with combined application of VA-mycorrhiza + Azotobacter + 50 per cent of recommended P<sub>2</sub>O<sub>5</sub> rate resulted in the highest root length, plant height (57.90 cm), bulb girth (19.20 cm), bulb fresh weight (321.66 g/bulb), root colonization (78.00%) and Phosphorus-uptake (38.60 mg/plant).

**Mengistu and Singh (1999)** noticed in onion bulb crop that an application of biofertilizers along with inorganic fertilizers recorded significantly more plant height than control.

**Thilakavathy and Ramaswamy (1999)** studied maximum plant height in onion (57.10 cm) with the treatment, 45 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> + Azospirillum + Trichoderma as compared to RDF i.e., 100:50:50 NPK kg/ha (46.01 cm).

**Gupta et al. (2000)** evaluated that, the farmyard manure @ 72.0 q/ha<sup>-1</sup> along with ammonium sulphate @ 565 kg/ha<sup>-1</sup> were effective in quality contributing characters such as onion bulb colour, compactness and total soluble solid.

**Singh et al. (2000)** conducted the field experiment at Institute of Advanced Studies, CCS, University, Meerut (Uttar Pradesh) and reported that, 75 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was found better for maximum growth and yield attributes of onion in comparison to higher dose (120 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>), lower dose (50 kg and 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and control.

**Muthuramalingam et al. (2001)** worked the plant height showed an increasing trend with increasing levels of nutrients and its interaction effect revealed that application of 60: 60: 30 kg NPK ha<sup>-1</sup> along with farmyard manure @ 25 tonne/ha<sup>-1</sup>, Azospirillum @ 2 kg ha<sup>-1</sup> and Phosphobacterium @ 2 kg ha<sup>-1</sup> with close spacing of 45×5 cm recorded higher plant height (48.5 cm) at 100 and 135 days of sowing in onion.

**Yadav and Yadav (2001)** observed the performance of onion recommended dose of FYM (30 tonne/ha<sup>-1</sup>) + NPK (100:50:100 kg ha<sup>-1</sup>) gave the highest significant bulb yield (370.37 q/ha<sup>-1</sup>) of onion cv. Role.

**Deho et al. (2002)** noticed that, the application of 80 N + 60 P<sub>2</sub>O<sub>5</sub> + 40 K<sub>2</sub>O (kg ha<sup>-1</sup>) produced a greater number of leaves, large bulb size and gave maximum onion yield (25.56 t ha<sup>-1</sup>).

**Jayathilake et al. (2002)** worked that the effect of organic manures, bio-fertilizers and chemical fertilizers on onion (cv. N-53) growth and yield. Treatments consisted of: 2 types of organic manure (FYM and vermicompost) and 2 types of bio-fertilizer (Azotobacter and Azospirillum), either alone or in combination with chemical fertilizers. Plant height and number of leaves per plant were highest at 100 days after transplanting upon treatment with bio-fertilizers + 50% recommended N through organic manures + 50% Nitrogen and 100% P, K through chemical fertilizers. An additional increase of 14.25% in plant height and 30.72% in leaf number was observed in plants treated with Azotobacter + vermicompost + chemical fertilizers compared to the control.

**Lee et al. (2003)** observed that, the highest marketable yields of 22.9, 23.8 and 23.4 t ha<sup>-1</sup> were obtained with Nitrogen @ 120 kg ha<sup>-1</sup>, P<sub>2</sub>O<sub>5</sub> @ 80 kg ha<sup>-1</sup> and K<sub>2</sub>O @ 120 kg ha<sup>-1</sup> levels respectively. The top dressing of Nitrogen at 30 and 60 days after transplanting was recommended for improving the growth and yield of onion.

**Sharma et al. (2003)** studied that, the application of fertilizers @ 100% (125 kg N, 33 kg P and 50 kg K ha<sup>-1</sup>) and 150% (187 kg N, 49 kg P and 75 kg K ha<sup>-1</sup>) of recommended dose registered an increase of 42 and 56 per cent over 50 per cent NPK level in bulb yield of onion. Similarly, application of farmyard manure at 10 and 20 tonne/ha<sup>-1</sup> increased bulb yield by 9 and 19% over 100% NPK alone, respectively. Bulb yield of onion recorded in 100% NPK along with 20 tonnes FYM ha<sup>-1</sup> (19.87 tonne/ha<sup>-1</sup>) which was at par with 150 per cent NPK alone (18.82 tonne/ha<sup>-1</sup>) thereby signifying the savings of chemical fertilizers of 52 kg N, 16 kg P and 25 kg K ha<sup>-1</sup>.

**Tumbare and Pawar (2003)** worked that the treatments comprised inorganic fertilizer; inorganic fertilizer + rhizobium (*Brady rhizobium japonicum*) + phosphate solubilizing bacteria (PSB); inorganic fertilizer (25% N through farmyard manure); inorganic fertilizer + soyabean straw with 75 and 100% recommended fertilizer rates. Onion bulb yield was maximum (62.85 tonne/ha) with application of 100 per cent recommended fertilizer rates. The substitution of Nitrogen through FYM and the addition of rhizobium and PSB and the in-situ incorporation of soyabean straw combined with inorganic fertilizers showed minimum losses due to rotting, sprouting, and physiological weight loss.

**Mondal et al. (2004)** evaluated that the application of farmyard manure, along with 75per cent of NPK through inorganic fertilizer gave significantly highest number of leaves per plant (13.58), bulb yield (15.25 tonnes/ha), bulb diameter and vitamin C content (8.10 mg/100 g). Significantly higher response was also found in the treatment receiving farmyard manure and pelleted form of organic matter, along with 75per cent of NPK through inorganic fertilizer.

**Gunjan et al. (2005)** worked the effect of 4 levels of nitrogen (25, 50, 75 and 100 kg ha<sup>-1</sup>) and 2 sources of bio-fertilizers viz. *Azotobacter* and *Azospirillum* on yield and quality of onion bulb (*Allium cepa L.*). The treatment combination N4A 1S2 (100 kg N ha<sup>-1</sup>) *Azotobacter* with seedling dipping) gave highest bulb yield and fresh weight of bulb, followed at par by N: A1S2 (75 kg N ha<sup>-1</sup> *Azotobacter* with seedling dipping).

**Singh et al. (2005)** conducted a field experiment to study the effect of nitrogen and potassium on quality of onion at College of Agriculture Research Farm, Bikaner during the year 2001-2002 and observed that, the maximum TSS content (12.49 %) was recorded with the level of 150:120 N: K.

**Mahmoud (2006)** observed that the application of organic, inorganic Nitrogen fertilizers and their combination significantly increased plant height and fresh and dry bulb weights after 100 days of transplanting. The total yield and average weight of 10 bulbs also increased significantly with the application of different levels of ammonium sulphate.

**Basavaraja et al. (2007)** found that the combined application of CPBC @ 15 tonne/ha. along with press mud (PM) and half the recommended dose of fertilizer (RDF) gave significant higher bulb yield of onion (14.70 tonne/ha.) as compared to RDF along with FYM (9.55 tonne/ha). The bulb yields were on par with the combined application of CPBC along with FYM and 50 per cent RDF or combined application of CPBC and Green manure (GM) along with 100per cent RDF, indicating the utility of CPBC in onion cultivation. The yield and quality parameters also differed significantly among the various combinations of CPBC with PM or FYM in conjunction with inorganic fertilizers.

**Sankar et al. (2008)** worked that the application of farmyard manure + Panchakavya resulted in the greatest increase in plant height over inorganic fertilizer alone. The highest number of leaves, average weight of bulbs (47.2 and 52.7g for the first and second crops, respectively) and marketable bulb yield (17.5 and 20.8 tonne/ha) were obtained with Panchakavya + NPK.

**Singh et al. (2008)** reevaluated that the treatments comprised: 100 per cent recommended dose (RD) of N; 100% RD of N and P; 50% RD of NPK; 100% RD of NPK; 150% RD of NPK; 100% NPK + 20 kg ZnSO<sub>4</sub>/ha; 100% NPK + 20 kg S/ha; 100% NPK + 10 tonneFYM/ha; 10 tonneFYM/ha. The highest bulb yield (34.70 tonne/ha), dry matter yield (5.46 tonne/ha) and protein content (6.95%) was obtained with 100% NPK + 10 tonne farmyard manure/ha.

**Nukte et al. (2009)** carried out a field experiment to study the effect of phosphorus and potassium on yield and quality of garlic and reported that, the maximum garlic fresh bulb yield (128.33 q ha<sup>-1</sup>), bulb weight (20.57 gm), diameter of bulb (3.49 cm), length of bulb (3.81 cm), diameter of clove (1.00 cm), length of clove (2.20 cm) and number of cloves per bulb (27.25) were recorded in treatment receiving 75 kg ha<sup>-1</sup> of potassium.

**Sharma et al. (2009)** conducted field experiment effect of vermicompost, farmyard manure and chemical fertilizers on yields of okra – onion cropping sequence and the results revealed that, the yield of okra was recorded in the treatment receiving 100 per cent recommended dose of NPK + 10 t FYM ha<sup>-1</sup> (10.46 and 10.03 tonne ha<sup>-1</sup>). Similarly, yield

of onion was obtained at 25 t FYM ha<sup>-1</sup> + 100 % NPK (8.86 and 12.08 tonne ha<sup>-1</sup>) over control treatment.

**Nandal and Bedi (2010)** observed the highest mean yield of 2 years (108.1 q/ha) with FYM+ fertilizers (recommended) and the mean splitting and bolting in onion bulbs were recorded 1.2 per cent and 2.6, respectively, in recommended farmyard manure. As far as plant growth parameters are concerned, average plant height and average number of leaves per plant were recorded maximum with FYM+ fertilizers (recommended) and the plant stand at harvest was recorded maximum with FYM + fertilizers (recommended).

**Mankar et al. (2011)** studied the effect of combined use of organic and inorganic fertilizer on growth, yield and quality of garlic cv. Yamuna Safed- 3. The experiment was laid out in randomized block design with three replication and ten treatments. The maximum plant height (71. 87cm) number of leaves (10.87) per plant, lowest bolting percentage (17.43%) and minimum neck thickness (0.95 cm) were recorded in treatment T7 (25% RDF+75% N through FYM). The treatment 50% RDV 50% N through FYM recorded significantly the earliness in maturity (126. 33 days). Significantly the highest polar diameter (4.7 cm) and equatorial diameter (5.2 cm) were recorded with application of 25% RDF+75% N through FYM The yield parameters like mean fresh (35 .35 g) and cured weight bulbs (33. 15 g) number of cloves per bulb (22), length (3. 50 cm) and diameter of clove (1. 35 cm), weight of clove (2.65 g). Yield per plot (5.08 kg) and yield per hectare (193 .16 q/ha) were maximum in the combined application of 25% RDF and 75% N through FYM Similarly, the quality parameters maximum TSS.

**Rohidas et al. (2011)** conducted the experiment in randomized block design with three replication and ten treatments. The vegetative growth parameters like height of number of leaves, bolting percentage, maturity, twin bulbs and bulb diameter were influenced significantly due to different treatments. The maximum height of plant (67.06 cm) was recorded in treatment 75% RDF+25% FYM while maximum number of leaves (13.16) per plant and lowest bolting percent (5.80%). Significantly the treatment 50% RDF+50% FYM recorded earliness in maturity (106 days). The lowest twin bulbs (2.52%) were observed in the treatment T<sub>8</sub> (75% RDF+25%FYM). Significantly the highest polar diameter (6.64 cm) and equatorial diameter (8.02 cm) were recorded by 50% RDF+50% FYM. The maximum fresh weight of bulb (171.80 g) and cured weight of bulbs (167 17 g) were obtained in the treatment -T<sub>3</sub>. The minimum values were observed in control. The

combination of 50% RDF+50% FYM was most effective in increasing a smaller number of cured bulbs per kg (5.98), highest bulb yield per plot (22.56 kg) and highest yield per hectare (67.16 t/ha).

**Umamaheswarapa P. and Chandrappa D. (2011)** Studied the response of onion Cv. Bellary Red to varying levels of Nitrogen, Phosphorous and Potassium were carried out during kharif season. The experiment was laid out in factorial randomized block design with three replications and total 27 treatment combination. Application of Nitrogen at 120kg/ha improved plant height, number of leaves, neck thickness, bulb diameter, bulb weight and bulb yield over its lower levels. Application of Phosphorous at 60kg/ha recorded maximum plant height, number of leaves, neck thickness, bulb diameter, bulb weight and bulb yield over rest of the doses. Application of Potassium at 120kg/ha recorded maximum plant height, number of leaves, neck thickness, bulb diameter, bulb weight and bulb yield over of the doses. Interaction effects of NPK at 120:60:120 kg/ha gave maximum plant height, number of leaves, neck thickness, bulb diameter, bulb weight and bulb yield (24.8 t/ha).

**Mohd *et al.* (2011)** conducted on experiment on effect of organic and inorganic fertilizers on growth, yield and quality of garlic cv. GG-1. The results reveal that 25 per cent RDF + 75 per cent through FYM produced more average bulb weight. In case of quality parameters 25 per cent RDF + 75 per cent through FYM was showing maximum TSS and ascorbic acid over all other treatments. The 50 per cent RDF + 50 per cent through FYM also showed beneficial effect over all other treatments 16 with control in respect to growth, yield and quality parameters of garlic. In general, it is seen that application of organic manures with their different level of combination with reduced doses of inorganic fertilizer significantly influenced the growth characters.

**Patel *et al.* (2011a)** studied the efficacy of sources of organic manures v/s chemical fertilizers on yield and quality of onion cv. White Local. The pooled data of three years revealed that poultry manure (9 t/ha), gave higher yield (72.44 t/ha) with the quality of onion bulbs cv. White Local as compared to FYM (45 t/ha) and castor cake (3.4 t/ha). Whereas, the combined application of organic and chemical fertilizers (32.5t FYM +37.5+18.75+ 18.75 kg NPK/ha) gave the highest bulb weight (138.13 g), bulb diameter, (67.71 mm) and production of bulb (75.17 t/ha). Moreover, variety White Local also

produced the highest average yield as compared to productivity of other countries like Korea (58.01 t/ha) and Japan (50.9t/ha).

**Patel et al. (2011b)** observed the effect of ten level of chemical fertilizer and three level of bio-fertilizer (Azotobacter, Azospirillum, PSB) on growth, yield and quality of Brinjal cv.SuratiRavaiya. The treatment combination (100% RDF + Azotobacter, +Azospirillum, + PSB) given highest growth, yield and quality parameter.

**Bangali et al. (2012)** conducted a field experiment for two seasons at Regional Agriculture Research Station Bijapur on medium black soil to study the effect of integrated nutrient management on growth and yield of onion (cv, Telagi Red) and reported that, the higher level of inorganic fertilizers (162:32:148 NPK kg ha<sup>-1</sup>) produced significantly higher bulb yield (41.55 t ha<sup>-1</sup>) which was at par with 81:16:74 NPK kg ha<sup>-1</sup>.

**Bhandari et al. (2012)** evaluated the effect of integrated nutrient management on growth, yield and quality of garlic (*Allium sativum* L.) cv. G G-3. Results indicated that the maximum plant height (59.67 cm), number of leaves per plant (8.96 nos.) and diameter of stem (1.52 cm) was recorded with the application of 100-40-60 NPK kg/ha + 100 kg N/ha through C.C. + Azotobacter + PSB. The maximum length of bulb (4.50 cm), diameter of bulb (5.34 cm), number of cloves per bulb (19.33), average weight of bulb (36.94 g), yield of bulb (124.56 q/ha), moisture content of bulb (61.77 %), and sulphur content (0.94 %) was recorded with the treatment 100-40-60 NPK kg/ha + 100 kg N/ha through C. C. + Azotobacter + PSB. In the grade wise weight, the grade A was found significantly higher in 100-40-60 NPK kg/ha + 100 kg N/ha through C.C. + Azotobacter + PSB, while in treatment 50-40-60 NPK kg/ha + 50 kg N/ha through C.C. + Azotobacter + PSB.

**Jawadagi et al. (2012)** worked the effect of different sources of nutrients on growth, yield and quality of onion in *rabi* and *kharif* and results showed that, the significantly maximum leaf length, number of leaves plant-1 and bulb yield was noticed with the application of RDF (125: 50: 125 NPK kg ha<sup>-1</sup>) + FYM (30 tonne ha<sup>-1</sup>).

**Kandil et al. (2013)** observed the effect of organic and mineral fertilizer on vegetative growth, bulb yield and quality of onion cultivars. Result reveals that mineral fertilization of onion with 214.2 kg N + 71.4 kg P<sub>2</sub>O<sub>5</sub> + 57.1 kg K<sub>2</sub>O/ha surpassed other studied fertilization treatments and resulted in highest values of most studied characters in both seasons and concluded that the interaction between onion cultivars and fertilization treatments significantly affected foliage fresh weight and marketable yield.

**Sharma et al. (2013)** reported the response of bio-fertilizer and NPK level on the growth and yield of garlic in north western Himalayas. Result reveals that highest yield (188 q/ha.) was recorded when the plots were supplemented with 100 % NPK + Azotobacter + PSB with inoculants.

**Shinde et al. (2013)** noticed on effect of organic, inorganic and biofertilizer on uptake of nutrients by onion grown under Western Maharashtra conditions and reported that, the treatment receiving 110:40:60:40 kg ha<sup>-1</sup> NPKS + 7.5 t FYM +2.5 tonne ha<sup>-1</sup> poultry manure + 2.5 tonne/ha<sup>-1</sup> vermicompost + biofertilizer (5 kg/ha<sup>-1</sup> each of Azospirillum +Tricoderma) recorded highest bulb yield of onion (57.61 t/ha<sup>-1</sup>) as compared to control (35. 82 tonne/ha<sup>-1</sup>).

**Singh et al. (2014)** worked the response of different doses of organic and inorganic fertilizers on growth and yield of Garlic (*Allium sativum L.*). The results revealed that the vegetative growth characters viz. plant height (cm), number of leaves per plant, diameter of stem (cm), leaf length (cm), leaf width (cm) as well as yield contributing characters viz., weight of bulb (g), diameter of bulb (cm), weight of 50 cloves (g), number of cloves per bulb and yield of bulb (q / ha) were found to be maximum with the application of 60 kg N + 36 kg P<sub>2</sub>O<sub>5</sub> + 60 kg K<sub>2</sub>O + 15 tonne Vermicompost/ha as compared to control.

**Manna et al. (2014)** observed the interaction effect of chemical and bio-fertilizers on growth, yield and quality of onion. Maximum plant height (67.66 cm), bulb weight (56.92 g), bulb diameter (4.82 cm), total yield (30.20 t/ha) and marketable yield (28.43 t/ha) was recorded with the application of 100 per cent RDF + PSB @ 2 kg/ha +Azospirillum @ 2 kg/ha. Though, the interaction effect of chemical and bio-fertilizers were not significant on the results of leaves number and neck thickness, however maximum average leaves number (6.89) and neck thickness (1.42 cm), was reported by the application of 100% RDF + PSB + Azospirillum. Maximum dry matter (14.87%) was reported.

**Verma et al. (2014)** evaluated the effect of chemical fertilizers and FYM on onion productivity and soil fertility. Results of a ten treatments field experiment revealed that the bulb yield increased by 73.1% with 150% NPK fertilizers over control. The combined application of chemical fertilizer and FYM significantly increased the bulb yield of onion (69.2%) as compared to control. Maximum bulb yield (37.59 t ha<sup>-1</sup>) was recorded with conjoint use of 100% NPK + 10 t FYM ha<sup>-1</sup> + 6 kg Zn + 20 kg S ha<sup>-1</sup> which was 87.5%

higher than control. Combined application of 100% NPK + 10 t FYM + 20 kg S + 6 kg Zn ha<sup>-1</sup> gave significantly higher values of organic carbon (4.0 g kg<sup>-1</sup>), available N (180.3 kg ha<sup>-1</sup>), P (9.8 kg ha<sup>-1</sup>) and K (160.0 kg ha<sup>-1</sup>) in post-harvest soil. Available S and DTPA-extractable Zn were found to be higher in the treatment combination of 100% NPK + 10 t FYM + 20 kg S ha<sup>-1</sup> and 100% NPK + 10 t FYM + 6 kg Zn ha<sup>-1</sup>, respectively. The minimum amounts of organic carbon and available nutrients were recorded under control treatment.

**Nainwalet *et al.* (2015)** evaluated the response of garlic to integrated nutrient management practices in a sodic soil of Uttar Pradesh. Results reveals that recommended dose of inorganic fertilizer (NPK) supplemented with 20 tonne/ha<sup>-1</sup> of 21 farmyard manure coupled with inoculation of PSB and Trichoderma can enhance yield and profitability of garlic.

**Shah *et al.* (2016)** reported the effect of inorganic and organic manure on growth, yield and quality of onion cv. Pusamadhavi under valley condition of Garhwal Himalya. The result reveals that bulb yield ha<sup>-1</sup> (41.88 q) was recorded highest under RDF 75% + FYM 25 %.

**Rai *et al.* (2016)** found the effect of integrated nutrient management on nutrients uptake and productivity of onion. Results revealed that significantly higher yield of onion (74.85 q/ha<sup>-1</sup>) was observed in the plots received 50 per cent Nitrogen through vermicompost + 25% through urea + PSB + Azotobacter as compared to other treatments. Similarly significant effect was observed on nutrient content (N, P, K and S) and nutrient uptake (N, P, K and S).

**Sachin *et al.* (2017)** studied the effect of organic and inorganic sources of nitrogen on growth and yield of garlic (*Allium sativum* L.) var. GG-4. Results 22 revealed that the application of different sources of organic and inorganic nitrogen gives significantly maximum plant height (45.73 cm at 60 DAS and 61.80 cm at 90 DAS), number of leaves per plant (11.96 at 90 DAS) early in maturity (127.15 days) with the application of 100% RDN through FYM. However, the bulb characters like fresh (24.46g) and dry weight of bulb (20.46g), diameter of bulb (39.15mm), no. of cloves per bulb (19.57), clove length (3.51cm), clove weight (2.10g) and yield (4.06 kg/plot and 8.16 t/ha) with maximum storage days (164.00 days) and minimum sprouting (6.66 %) was significantly influenced by the application of 100% RDN through vermicompost in garlic cv. GG-4.

**Dhaker (2017)** observed the FYM and Vermicompost with PSB and Azotobacter and rates of organic manures (50% and 100% RND) on yield, quality and economics of onion (Agrifound Dark Red) on clay loam soil. Results revealed that the application of organic manure significantly influenced the diameter of bulb (cm), bulb weight (g), bulb yield ( $\text{q ha}^{-1}$ ), total soluble solid (OB) and allyl propyl content (ppm) with 100% RDF through Vermicompost + PSB + Azotobacter).

**Bhati et al. (2018)** worked the Effect of levels of farmyard manure, fertilizers and biofertilizers on growth attributes of onion (*Allium cepa* L.) cv. N-53". The experiment comprising of 27 treatment combinations and replicated three times, organic manure (control, FYM @ 20 tonne  $\text{ha}^{-1}$  and FYM @ 10 tonne/ $\text{ha}^{-1}$ ) and three bio-fertilizers (No inoculation, PSB inoculation and Azospirillum inoculation) were applied in the plots. The results of the study have clearly shown that application of inorganic fertilizers @ 100% RDF significantly increased all the growth parameters (Plant height, number of leaves, chlorophyll content in leaves and, fresh and dry weight of leaves) similarly followed by FYM @ 20 tonne/ $\text{ha}^{-1}$  over the other treatments in the respective groups. Moreover, Application of Azospirillum treatment was also found significantly in all the growth attributes of onion bulbs over the control but it was statistically at par with PSB.

**FikruTamiruKenea and FikreyohannesGedamu (2018)** studied the yield of the crop is often constrained by low and unbalanced nutrient supply in the soil. This study was undertaken to assess response of garlic variety Chelenko to FYM and mineral N fertilizer application on growth and bulb yield of the crop during main rainy season. The treatment consists of a factorial combination of four levels of FYM (0, 2.5, 5 and 7.5 t  $\text{ha}^{-1}$ ) and five levels of mineral N fertilizer (0, 52.5, 80, 105 and 130 kg N  $\text{ha}^{-1}$ ), laid out in a randomized complete block design in a factorial arrangement and replicated three times. Data was collected on plant growth, yield component and bulb yield of garlic. Results revealed that significant ( $P < 0.05$ ) maximum leaf length (41.08 cm), bulb weight (39.17 g/bulb), harvest index (63.94%) and total bulb yield (12.93 t  $\text{ha}^{-1}$ ) were recorded at the rate of 7.5 t  $\text{ha}^{-1}$  of FYM application while maximum average leaf width (1.25 cm), clove number (13.57 cm), and bulb dry matter (51.66%) were obtained at maximum rate of 130 kg  $\text{ha}^{-1}$  mineral N fertilizer.

**Dhonde et al. (2019)** conducted for 2 years on a clay loam soil at the IFSRP, Rahuri, to study the evaluation of organic farming package for *khariif* onion based cropping

system on yield, quality and uptake of onion crop. The treatment 50% N through FYM + 50% N through vermicompost was recorded significantly higher yield, quality and uptake of nutrients in onion than rest of the treatments.

**FikruTamiru and Fikreyohanne (2019)** conducted to assess the effect of application of FYM and mineral nitrogen (N) fertilizer on growth and bulb yield of a garlic variety named 'Chelenko I'. The treatments consisted of four rates of FYM (0, 2.5, 5.0 and 7.5 t ha<sup>-1</sup>), and five rates of mineral nitrogen (N) fertilizer (0, 52.5, 80, 105 and 130 kg N ha<sup>-1</sup>). Data were collected on days to maturity, plant height, leaf number, yield components, namely, bulb length and clove weight, and marketable and unmarketable bulb yield of garlic. Due to combined application of FYM (7.5 t ha<sup>-1</sup>) and mineral N fertilizer (130 kg ha<sup>-1</sup>) unmarketable bulb yield was reduced by 41.03% over the control treatment. The highest net benefit was recorded from the maximum marketable bulb yield of garlic at the application of 7.5 t ha<sup>-1</sup> of FYM and 130 kg N ha<sup>-1</sup>.

**Dhillon et al. (2020)** observed that significant variation in organic carbon, bulk density, available macro (N, P, K and S) and micro (Fe, Mn, Zn and Cu) nutrients status was noticed when organic manures were integrated with inorganic fertilizers as compared to sole use of inorganic fertilizers and initial status of soil. The maximum available nutrient status was recorded with treatment T<sub>12</sub> {25% RDNF + 25% N (FYM) + 25% N (VC) + 25% N (PM)} whereas lowest was recorded with treatment T<sub>1</sub> (control). The soil properties such as pH, EC, particle density and porosity did not show any significant difference.

**Pal et al. (2020)** found the effect of organic manure and inorganic fertilizer on growth yield, and yield attributes in onion (*Allium cepa* L.) cv. Agrifound Light Red. The experiment was laid out in RBD with 8 treatments of organic manure and inorganic fertilizer viz. Control (T1), 100% N.P.K (T2), 100% F.Y.M (T3), 100% Neem Cake (T4), 50% N.P.K + Neem Cake (T5), 50% F.Y.M. + Neem Cake (T6), 33% N.P.K. + F.Y.M. + Neem Cake (T7) and 50% N.P.K + F.Y.M (T8). The results showed that the growth attributes were very much fluctuated in different treatments

**Maida et al. (2021)** carried out the effect of organic and inorganic sources of nutrients on growth of Garlic. The treatment combinations involving three levels of organic manure i.e., O1- FYM (farm yard manure@20.t/ha, O2- Vermicompost@10.t/ha, O3- Poultry manure@05.t/ha, three levels of In-organic fertilizer i.e. I1- Control, I2- 100% RDF (NPK-150:80:60), I3- 50% RDF (NPK-75:40:30) and Bioenhancers in three levels

i.e., B1- Panchgavya (45 and 60 DAT), B2- Jivamrit-500 lit. /ha (with every irrigation), B3- Bijamrit- seed treatment + seedling treatment Practices were given in Agrifound Dark Red variety. neck thickness of bulb (cm), total soluble solids content in bulb (%), vitamin-C (Ascorbic acid), allyl-propyl disulphide (C<sub>6</sub>H<sub>12</sub>S<sub>2</sub>). were observed by the maximum at 1st year, 2nd year and Pooled were observed under the treatment I2 (100% RDF (NPK-150:80:60) at all the growth stages.

**Kalirawna et al. (2022)** found the Effect of organic manures and inorganic fertilizers on growth, yield and quality of onion (*Allium cepa* L.) cv. Nasik Red. The field experiment was set up in RBD with 13 treatments and 3 replications. T3 75% of RDF + 25% Vermicompost was found best in respect of growth, yield and quality parameter of onion (*Allium cepa* L.) cv Nasik Red. The results of the investigation are found significantly increased with the higher plant height (78.44cm), number of leaves per plant (10.63), fresh weight of bulb (94.50g), Dry weight of bulb (86.36g), Days to first bulb harvesting (51.29 Days), diameter of bulb (9.63cm), neck thickness (1.35cm), bulb yield per plot (5.00), bulb yield (500.85t ha<sup>-1</sup>), ascorbic acid (mg/100 g fresh weight) (13.34) and total soluble solid (Obrix) (14.53) of onion (*Allium cepa* L.) cv Nasik Red.

#### **2.4 To study the economic possibility of treatment variables.**

**Singh et al. (2001)** worked maximum net returns and benefit: cost ratio with the application of nitrogen @ 150 kg per hectare along with 10 t per hectare of farmyard manure.

**Jayathilake et al. (2002)** noticed at Acharya N.G. Ranga Agriculture University, Hyderabad, India and reported that the maximum net returns (49393.00 Rs ha<sup>-1</sup>) and maximum benefit: cost ratio (1.60) were recorded by the application of 50 % N through vermicompost and 50 % N and 100 per cent PK through chemical fertilizers.

**Sharma et al. (2003)** reported the highest yield (250.4 q/ha) and benefit: cost ratio (3.35) in turmeric with the application of 50% RDF along with 10 tonne/hectare vermicompost.

**Shamima and Hossain (2004)** observed significantly highest bulb yield, and maximum net return and benefit cost ratio of onion by applying 100 kg N, 100 kg P205' 100 kg K20, 20 kg S and 5 kg Zn per hectare. The lowest bulb yield, net return and benefit cost ratio were recorded when the plot received zero fertilization (control).

**Mamatha (2006)** found maximum profit with the application of FYM and lower returns with vermicompost in onion; the lesser B: C ratio of vermicompost could be due to its higher cost. She concluded that supplementation of nitrogen with 75 to 100 per cent organic sources give higher profit as compared to control.

**Basavaraja et al. (2007)** studied that higher net and gross returns were recorded with CPBC and press mud (PM) @ 15 t per hectare each along with 50 per cent RDF with better benefit cost ratio.

**Bhosale (2008)** reported a field experiment at Post Graduate Institute Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) on nutrient management in soybean-onion cropping sequence through inorganic and organic sources and concluded that the application of RDF + 3 t VC ha<sup>-1</sup> + biofertilizers resulted higher gross monetary returns (188992 Rs ha<sup>-1</sup>), net monetary returns (124576 Rs ha<sup>-1</sup>) and B:C ratio 1.93.

**Mandloi et al. (2008)** revealed that the response of inorganic fertilizers on the growth and yield of onion. The treatments comprised: 5.0t/ha. Vermicomposed; 15.24 t NADEP/ha; 25 t FYM/ha; 3.28 t poultry manure/ha; recommended dose of N :125, P: 60, K :100, 1.25 t Agric/ha; and the control. N :125, P:60, K:100 application proved the most beneficial for growing onion cv. N-53. It yielded the maximum up to 378.61q/ha onion bulb with the highest net return of Rs. 83 071/ha and B: C ratio of 3.72. However, the second-best treatment was poultry manure (3.28 t/ha).

**Hari et al. (2009)** observed that the cost: benefit ratio was highest in 100% RNF (7.7) compared to other treatments.

**Kale and Allolli (2010)** evaluated that among potassium sources, the higher net return was obtained with sulphate of potash. But muriate of potash exhibited higher B: C ratio than sulphate of potash due to its lower cost. Among nitrogen sources, the highest net return was realized due to application of ammonium sulphate. But the highest B: C ratio was noticed due to application of urea which was mainly attributed to lower cost of urea. The highest B: C ratio recorded due to interaction effect of muriate of potash and urea, which may be further attributed to lower prices of both urea and muriate of potash.

**Hariyappa et al. (2011)** observed that among all treatment combinations, fertilizer dose of 125 kg potassium and 30 kg sulphur per hectare was found more remunerative in respect of net returns.

**Singh et al. (2011)** studied the experiment on variety Agrifound Light. The treatments were comprised of six levels of sulphur as soil application (0, 10, 20, 30, 40 and 50kg/ha) and foliar application of wettable sulphur 1% at 15, 30, 45 and 60 days after transplanting. The trial was laid out in RBD and replicated thrice. The result revealed that significantly highest gross yield (348q/ha) as well as marketable yield (332q/ha) were recorded with foliar applications of wettable sulphur @ 1% at 15, 30, 45 and 60 DAT and found to be at par with soil application of sulphur 30kg/ha and the yield was reduced in soil application of S at higher levels (40 and 50kg/ha). Significantly highest bulb diameter (5.60cm) and bulb size index (28 .55cm) were also recorded in foliar application of wettable sulphur.

**Pugalendhi et al. (2011)** observed the effect of integrated management on growth, yield and quality of onion. The experiment was laid out in a Randomized Block Design with three replications. A basal dose of 110 :40: 60 40 kg NPKS with organic manures viz FYM and recommendation (150: 50 :80 :50kg NPKS+20tFYM/ha) in Onion cv. Arka Niketan. The results revealed that all the treatments were significantly superior over local fertilizer recommendation (with and without bio-fertilizers). Among the treatments, application of 150:50 :80 :50 Kg NPKS+ 20 FYM ha<sup>-1</sup> recorded highest total and marketable yield of 29. 72 and 27.801 /ha respectively.

**Sankar et al. (2011)** studied the Combined application of organic manures and fertilizer can help in improving the nutrients uptake and mitigate the losses of plant mix when applied to the soil. The results revealed that, application of organic manures (Farmyard mamare-7 t/ha) along with 80% higher marketable bulb yield of onion (45.5t/ha) compared to other combinations. The maximum storage losses (46.5 per cent) were noticed in inorganic fertilizers applied bulbs (NPK 50:50:80 kg/ha as basal 100 kg N in seven splits through drip irrigation+ without organic manures) and minimum storage losses (33.3 per cent) were observed in combined application of FYM 80% of recommended dose of fertilizers in the form of water soluble through drip irrigation.

**Sankar et al. (2011)** studied the experiment was conducted in onion under four preceding crops of mung bean, French bean, bajra and soybean. Preceding crops and onion were fully organically without using any chemicals Organic manures (FYM 20/ha). Among the preceding crops various organic manures evaluated, pooled results of five years experiment revealed that soybean in *kharif* season and onion in *rabi* season with

application of FYM (10t/ha) recorded the marketable yield of 24t/ha. While in the case of inorganic package (recommended dose of NPK) recorded higher marketable bulb yield of 27.31/ha Almost 10-20% recorded

**Shindhe et al. (2011)** studied the foliar application in rabi season with cultivar N-2-4-1. The experiment was laid out in a Randomized Block Design with three replications having seventeen treatments including control. The treatments were consisted of NPK gradients viz. 19:19:19, 20:20:20, 19:09:19, 17:10:27, 0:0:50. The results revealed that the plant height (55.20cm to 65.40 cm), no of leaves (8.7 to 11.5) and neck thickness (1.30cm to 1.50 cm) were influenced by different treatments and were minimum in control and maximum are 20: 20: 20 NPK grade as foliar application. The polar and equatorial diameter was also influenced by different treatments. The polar diameter was ranged from 5.19 to 5.70 cm and equatorial diameter from 5.60 to 6.21 cm. The average weight of bulb varies from 70.2 to 88.60 g. The TSS. was not much influenced by different treatments and it was ranged from 10.5 to 13.5% The percentage of "A" grade.

**Jawadagi et al. (2012)** worked the effect of different sources of nutrients on growth, yield and quality parameters of onion Cv. Bellary red. Results revealed that significantly maximum, leaf length and number of leaves noticed with the application of RDF (125:50:125 NPK kg ha<sup>-1</sup>) +FYM (30 t ha<sup>-1</sup>) followed by the application of 50% FYM (12.50 t ha<sup>-1</sup>) +50% VC (2 t ha<sup>-1</sup>) + Bio-fertilizers in both the seasons under investigation. The results also indicated that the same treatments recorded the highest bulb weight, bulb, yield as well as net returns and B:C ratio in both *rabi* and *kharif* seasons as compared to other treatments.

**Verma et al. (2013)** conducted a field experiment d suitable dose of sulphur to obtain high yield and net returns in garlic (*Allium sativum* L.). Application 90 kg ha<sup>-1</sup> sulphur individually produced maximum plant height, number of leaves per plant, chlorophyll content in leaves, fresh weight of leaves, neck thickness, number of cloves per bulb, weight of bulb, bulb diameter and bulb yield, whereas, 60 kg ha<sup>-1</sup> sulphur was found to be significantly superior with respect to weight of bulb (34.55 g), bulb yield (199.18 q ha<sup>-1</sup>) and net returns of garlic.

**Damse et al. (2014)** conducted field experiment on integrated nutrient management in garlic and results indicated that, among all the treatments, treatment T6 (75:40:40:40 kg ha<sup>-1</sup> NPKS + 7.5 t ha<sup>-1</sup> FYM + 3.75 t ha<sup>-1</sup> FYM) was found superior in respect of bulb yield

(150.41 q ha<sup>-1</sup>) and benefit cost ratio (1.68) followed by treatment T5 (75:40:40:40 kg ha<sup>-1</sup> NPKS + 7.5 t ha<sup>-1</sup> FYM) in all three seasons of the experimentation.

**Sekhon *et al.* (2016)** observed the effect on yield of onion. Three farmyard manure (FYM) rates (0, 25 and 50 t ha<sup>-1</sup>), three nitrogen (N) rates (75,100 and 125 kg N ha<sup>-1</sup>), three P rates (30, 50 and 70 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and three K rates (30, 50 and 70 kg K<sub>2</sub>O ha<sup>-1</sup>) were tested on Punjab Naroya cultivar. The treatments were replicated over three artificially created fertility strips. Fertilizer N was the most limiting element. Higher FYM rates though can be used to reduce N, P, and K fertilizer rates, but doubling FYM rate from 25 to 50 t ha<sup>-1</sup> did not benefit in general. Bulb yield data indicated that 25 t ha<sup>-1</sup> FYM, 100 kg N ha<sup>-1</sup>, 50 kg of P and K ha<sup>-1</sup> gave the best results. The results hold significance in view of higher FYM rate recommendation (50 t ha<sup>-1</sup>).

**Sharma *et al.* (2017)** found the effect of different levels of organic and inorganic nutrients on yield, quality and production economics of onion. The experiment was laid out in randomized block design (RBD) comprised of seven treatments with three replications. Application of medium to high doses of FYM and/or mustard oil cake along with state recommended/soil test based NPK dressing enrich the post-harvest soil with organic carbon increased the available phosphorus and maintain the available potassium level in soil. The highest yield of 28.0 t ha was noticed from the treatment T and it performed significantly better than others with 50.5 mm polar and 53.8 mm 4 2 equatorial diameter, 0.94 bulb shape index, 27.2 cm bulb index, 69.7g bulb weight, 12.3°Brix TSS, 10.8 scales/bulb, 7.9 µmol/g pyruvic acid, -1 -1 highest net income (Rs. 3,28,421.60) and benefit: cost ratio (3.75). Therefore, 20 t ha FYM + (state recommended) NPK (125-100-100 kg ha<sup>-1</sup>) performed best among treatments in respect to quality and yield attributes, higher productivity, net return and benefit-cost ratio.

**Somen Acharya and Hitesh Kumar (2018)** studied the usage of organic fertilizer for garlic quality. Large amounts of inorganic fertilisers are used to increase vegetable crop yields, which has led to nutrient deficiencies and a decrease in soil organic carbon. In addition to economic costs, using chemical fertilisers and pesticides has health and environmental implications as well.

**Kim *et al.* (2019)** studied the Organic fertilization was an effective management strategy to improve crop yield and soil fertility. Determination of optimum application rate has been received great interest as a major research field. In this study, we evaluated

optimum application level of three different organic fertilizers; mixed expeller compost mixed organic fertilizer (MOF) and organic complex fertilizer for garlic cultivation. Treatments consisted of MEC, MOF, OCF (50, 100, 150% of standard nitrogen input), inorganic fertilizer (NPK, N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O: 250-78-128 kg ha<sup>-1</sup>) and no-fertilization (control). Overall, the yields of garlic under MEC, MOF and OCF 100% (5,337, 5,617 and 5,276 kg ha<sup>-1</sup>) were higher than under control (4,496 kg ha<sup>-1</sup>).

**Patel et al. (2019)** studied the effect of organic manures and bio-fertilizer on growth and productivity of garlic. In total six treatment combinations comprising of three treatments of organics which were applied on nitrogen equivalent basis. significantly higher average bulb weight (11.98 g), bulb yield (7.9 t ha<sup>-1</sup>). In case of interaction effect, application of recommended dose of N @ 100 kg/ha of which 50% N through with bio-fertilizers recorded higher bulb yield (9.2 t ha<sup>-1</sup>), gross return (₹ 3,66,174 ha<sup>-1</sup>), net return (₹ 2,63,039ha<sup>-1</sup>) and BC ratio (2.55) followed by 50% N through FYM as basal + 50% N through castor cake at 40 DAS with bio-fertilizer.

**Badal et al. (2019)** studied the effects of organic manures and inorganic fertilizers on growth, yield and its attributing traits in garlic. Among the different treatments, the treatment T1 (application of 100 % RDF- Recommended Dose of Fertilizer) recorded the maximum plant height (70.6cm), plant diameter (0.84 cm) and length of longest leaf at 60 DAP (41.07 cm) and 90 DAP (69.47 cm) as compared to other treatments .Weight of bulb (39.68g), length (5.24 cm) and diameter of bulb (5.03 cm), number of cloves per bulb (27.63), length of clove (3.82cm),weight of single clove (1.52g) of competitive plants, bulb yield per plot(4.66kg) and bulb yield per ha (155.48q) was maximum in the treatment T7 (50% RDF + 7.5t/ha FYM +2 t/ha FYM).

**Yoldas et al. (2019)** observed the yield and yield performance of onion. The application of manure significantly improved yield, bulb weight, bulb height, number of shoot tip, number of dried leaves compared to control. Highest yield (72.99 t ha<sup>-1</sup>) observed. The onion cultivar Burgaz was more responsive to the FYM compared to other onion cultivars. The best yield was shown of Burgaz cultivar and the 20t ha<sup>-1</sup> FYM treatments by the interaction. As a result, this method is the most suitable for onion production.

**Vishvkarma (2020)** studied the application of bio-fertilizer with different dose of fertilizers had significantly enhanced economic cost and yield attributes viz., maximum

equatorial diameter of bulb (6.95 cm), polar diameter of bulb (6.29 cm), fresh yield per plant (56.86 g), yield per plot (22.74 kg), yield per hectare (276.02 q/h) and dry weight of bulb (31.49 g). This treatment, gave significantly higher qualitative yield (379.09 q ha<sup>-1</sup>) and net returns of (Rs. 3, 41, 198).

**Gererufael *et al.* (2020)** found the effect of organic and inorganic fertilizer on growth, yield and yield components of onion. The experiment consisted of four levels of FYM (Farmyard manure) as 0, 10, 20 and 30 t ha<sup>-1</sup> and four levels of inorganic N as 0, 34.5, 69 and 103.5 kg ha<sup>-1</sup>. Analysis of variance revealed that the main effect of N, FYM as well as their interactions significantly (PP) influenced days to maturity, plant height, leaf number, leaf diameter, bulb diameter, neck diameter, average bulb weight, above ground dry biomass, marketable bulb yield and total bulb yield of onion.

**Gashaw, Bewuket (2021)** observed the treated with six rates of NPS (T1 (0: 0:0 kg/ha NPS) (control), T2 (19: 38: 7 kg/ha NPS), T3 (28.5: 57 :10.5 kg/ha NPS), T4 (47.5: 76 :14 kg/ha NPS), T5 (47.5: 95: 17.5 kg/ha NPS), and T6 (57 :114: 21 kg/ha NPS). Data were collected for days to 50% emergence, plant height, leaf number, leaf length, bulb weight, and total bulb yield. Significantly highest leaf length (41.51 cm), leaf number (13.63), plant height (61.19 cm), bulb weight (39.44 g), and total bulb yield (14.91ton ha<sup>-1</sup>) were recorded from T6 (57 :114: 21 kg/ha NPS). The result of this study, it can be concluded that the maximum total bulb yield of garlic was obtained with the application of 57 :114: 21 kg/ha NPS rate.

**Sahoo *et al.* (2022)** studied the Onion variety N-53 was grown with 150: 60: 80: 30 kg ha<sup>-1</sup> of N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O: S as recommended dose of fertilizer (RDF). Results revealed that the integration of 50% RDF i.e., 75: 30: 40: 15 kg ha<sup>-1</sup> of N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O: S along with the biofertilizer (Azospirillum and Trichoderma@ 5 kg ha<sup>-1</sup> each) incorporated farmyard manure (5t ha<sup>-1</sup>) and vermicompost (1.25 t ha<sup>-1</sup>) produced better vegetative growth, comparatively higher bulb weight (77.7 g), maximum marketable bulb yield (225.3 q ha<sup>-1</sup>) and total bulb yield (279.6 q ha<sup>-1</sup>) among all other nutrient combinations. This nutrient combination produced higher yield of onion.



## MATERIALS AND METHODS

This chapter includes the details about the experimental materials, observations, and methods or techniques adopted during the course of the investigation entitled “Performance of *Kharif* onion under organic and inorganic nutrient level.” which was carried out in *Kharif* season during the year 2022.

### 3. Details of experiments

#### 3.1 Experimental site

The present investigation was conducted at Vegetable Research Farm, Department of Vegetable Science, college of Horticulture, Banda University of Agriculture and Technology, Banda, 210 001, Uttar Pradesh during the *Kharif* season 2022. The university situated at 24°53-25° 55 N latitudes and 80° 07-81° 34 E longitudes. Though, Banda district is bounded by districts of Fatehpur in the north, Hamirpur and Mahoba in the west Chitrakoot in the east, and Panna, Satna, and Chhatarpur (Madhya Pradesh) in the south.

**Table 3.1.1 Initial chemical properties of the soil**

S.N.	Soil properties	Values (%)	Method of Determination	Remarks	Reference
a	Soil pH	8.2	Conductivity bridge	Slightly high	(Jackson,1966)
b	Soil EC (ds m <sup>-1</sup> )	0.42	Electrometric glass electrode method	Low	(Jackson,1966)
c	Available Organic Carbon (%)	0.38	Walkley and black's method	Medium	(Walkley and Black,1966)
e	Available Sulphur (kg ha <sup>-1</sup> )	13.96	CaCl <sub>2</sub> - extractable S. method	Medium	Turbidimetric method (Chesnn and Yein, 1950)
f	Available nitrogen (kg ha <sup>-1</sup> )	254	Alkaline permanganate method	Low	S. Subbiah and Asija (1956).
g	Available P (kg ha <sup>-1</sup> )	17.3	Olsen method	Medium	(Olsen <i>et al.</i> , 1954)
h	Available K (kg ha <sup>-1</sup> )	259	Flame photo meter Method	Medium	(Jackson,1966)



**Estimation of organic carbon**



**Estimation of phosphors**

### **3.1.2 Climate and weather conditions**

The climate of Bundelkhand region is predominately semi-arid, with dry and warm summers, agreeable monsoons, and slightly cold winters. More than 88–90% of the region's annual rainfall, or 800-910 mm, falls during just three months: August and September; the remaining 7–9% falls in June and October. The yearly temperature is comparably high and ranges from 12 to 20 °C in the winter, 35 to 48 °C in the summer, and 23 to 28 °C in the rainy season. The hottest months are April, May, and June, with temperatures frequently above 45 to 48 °C. The appendix lists the minimum and maximum temperatures, relative humidity, and average weekly rainfall for the experimental periods.

**Table 3.1.2 Meteorological conditions during cropping season 2022**

Week No.	Month	Date	Maximum Temperature (°C)	Minimum Temperature (°C)	Relative Humidity (%)	Average Wind Velocity ( Km/hr)	Total Rainfall (mm)	Evapotranspiration (mm)
23	1-june-2022	7-june-2022	46.00	30.85	26.00	4.20	0.00	31.60
24	8-june-2022	14-june-2022	45.28	33.85	28.70	6.10	0.25	32.32
25	15-june-2022	21-june-2022	39.28	27.71	63.60	6.70	10.00	3.03
26	22-june-2022	28-june-2022	41.14	30.85	51.20	3.50	0.00	25.71
27	29-june-2022	5-july-2022	35.71	27.85	74.20	3.60	7.00	5.77
28	6-july-2022	12-july-2022	39.71	30.71	57.50	5.50	0.00	13.25
29	13-july-2022	19-july-2022	39.42	30.71	55.80	7.20	18.40	12.57
30	20-july-2022	26-july-2022	34.85	27.57	88.60	3.70	152.7	0.00
31	27-july-2022	1-Agust-2022	35.57	27.28	86.30	4.20	92.05	0.00
32	2-Agust-2022	8-Agust-2022	34.57	27.57	87.00	2.50	51.50	0.00
33	9-Agust-2022	15-Agust-2022	32.00	26.85	88.40	7.60	35.50	0.00
34	16-Agust-2022	22-Agust-2022	33.00	26.28	85.90	5.90	55.0	0.00
35	23-Agust-2022	29-Agust-2022	32.14	26.28	90.40	3.00	4.75	0.00
36	30-Agust-2022	5-Sep.-2022	37.00	27.42	82.20	3.00	1.00	0.00
37	6-Sep.-2022	12-Sep-2022	35.71	27.57	79.40	4.40	6.75	0.00
38	13-Sep-2022	19-Sep-2022	32.14	25.71	89.80	5.20	58.00	0.00
39	20-Sep-2022	26-Sep-2022	31.85	25.57	92.50	2.70	117.5	0.00
40	27-Sep-2022	3-Oct-2022	35.42	25.57	77.10	2.10	0.25	0.00
41	4-Oct-2022	10-Oct-2022	33.00	24.71	90.30	3.40	112.0	0.00
42	11-Oct-2022	17-Oct-2022	33.00	23.14	79.00	1.80	1.00	12.68
43	18-Oct-2022	24-Oct-2022	33.85	21.14	66.00	2.50	0.00	9.71
44	25-Oct-2022	31-Oct-2022	33.71	18.85	61.80	1.80	0.00	5.48
45	1-Nov-2022	7-Nov-2022	33.42	19.42	63.40	2.10	0.00	11.42
46	8-Nov-2022	14-Nov-2022	31.42	18.28	62.50	2.10	0.00	6.17
47	15-Nov-2022	21-Nov-2022	28.57	15.14	57.50	3.30	0.00	3.20
48	22-Nov-2022	28-Nov-2022	28.14	13.42	59.30	3.10	0.00	1.71
49	29-Nov-2022	5-Dec-2022	26.85	12.85	69.50	1.60	0.00	4.80
50	6-Dec-2022	12-Dec-2022	26.28	12.00	71.00	3.10	0.00	0.00
51	13-Dec-2022	19-Dec-2022	25.28	12.42	66.50	3.30	0.00	0.00
52	20-Dec-2022	26-Dec-2022	23.85	11.00	72.10	2.60	0.25	0.00

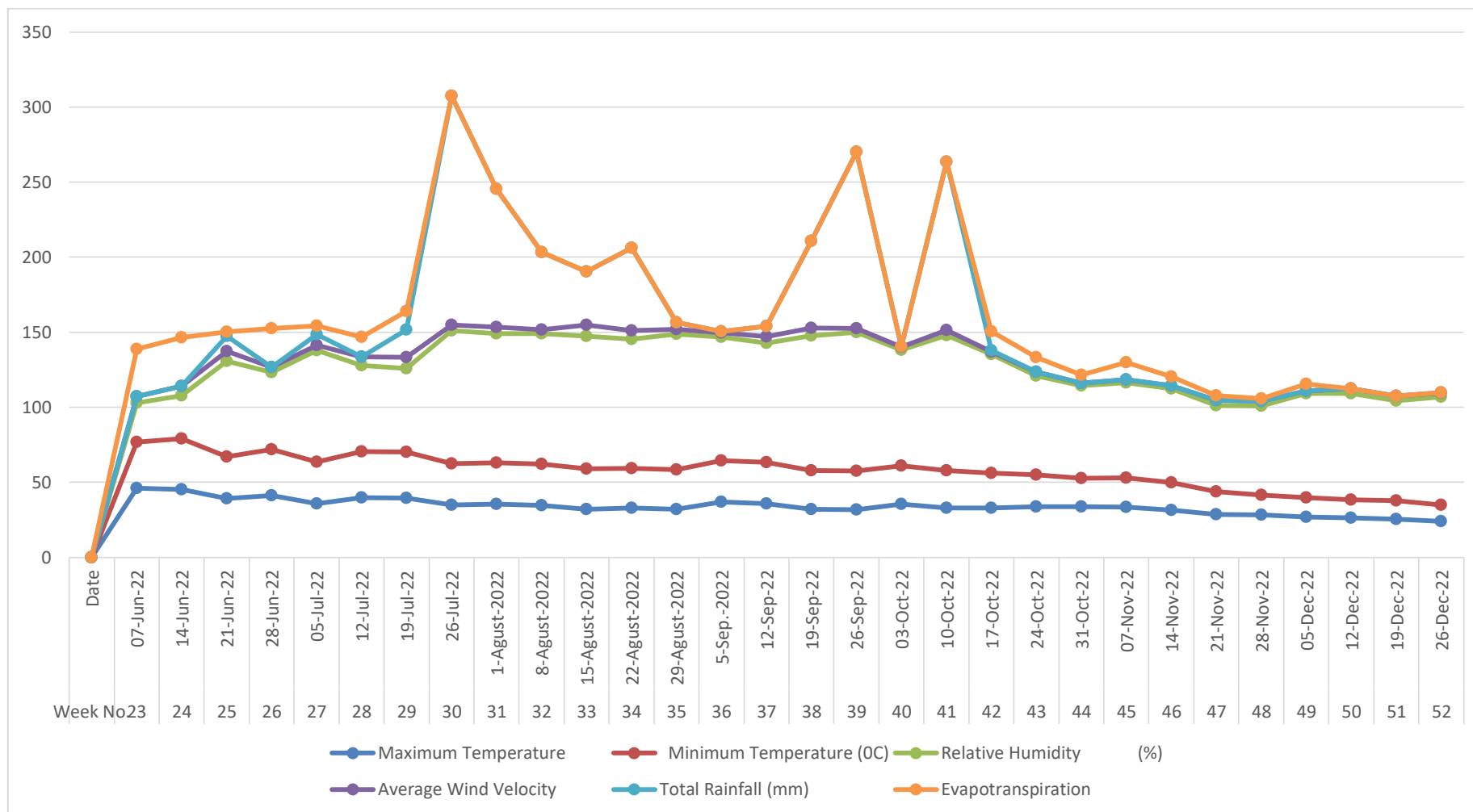


Fig 3.1.2 Weather parameters during the crop period

### 3.2 Treatment details

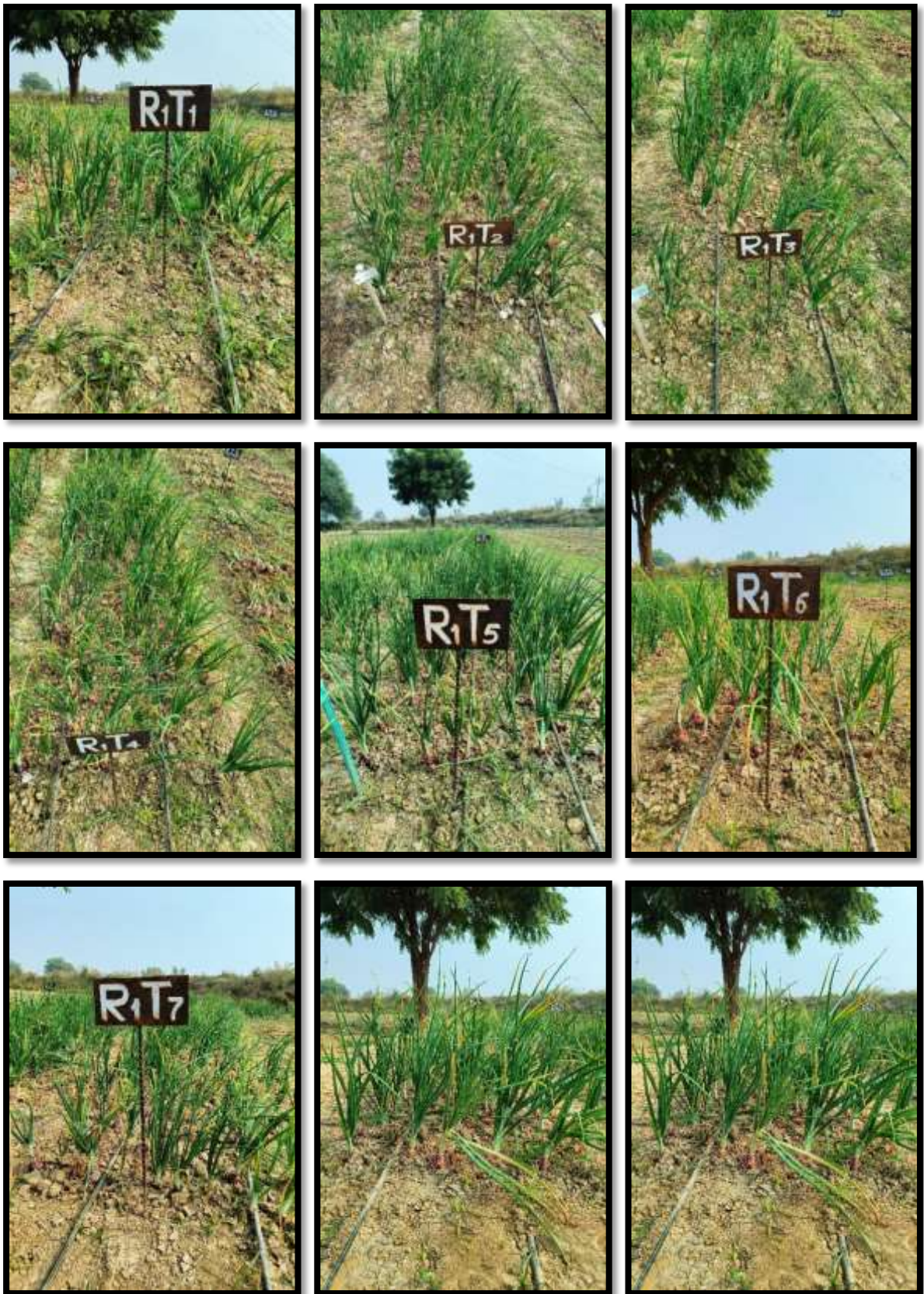
The experiment was laid out in Randomized Block Design (RBD) with three replications during *Kharif* season 2022 with nine treatments. The details of the treatments are given in Table 3.2.1.

6.87 cm

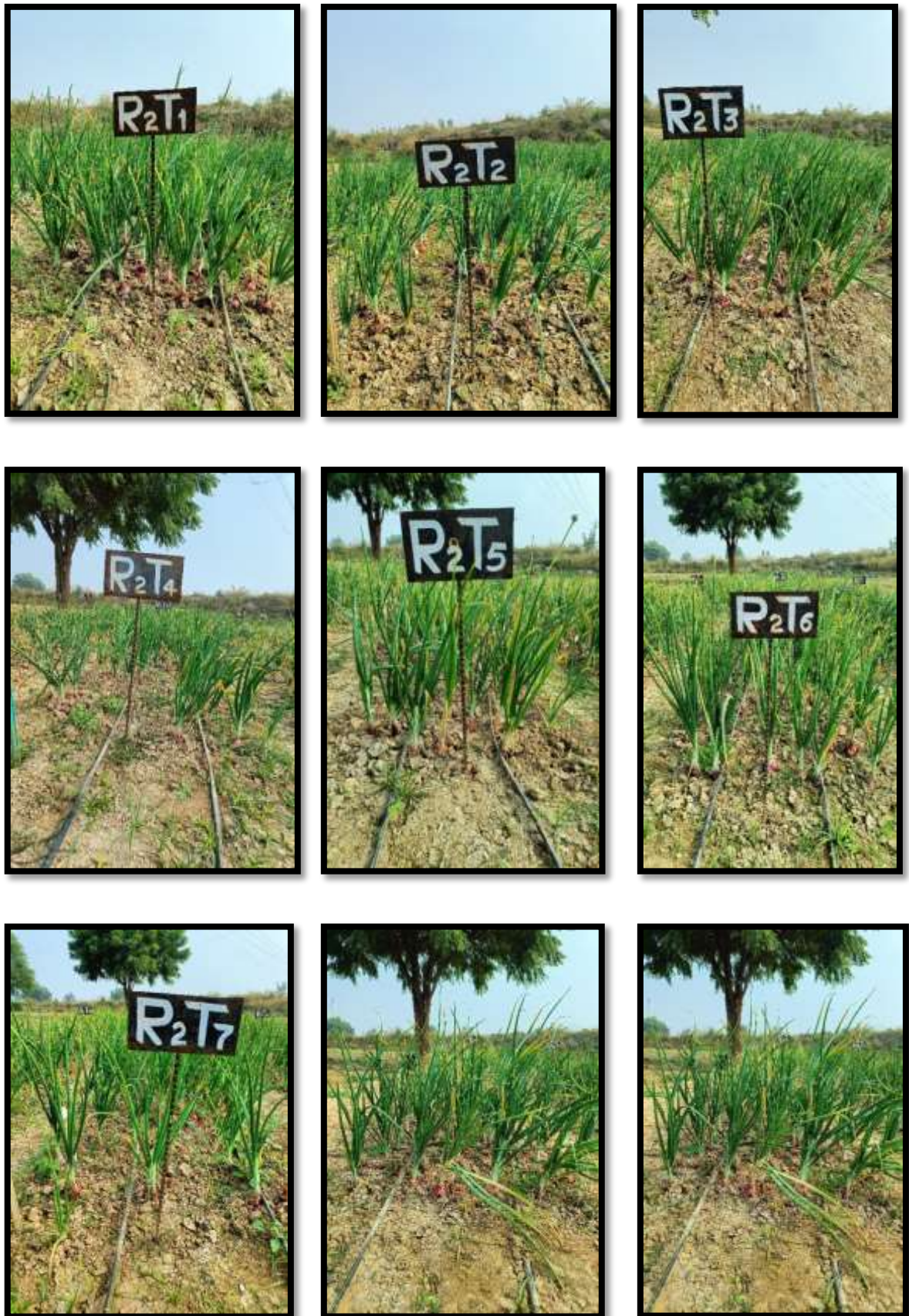
**Table 3.2.1 Treatment details for field experiment:**

S.N.	Treatment	Notation
1	T <sub>1</sub>	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha
2	T <sub>2</sub>	Recommended NPKS:100-50-50-30 kg/ha
3	T <sub>3</sub>	NPKS:120-50-50-40 kg/ha
4	T <sub>4</sub>	NPKS:140-50-60-50 kg/ha
5	T <sub>5</sub>	NPKS:150-50-60-70 kg/ha
6	T <sub>6</sub>	20 tones enriched FYM
7	T <sub>7</sub>	75 % RDN + 5 tones enriched FYM
8	T <sub>8</sub>	50% RDN + 10 tones enriched FYM
9	T <sub>9</sub>	25 % RDN + 15 tones enriched FYM

- **EFYM-FYM** is treated with 4 different bio fertilizers namely PSB, Azotobacter, Trichoderma and NPK Consortia 5 tones FYM has to be treated with 1.0 kg each biofertilizer.



**General view of treatments in replication-1**



**General view of treatments in replication-2**



**Genral view of tretments in replication-3**

### 3.3 Experiment details

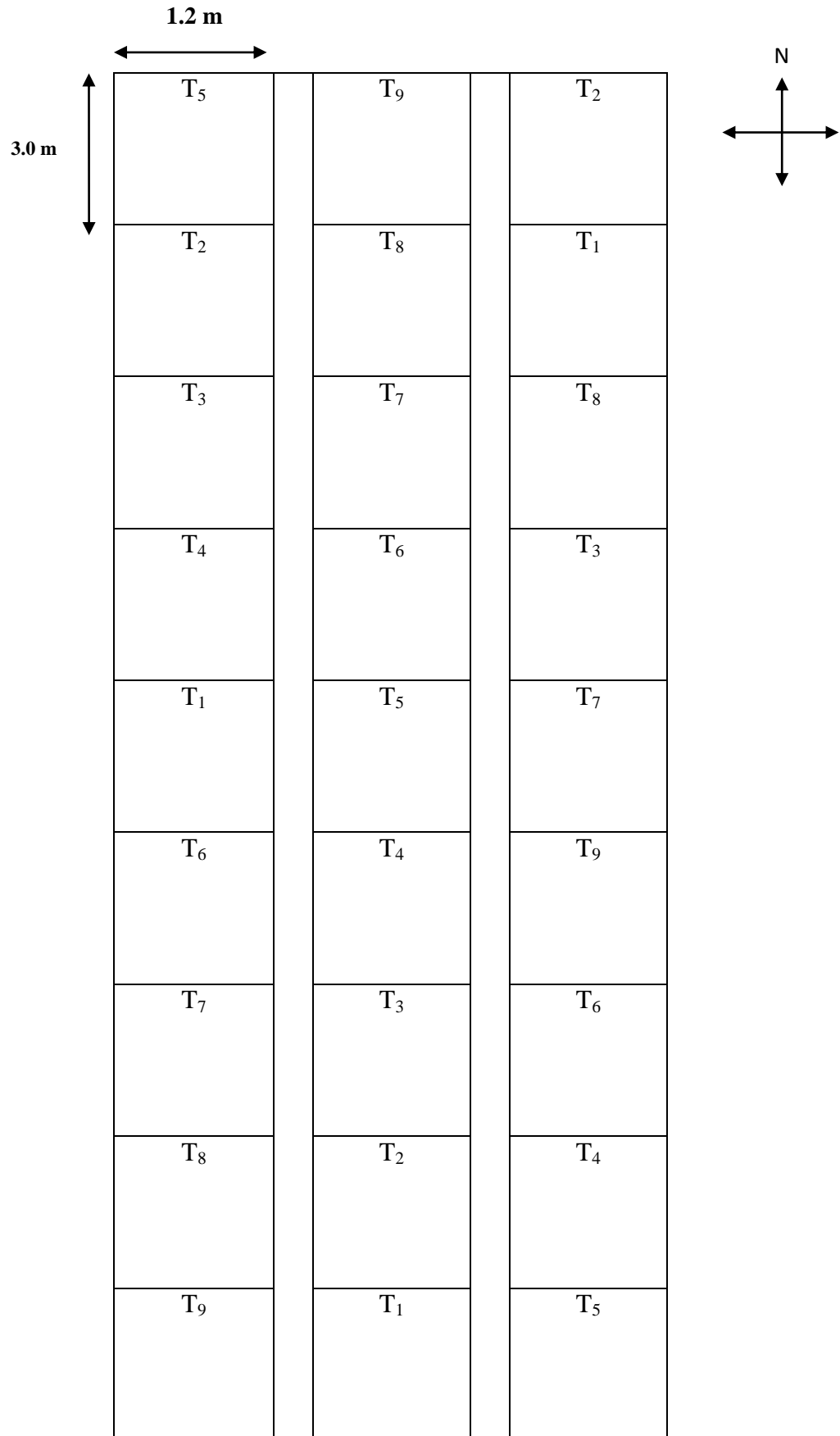
The experiment was laid out in Randomized Block Design with three replications at Vegetable Research Farm, Banda University of Agriculture and Technology, Banda. Each treatment considers of 12 plants in 20 rows, in the spacing of 15 x 10 cm during *Kharif* season. The suggested agronomical and plant protection practices were followed for the successful raising of crops.

#### 3.3.1 Detail of experiment

<b>Crop</b>	<b><i>Kharif</i> onion</b>
Name of variety	Line-883
Season and Year of field trial	<i>Kharif</i> season, 2022
Experimental design	Randomized Block Design (RBD)
Replications	3
Treatment	9
Plant spacing	15 x10 cm
No. of plots	27
Plot size	3.0 x 1.2m
DOT	24/08/2022



**General view of field experiment**



**Plan and Layout of the Experiment**

### **3.3.2.1 Nursery management for healthy seedlings**

The soil for nursery should be humus-rich, well-draining, deep friable, fertile, and rich in organic matter. It might be light loam, sandy loam, or clay loam. Three to four ploughings are necessary to achieve a fine tilth on the field. Before sowing, the nursery bed was irrigated for 15–20 days. To promote soil solarization, covered with 250-gauge transparent polythene. Use, of fungal culture of such as *Trichoderma viridae* @ 5 kg/ha to control damping off and raise the healthy nursery. The nursery bed prepared raised 15–20 cm above the ground. The nursery bed should have a width of 0.80 to 1.0 metre and a length of 3 to 4 metres. There should be between 60 and 75 cm between to each bed. The surface of the beds should be flat and smooth. To manage the damping-off disease, the seed should be treated with thiram @ 2 g/kg of seed. Onion seeds should be sown in lines at a proper spacing of 5-7 cm from row- to- row. The nursery was treated with captan or thiram at 4-5 g/m<sup>2</sup>. After seeding, cover the area with finely ground FYM or compost, and then lightly water it with a rose can. To keep the nursery beds at the proper temperature and moisture level, dry paddy straw should be used as a covering. Until germination is complete, watering should be done using a rose can as needed. When germination has finished, mulching materials are removed. Stomp (Pendimethalin 30 EC) @ 2.5 l/ha or Goal (Oxyfluorfen 23.5%EC) @ 600 ml/ha can be applied even 15-20 days before sowing to manage the weeds economically or spray of Oxyfluorfen 2.5 ml + fusolfop ethyl 5 ml in 15 litre of water after 20 days of seed sowing followed by spray of calcium nitrate 3 g/l + copper oxy chloride 2.5 g/l control the weeds and check yellowing and tip burning of seedlings. When the seedlings are 0.6-0.9 cm in diameter and have been growing for 8-9 weeks, they are prepared for transplanting.



**Nursery bed preparation and seed sowing at experimental farms**





**Healthy seedlings of onion ready for transplanting**

### **3.3.2.2 Main field preparation**

By giving the field four ploughing with a proper gap between each, the field is ploughed to a fine tilth. The ploughing must be done by tractor-drawn implements or *deshi* plough. It must be shallow as maximum of the onion roots penetrate to a depth of not more than 5-6 cm. The planking must be completed for correct levelling. Unlevelled ground causes water logging at one point and no water at another. The water logging has a negative impact on the production and quality of bulbs. A bed is usually around 1.20 m wide. The length may vary depending to level of land but it is well to have small-sized beds for proper irrigation and other cultural practices. If beds are wider than 1.20 m, enter in bed for weeding and hoeing as also topdressing or plant protection resulting in injury to plants. The width of the beds should allow for intercultural operations to be set up while sitting on the bunds.



**Field preparation and layout**

### **3.3.2.3 Seedling treatment before uprooting and transplanting**

To prevent root damage or harm, light irrigation is performed before uprooting of onion seedlings in nursery beds. One application of fungicides like Propineb @ 0.2%, Mancozeb @ 0.25%, or Chlorothalonil @ 0.2% can stop the transmission of foliar diseases like stemphylium blight and purple blotch (*Alternaria porri*) from the onion nursery to the main field. Before transplanting, cut the tip portion of the seedling and soak it for 10 minutes in a 0.1% Bavistin solution to help the seedlings establish themselves well and prevent from the infection of soil borne diseases viz., basal rot (*Fusarium oxysporum*) and white rot (*Sclerotium rolfsii*) in (*Sclerotium rolfsii*) in the main field.



**Transplanting of seedlings at main field**

**3.3.3 Irrigation**

Drip irrigation was used to provide irrigation when it was required to harvest high-quality bulbs.

**3.3.4 Intercultural operations**

The experimental plot was saved weed free. Hand weeding was done as and when needed. Weeding was done with one hand. Trizophos 0.1%, Propenophos 0.2%, and Redomil were sprayed on the crop to protect it from pests and disease while it was growing



**Hand weeding of experimental field**

### **3.3.5 Plant protection**

The crop was sprayed with to have the crop free from diseases and pest during growth period.

### **3.3.6 Nutrient management**

Nutrient management was applied as per treatment, however, the sources of fertilizer treatments used were FYM, Urea, DAP, MOP, Bentonite, PSB, NPK consortia, Trichoderma, and Azotobacter. The amount of manure and fertilizer was calculated and administered during sowing time. Fertilizers were applied 5-6 cm apart from the row lines, and the basal application of DAP and MOP were used. In addition, enriched FYM was used as per the treatment. Here as per the treatment we take, bulked FYM on a dry weight basis and then divided it into 12 parts, each part of FYM is treated with different bio fertilizers like Azotobacter, N.P.K consortia, PSB, and Trichoderma. The treated farmyard manure was cultured for 7 days in a shady place, once the cultured make their colonies and get developed then we mix them accordingly and made a bulk enriched farmyard manure that was added applied according to the treatment where necessary.



**Weighing of fertilizers**



**Measuring of biofertilizers**



**Mixing of biofertilizers in FYM**

### **3.3.7 Sampling**

A random selection of 10 plants was made in each plot, and the plants that were selected were tagged. The following observation was made using these tagged plants.

### **3.4 Observations**



**Observations recorded**



**Estimation of TSS**



**Estimation of dry matter**

### **3.4.1 Growth and yield parameters**

#### **3.4.1.1 Plant stands at maturity**

The total number of plants stand calculated when leaves curved yellow and tops falling or at the time of maturity of the crops.

#### **3.4.1.2 Plant height (cm) at 30, 60 and 75 days after transplanting**

The plant height was measured from ground level to the tip of the longest leaf vertically at 30, 60 and 75 days after transplanting with support of meter scale. The mean of ten plants in all the plots was operated and it was expressed in centimetres (cm).

#### **3.4.1.3 Number of leaves per plant at 30, 60 and 75 days after transplanting**

The numbers of entirely grown, green and photo synthetically active leaves were noted and the average number of leaves per plant was operated from the ten randomly selected plants at 30, 60 and 75 days after transplanting and expressed in numbers.

#### **3.4.1.4 Neck thickness (cm) at 30, 60 and 75 days after transplanting**

The neck thickness below the joint of leaf lamina was measured with the help of vernier callipers and the measurements were expressed in centimetre's (cm). The observations were recorded from all the ten plants in all the plots at 30, 60 and 75 days after transplanting and be around to get the mean values.

#### **3.4.1.5 Equatorial bulb diameter (cm)**

The equatorial bulb diameter was measured with the help of vernier callipers and expressed in centimetres (cm).

#### **3.4.1.6 Polar bulb diameter (cm)**

The length between two polar ends of the bulb was observed with the help of vernier callipers and the mean diameter was worked out from all the ten bulbs in each plot at harvest. It was expressed in centimetres (cm).

#### **3.4.1.7 P: E ratio**

This is the ratio of polar and equatorial bulbs calculated by after taking polar bulb diameter and equatorial bulb diameter.

#### **3.4.1.8 20 Bulbs weight (kg)**

By recording the 20 bulbs weight randomly selected twenty bulbs from each plot (big, medium and small). The weight of 20 bulbs was operated in kilogram.

#### **3.4.1.9 Average bulb weight (g)**

The total weight of 20 bulbs divided by the twenty it expressed average fresh weight bulb and was calculated and stated in grams (g).

#### **3.4.1.10 Double percentage on number basis**

The bulbs having splits or doubles were noted after the harvest in number basis. At that time the percentage of doubles/splits was worked out for each plot.

#### **3.4.1.11 Bolter percentage on number basis**

The bolting percentage was noted by counting the number of bolted plants before harvesting.

#### **3.4.1.12 Rotten percentage at number basis**

The rotten bulbs were calculated after just harvesting from each treatment and percentage of rotten bulbs of trial.

#### **3.4.1.13 Gross yield (kg/plot)**

The total gross bulb yield was noted after curing and neck cutting of harvest onion. The yield in kilogram per plot was calculated.

#### **3.4.1.14 Gross yield (q/ha)**

The total gross bulb yield was recorded after curing and neck cutting of harvest onion crop. The gross yield per hectare was calculated from the yield obtained per plot.

#### **3.4.1.15 Marketable yield (kg/plot)**

The sum total weight of A, B and C grade bulbs was considered as total marketable weight of marketable bulbs. Weight of marketable bulbs was noted separately and yield was calculated.

#### **3.4.1.16 Marketable yield (q/ ha)**

The bulbs were sorted in four grades giving to their size. Among them, grades A, B and C were taken as marketable bulbs, whereas, grade D bulbs were considered as

undersized bulbs. The marketable bulb yield of all treatments in each replication was recorded on net plot basis and the mean value was calculated as marketable bulb yield in q/ha.

#### **3.4.1.17 Days to maturity at 60-70% neck fall**

For recording maturity, number of days taken from transplanting when 60-70 % neck fall happened of the population in each plot or leaf yellowing stage was considered.



**Treatment wise harvesting**

#### **3.4.1.18 Days to harvesting**

The total number of days taken from the date of transplanting to the harvesting was calculated.

#### **3.4.1.19 Thrips per plant at 60 days after transplanting**

The counting of thrips randomly selected 10 plants with the support of hand lance between two leaves of the plants. And average of ten plants added in numbers.

#### **3.4.1.20 Stemphylium blight (intensity %)**

The disease intensity for Stemphylium blight is rated using 0-5 scale (Sharma, 1986)

0 - No disease symptom

- 1- A limited spots towards tip covering 10 percent leaf area
- 2- Some purplish brown patches covering up to 20 percent of leaf area Materials and Methods 50
- 3- Some patches with paler outer zone covering up to 40 percent leaf area
- 4- Leaf streaks covering up to 75 percent leaf area or breaking of the leaves from centre

5- Whole drying of the leaves or breaking of leaves from centre.

**3.4.1.21 Colour of bulbs**

Dark red colour of bulbs

**3.4.1.22 Total soluble solids (%)**

An onion bulb that was fully matured was chosen, and its juice was extracted at room temperature. A drop of juice was applied to the prism displayed in the hand refract meter. Using a hand refractor meter with a reading range of 0 to 30 Brix, TSS analysis was performed. The total soluble solids content of the bulb was calculated by averaging the TSS values for each of the ten onion bulbs for each treatment. The value was given as percentage.

**3.4.1.23 Dry matter content (%) (Oven dry method):**

Using a stainless-steel knife, five randomly chosen plants were removed after being transplanted from the third row on either side of the plot. A fresh sample with a known weight was held in a hot air oven at 60°C until the weight remained constant. Dry plant weights were measured and represented as g plant<sup>-1</sup>.

**3.5 Chemical analysis of soil:**

Before transplanting the experimental crop, soil samples were taken at random from a depth of 0 to 15 cm. After the samples were taken, they were bulked and a composite sample was drawn; this composite sample was maintained for laboratory analysis of soil characteristics, particularly pH, EC, OC, NPK and Sulphur. The composite samples were first drawn, then crushed into small, fine-textured soil particles and sieved through a 2 mm sieve.



**Estimation of available Nitrogen**



**Estimation of Available Potassium**

### **3.5.1 Soil pH (before sowing and after harvesting)**

The method described by Piper in 1966 was used to measure the pH of the soil using a Blackman glass electrode pH meter in a 1:25 soil: water suspension at 25°C.

### **3.5.2 Soil Ec (before sowing and after harvesting)**

According to Piper (1966), the conductivity of soil was measured using a conductivity meter in a 1:25 soil-to-water suspension at 25°C.

### **3.5.3 Organic carbon (before sowing and after harvesting)**

The organic carbon content of soil was estimated by Walkely and Black's wet oxidation method as described by Walkely and Black's (1966).

### **3.5.4 Available nitrogen ( $\text{kg ha}^{-1}$ ) (before sowing and after harvesting)**

It was estimated by using alkaline permanganate method as suggested by Subbiah and Asija (1956).

### **3.5.5 Available phosphorus ( $\text{kg ha}^{-1}$ ) (before sowing and after harvesting)**

The Olsen method, which Jackson (1967) described, was used to determine the available phosphorus concentration.

### **3.5.6 Available potassium ( $\text{kg ha}^{-1}$ ) (before sowing and after harvesting)**

According to Jackson (1967), the Available potassium concentration was measured by extraction with a flame photometer (ELICO Model) and a neutral normal ammonium acetate solution.

### **3.5.7 Available Sulphur ( $\text{kg ha}^{-1}$ ) (before sowing and after harvesting)**

It was determined by turbidimetric method given by Chopra and Kanwar (1976).

## **3.6 Economic parameter**

There are many different economic indices available to evaluate cropping system profitability. A variety of indices is used to evaluate the economic impact and the system's viability because no single statistic can effectively compare various treatments. Since then, the price of agricultural goods has changed from year to year, causing changes in the system's profitability from season to season and location to location. The procedures for determining the economics of various conditions the suggested treatments were suggested by Yang et al. (1989).

### **3.6.1 Gross return ( $\text{Rs ha}^{-1}$ )**

Gross return is the total value of economic produce obtained from the crop raised in the different treatments, which is calculated based on the local market prices.

### **3.6.2 Total cost of cultivation ( $\text{Rs ha}^{-1}$ )**

The whole cost of cultivation in a treatment is the total amount expended on growing the crop, Labour, a tractor for ploughing, harrowing, and planking, as well as the cost of seeds, fertilizers, and irrigation charges, are all involved in this expenditure.

### **3.6.3 Net return ( $\text{Rs ha}^{-1}$ )**

Net return calculated by taking total cultivation costs from gross revenue. It is a moral forecaster of a crop's correctness because it shows the farmer's actual income with the use of current economic returns; economic returns for several therapies were computed. In the tests, different inputs and market rates of produce were used.

Net Returns ( $\text{Rs ha}^{-1}$ ) = Gross return ( $\text{Rs ha}^{-1}$ ) – Total Cost of cultivation ( $\text{Rs ha}^{-1}$ )

**3.6.4 Benefit cost ratio**

It is the ratio of net return to total cost of cultivation. The following formula was used for calculating the benefit cost ratio.

$$\text{Benefit-Cost Ratio (B: C)} = \frac{\text{Net Return (Rs ha}^{-1}\text{)}}{\text{Cost of Cultivation (Rs ha}^{-1}\text{)}}$$

**3.7 Statistical analysis**

The data obtained from set of observation for each character were subjected to “Analysis of Variance” as advocated by Panse and Sukhatme (1984). The Skeleton of ANOVA as per design is as given in Table 3.7.1

**Skeleton of analysis of variance**

The data have been presented in the form of summary tables with mean values of the characters and C.D. at 5% level of probability.

**3.7.1 Skeleton of analysis of variance (ANOVA)**

Sources of variation	Degree off freedom	Sum of square	Mean sum of square	Calculated F value	F table value at 5% level of significance
Replication	r-1	RSS	RMS=RSS	RMS/EMS	
Treatment	t-1	TSS	TSS=TSS	TMS/EMS	
Error	(t-1) (r-1)	ESS	EMS=ESS		
Total	rt-1				

The significance of the treatment difference was judged by using critical difference (C.D.), which was calculated by using formula given by Panse and Sukhatme (1984).

**A. Standard error of mean (SEm±)**

$$S. Em. \pm = \sqrt{EMS / \text{no. of replication}}$$

Critical difference (CD)

Were,

$$CD = S_{em} \pm \times \sqrt{2 \times t_{5\%} (edf)}$$

EMS = Error mean some of squares

R = Replications

t5% (edf) = Table value at error degree of freedom

S. Em.  $\pm$  = Standard error of mean CD = Critical differences

CD = Critical differences



## RESULTS

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This chapter embodies the results of the present investigation entitled “Performance of *Kharif* onion under organic and inorganic fertilizer nutrient level” conducted during *kharif* season with nine treatments. The results pertaining to various growth, yield and quality characters with economics as influenced by different levels of combination of organic and inorganic bio fertilizers application along with statistical inferences are presented through respective tables and graphs wherever found necessary, in this chapter under following major heads:

### 4.1 GROWTH PARAMETERS

#### 4.1.1 Plant height (cm) at 30, 60 and 75 DAT

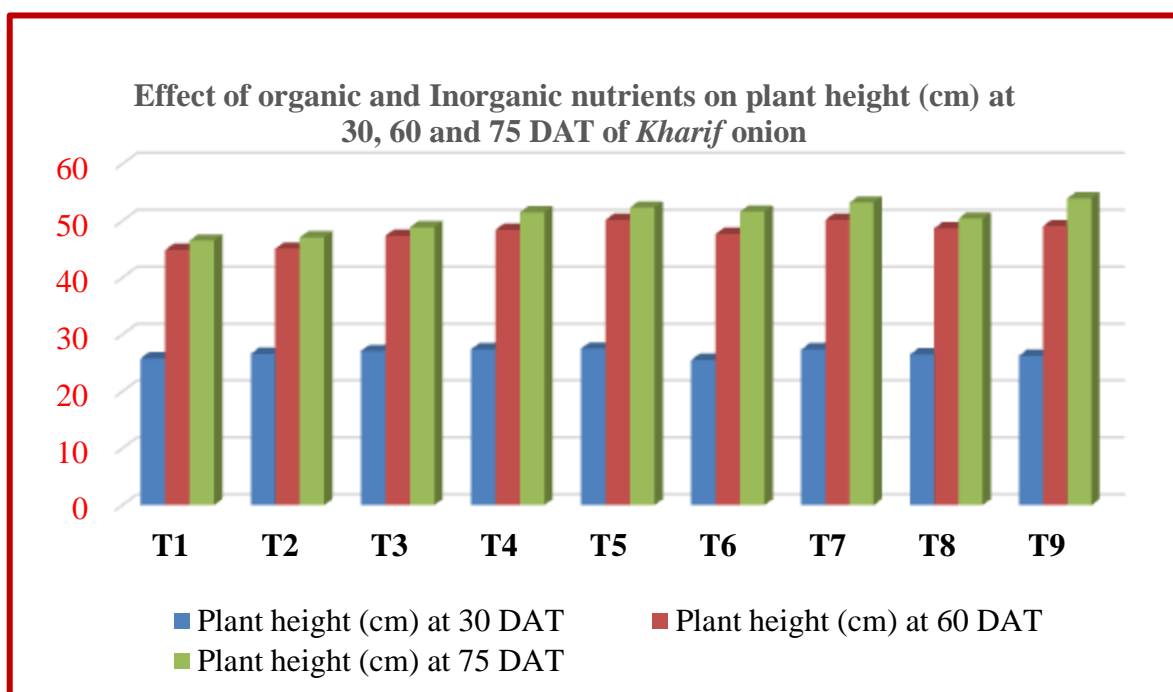
The plant height of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.1. Plant height was recorded at 30, 60 and 75 days after transplanting and its graphical presentation of 30, 60 and 75 days after transplanting presented in table- 4.1.

The maximum plant height at 30 days after transplanting (27.53cm) was recorded in treatment T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha and showed non-significant differences. However, the minimum plant height (25.53 cm) was recorded in treatment T<sub>6</sub>-20 tones enriched FYM. The significantly maximum plant height at 60 days after transplanting (50.17cm) was recorded in both treatment T<sub>5</sub>-NPKS:150-50-60-70 kg/ha and T<sub>7</sub>-75% RDN + 5 tons enriched FYM, and it was at par with T<sub>9</sub>-25 % RDN + 15 tons enriched FYM (49.07 cm), T<sub>8</sub>-50 % RDN + 10 tons enriched FYM (48.67 cm), T<sub>4</sub>-NPKS:140-50-60-50 kg/ha (48.43 cm), T<sub>6</sub>-20 tones enriched FYM (47.70 cm) and T<sub>3</sub>-NPKS:120-50-50-40 kg/ha (47.38 cm). The minimum plant height (44.87 cm) was recorded in treatment T<sub>1</sub>-Farmers practice (NPKS: 70-40-40-0 Kg/ha).

The significantly maximum plant height at 75 days after transplanting (53.93 cm) was recorded in treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM, while the minimum plant height (46.53 cm) was recorded in treatment T<sub>1</sub>-Farmers practice NPKS: 70-40-40-0 kg/ha. Among the treatment of organic and inorganic nutrients applied the highest plant height at 75 days after transplanting (53.93 cm) was recorded with treatment T<sub>9</sub>-(25 % RDN + 15 tons enriched FYM) and it was at par with, T<sub>7</sub>-75 % RDN + 5 tons enriched FYM (53.20 cm), T<sub>5</sub>- NPKS: 150-50-60-70 kg/ha (52.33 cm), T<sub>6</sub>- 20 tones enriched FYM (51.63 cm) and T<sub>4</sub>- NPKS:140-50-60-50 kg/ha. (51.50 cm).

**Table 4.1 Effect of organic and Inorganic nutrients on plant height (cm) at 30, 60 and 75 DAT of *Kharif* onion**

Notation	Treatments	Plant height(cm)		
		30 DAT	60 DAT	75 DAT
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	25.83	44.87	46.53
T2	Recommended NPKS:100-50-50-30 kg/ha	26.60	45.10	47.07
T3	NPKS:120-50-50-40 kg/ha	27.10	47.38	48.87
T4	NPKS:140-50-60-50 kg/ha	27.40	48.43	51.50
T5	NPKS:150-50-60-70 kg/ha	27.53	50.17	52.33
T6	20 tones EFYM	25.53	47.70	51.63
T7	75 % RDN+5 tons enriched FYM	27.37	50.17	53.20
T8	50% RDN+10 tones enriched FYM	26.50	48.67	50.40
T9	25% RDN+ 15 tones enriched FYM	26.27	49.07	53.93
SEM±		0.75	1.19	1.47
C.D. (0.05)		N/S	3.58	4.40
CV		4.85	4.31	5.02



**Fig. 4.1 Effect of organic and Inorganic nutrients on plant height (cm) of *Kharif* onion**

**4.1.2 Number of leaves per at 30, 60 and 75 DAT**

The number of leaves per plant of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.2. Number of leaves per plant was recorded at 30, 60 and 75 days after transplanting and its graphical presentation of 30, 60 and 75 days after transplanting of *Kharif* onion presented in 4.2.

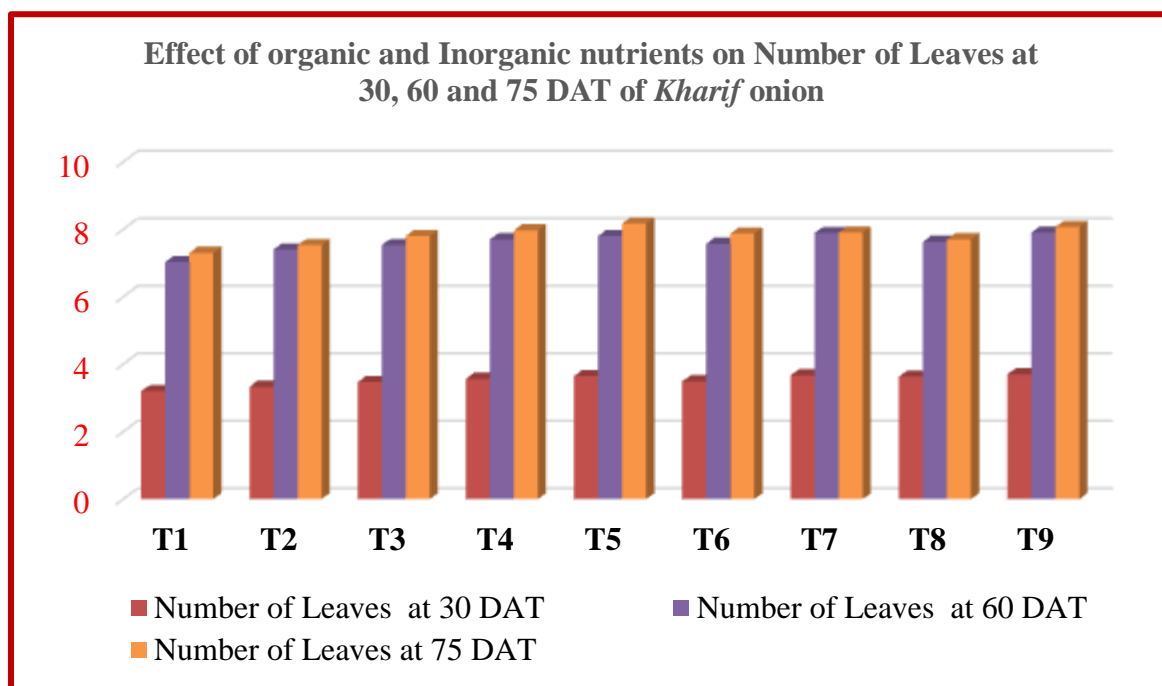
The non-significantly maximum number of leaves per plant at 30 days after transplanting (3.70) was recorded in treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM, while the minimum number of leaves (3.20) was recorded in treatment T<sub>1</sub>-Farmers practice: (NPKS:70-40-40-0 kg/ha). Among the treatment of organic and inorganic nutrients applied the highest number of leaves per plant at 30 days after transplanting (3.70) was recorded with treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM and was at par with, T<sub>7</sub>-75 % RDN + 5 tons enriched FYM (3.67), T<sub>5</sub>-NPKS:150-50-60-70 kg/ha (3.65), T<sub>8</sub>-50 % RDN + 10 tons enriched FYM (3.63), T<sub>4</sub>-NPKS:140-60-60-50 kg/ha (3.57), T<sub>6</sub>-20 tons enriched FYM (3.49) and T<sub>3</sub>-NPKS:150-50-60-70 kg/ha (3.47).

The significantly maximum number of leaves per plant at 60 days after transplanting (7.90) was recorded in treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM and it was at par with T<sub>7</sub>-75% RDN +5 tons enriched FYM (7.89), T<sub>5</sub>-NPKS:150-50-60-70 kg/ha (7.80), T<sub>4</sub>-NPKS:140-50-60-50 kg/ha (7.70), T<sub>8</sub>-50 % RDN + 10 tons enriched FYM (7.63) and T<sub>6</sub>-20 tons enriched FYM (7.57). The minimum number of leaves per plant (7.03) was recorded in treatment T<sub>1</sub>-Farmers practice NPKS: 70-40-40-0 kg/ha.

The significantly maximum number of leaves per plant at 75 days after transplanting (8.17) was recorded in treatment T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha, while the minimum number of leaves (7.30) was recorded in treatment T<sub>1</sub>-Farmers practice: NPKS: 70-40-40-0 kg/ha. Among the treatment of organic and inorganic nutrients applied the highest number of leaves per plant at 75 days after transplanting (8.17) was recorded with treatment T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha. It was at par with, T<sub>9</sub>-25 % RDN + 15 tons enriched FYM (8.07), T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha. (7.97), T<sub>7</sub>-75 % RDN + 5 tons enriched FYM (7.90) and T<sub>6</sub>-20 tons enriched FYM (7.87) and T<sub>3</sub>-NPKS: 120-50-50-40 kg/ha. (7.80).

**Table 4.2 Effect of organic and Inorganic nutrients on Number of Leaves at 30, 60 and 75 DAT of *Kharif* onion**

Notation	Treatments	Number of Leaves		
		30 DAT	60 DAT	75 DAT
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	3.20	7.03	7.30
T2	Recommended NPKS:100-50-50-30 kg/ha	3.33	7.40	7.53
T3	NPKS:120-50-50-40 kg/ha	3.47	7.53	7.80
T4	NPKS:140-50-60-50 kg/ha	3.57	7.70	7.97
T5	NPKS:150-50-60-70 kg/ha	3.65	7.80	8.17
T6	20 tones EFYM	3.49	7.57	7.87
T7	75 % RDN+5 tons enriched FYM	3.67	7.89	7.90
T8	50% RDN+10 tones enriched FYM	3.63	7.63	7.70
T9	25% RDN+ 15 tones enriched FYM	3.70	7.90	8.07
SEM±		0.12	0.11	0.16
C.D. (0.05)		N/S	0.34	0.47
CV		6.13	2.56	3.49



**Fig. 4.2 Effect of organic and Inorganic nutrients on number of leaves of *Kharif* onion**

#### **4.1.3 Neck thickness (cm) at 30, 60 and 75 DAT**

Neck thickness (cm) of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.3. Neck thickness was recorded at 30, 60 and 75 days after transplanting and its graphical presentation of 30, 60 and 75 days after transplanting of *Kharif* onion presented in 4.3.

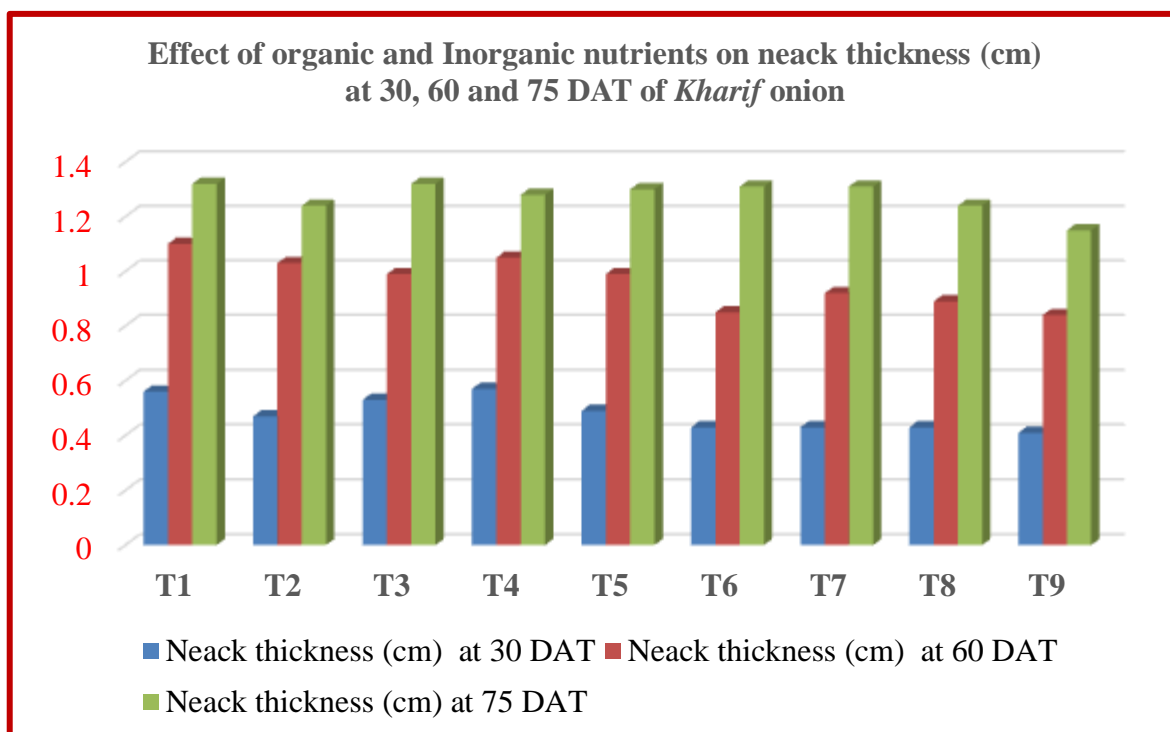
Significantly minimum neck thickness at 30 days after transplanting (0.41 cm) was recorded in treatment T<sub>9</sub>-25% RDN + 15 tons enriched FYM, while the maximum neck thickness (0.57 cm) was recorded in treatment T<sub>4</sub>-NPKS:140-50-60-50 kg/ha. Among the treatment of organic and inorganic nutrients applied the minimum neck thickness (cm) at 30 days after transplanting (0.41cm) was recorded with treatment T<sub>9</sub>-25% RDN + 15 tons enriched FYM. It was at par with, T<sub>6</sub>- 20 tons enriched FYM (0.43 cm), T<sub>7</sub>-75% RDN + 5 tons enriched FYM (0.43 cm), T<sub>8</sub>-50% RDN + 10 tons enriched FYM (0.43 cm) are same, T<sub>2</sub>- NPKS:100-50-50-30 kg/ha (0.47 cm), T<sub>5</sub>- NPKS:150-60-60-70 kg/ha (0.49 cm), T<sub>3</sub>- NPKS:120-50-50-40 kg/ha (0.53 cm) and T<sub>1</sub>- NPKS:70-54-40-30 kg/ha (0.56 cm).

Significantly minimum neck thickness at 60 days after transplanting (0.84 cm) was recorded in treatment T<sub>9</sub>-25% RDN + 15 tons enriched FYM, and was at par with, T<sub>6</sub>- 20 tons enriched FYM (0.85 cm), T<sub>8</sub>- 50% RDN+10 tons enriched FYM (0.89 cm), T<sub>7</sub>-75 % RDN + 5 tons enriched FYM (0.92 cm), T<sub>3</sub>- NPKS:120-50-50-40 kg/ha (0.99 cm), T<sub>5</sub>- NPKS:150-50-60-70 kg/ha (0.99 cm) and T<sub>2</sub>- NPKS:100-50-50-30 kg/ha (1.03 cm). However, the maximum neck thickness (1.10 cm) was recorded in treatment T<sub>1</sub>- NPKS: 70-40-40-0 kg/ha.

The non-significantly minimum neck thickness at 75 days after transplanting (1.15 cm) was recorded in treatment T<sub>9</sub>-25% RDN + 15 tons enriched FYM, while the maximum neck thickness (1.32 cm) was recorded the both treatments T<sub>1</sub>- NPKS: 70-40-40-0 kg/ha and T<sub>3</sub>- NPKS:120-50-50-40 kg/ha.

#### 4.3 Effect of organic and Inorganic nutrients on neck thickness at 30, 60 and 75 DAT of *Kharif* onion

Notation	Treatments	Neck thickness (cm)		
		30 DAT	60 DAT	75 DAT
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	0.56	1.10	1.32
T2	Recommended NPKS:100-50-50-30 kg/ha	0.47	1.03	1.24
T3	NPKS:120-50-50-40 kg/ha	0.53	0.99	1.32
T4	NPKS:140-50-60-50 kg/ha	0.57	1.05	1.28
T5	NPKS:150-50-60-70 kg/ha	0.49	0.99	1.30
T6	20 tones EFYM	0.43	0.85	1.31
T7	75 % RDN+5 tons enriched FYM	0.43	0.92	1.31
T8	50% RDN+10 tones enriched FYM	0.43	0.89	1.24
T9	25% RDN+ 15 tones enriched FYM	0.41	0.84	1.15
SEM±		0.02	0.04	0.05
C.D. (0.05)		0.07	0.12	N/S
CV		8.05	7.50	6.86



**Fig.4.3 Effect of organic and inorganic nutrients on neck thickness (cm) at 30, 60 and 75 DAT of *Kharif* onion**

## **4.2 Yield parameter**

### **Equatorial bulb Diameter (cm)**

Equatorial bulb diameter of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.4. The equatorial bulb Diameter was recorded after harvesting of *Kharif* onion and its graphical presentation of *Kharif* onion presented in 4.3. The non-significantly maximum equatorial bulb diameter that was taken after harvesting (5.95cm) was recorded in treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM, while the minimum equatorial bulb diameter (5.23cm) was recorded in treatment T<sub>4</sub>-NPKS:140-50-60-50 kg/ha.

### **Polar bulb diameter (cm)**

Polar bulb diameter of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.4. Polar bulb diameter was recorded after harvesting of *Kharif* onion. The graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.4.

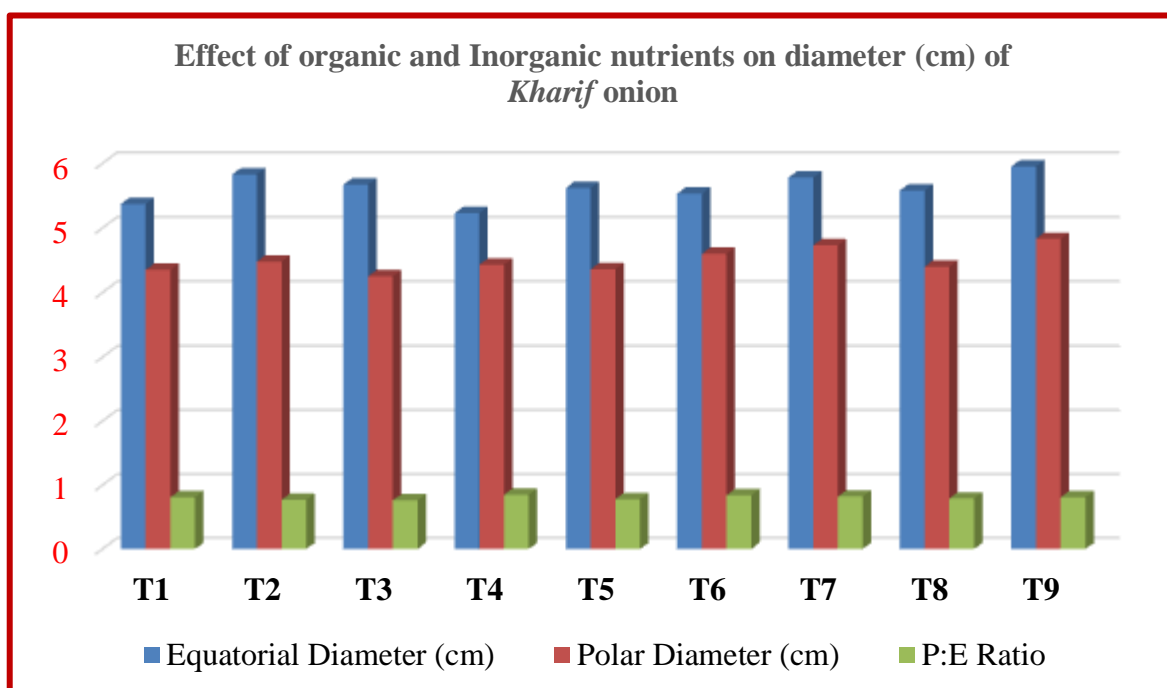
The significantly maximum polar bulb diameter that was taken after harvesting (4.83 cm) was recorded in treatment T<sub>9</sub>- 25 % RDN+15 tons enriched FYM, while the minimum polar bulb diameter (4.25 cm) was recorded in treatment T<sub>3</sub> .NPKS:120-50-50-40 kg/ha. Among the treatment of organic and inorganic nutrients applied the highest polar bulb diameter that was taken after harvesting (4.83 cm) was recorded with treatment T<sub>9</sub>- 25 % RDN + 15 tons enriched FYM and it showed at par with, T<sub>7</sub>- 75 % RDN +5 tons enriched FYM (4.73 cm) and T<sub>6</sub>- 20 tones enriched FYM (4.60 cm).

### **Polar: Equatorial bulb ratio**

P: E ratio of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.4. The graphical presentation that was taken after harvesting of *kharif* onion presented in 4.4. The non-significantly maximum P: E ratio that was taken after harvesting (0.85 cm) was recorded in treatment T<sub>4</sub>- NPKS: 140-50-60-50 kg/ha, while the minimum P: E ratio (0.76 cm) was recorded in treatment T<sub>3</sub> -NPKS: 120-50-50-40 kg/ha.

**Table 4.4 Effect of organic and Inorganic nutrients on equatorial, polar diameter (cm) and P: E ratio of *Kharif* onion**

Notation	Treatments	Diameter of onion (cm)		
		Equatorial Diameter (cm)	Polar Diameter (cm)	P: E Ratio
T1	Farmers practice (N-P-K-S) 70-40-40-0 kg/ha	5.37	4.35	0.81
T2	Recommended NPKS:100-50-50-30 kg/ha	5.83	4.48	0.77
T3	NPKS:120-50-50-40 kg/ha	5.67	4.25	0.76
T4	NPKS:140-50-60-50 kg/ha	5.23	4.43	0.85
T5	NPKS:150-50-60-70 kg/ha	5.62	4.36	0.78
T6	20 tones EFYM	5.53	4.60	0.84
T7	75 % RDN+5 tons enriched FYM	5.78	4.73	0.82
T8	50% RDN+10 tones enriched FYM	5.58	4.40	0.79
T9	25% RDN+ 15 tones enriched FYM	5.95	4.83	0.81
SEM±		0.20	0.10	0.04
C.D. (0.05)		N/S	0.29	N/S
CV		6.16	3.76	8.10



**Fig.4.4 Effect of organic and Inorganic nutrients on bulb diameter (cm) of *Kharif* onion**

**20 bulbs weight (kg)**

20 bulbs weight of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.5. The trait 20 bulbs weight was recorded after harvesting of *Kharif* onion and its graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.5.

The significantly maximum 20 bulb weight that was taken after harvesting (1.32 kg) was recorded in treatment T<sub>9</sub>- 25 % RDN +15 tons enriched FYM and it was at par with, T<sub>7</sub>- 75 % RDN +5 tons enriched FYM (1.27 kg) and T<sub>2</sub> -NPKS:100-50-50-30 kg/ha (1.21 kg). However, the minimum 20 bulbs weight (1.00 kg) was recorded in treatment T<sub>4</sub> - NPKS: 140-50-60-50 kg/ha.

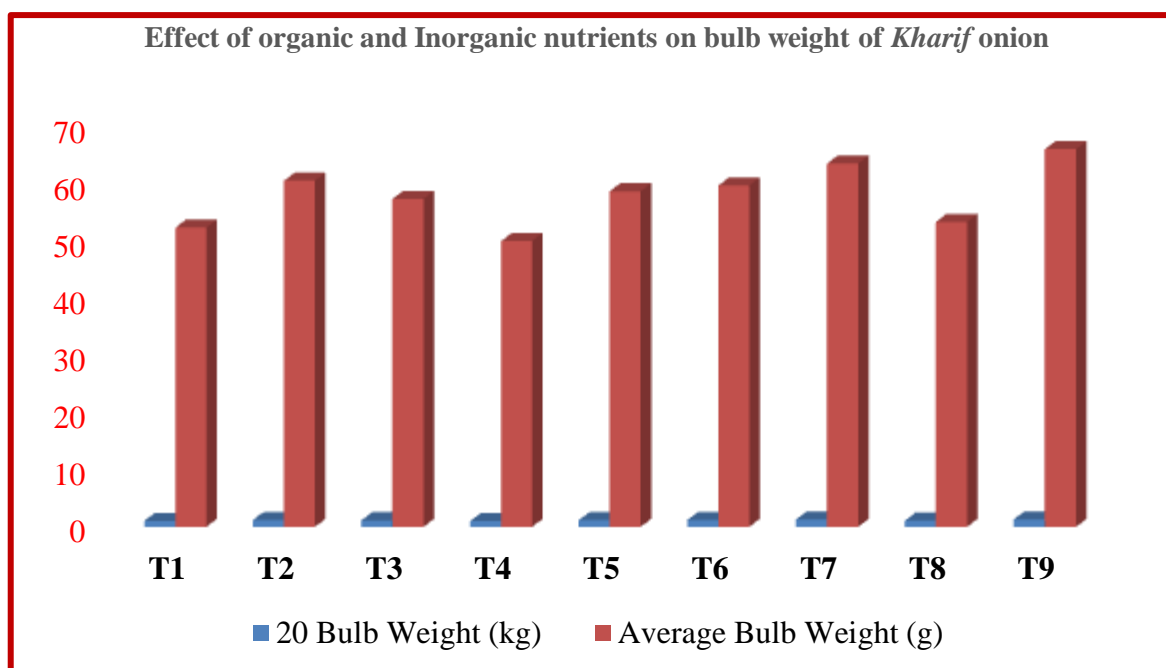
**Average bulb weight (g)**

Average bulb weight of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.5. The graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.5.

The significantly maximum average bulb weight that was taken after harvesting (66.00g) was recorded in treatment T<sub>9</sub>- 25% RDN + 15 tons enriched FYM, while the minimum average bulb weight (50.00 g) was recorded in treatment T<sub>4</sub>-NPKS:140-50-60-50 kg/ha. Among the treatment of organic and inorganic nutrients applied the highest average bulb weight that was taken after harvesting (66.00 g) was recorded with treatment T<sub>9</sub>- 25 % RDN + 15 tons enriched FYM and was at par with, T<sub>7</sub>- 75 % RDN + 5 tons enriched FYM (63.50 g) and T<sub>2</sub>-NPKS:100-50-50-30 kg/ha (60.50 g).

Table 4.5 Effect of organic and Inorganic nutrients on bulb weight of *Kharif* onion

Notation	Treatments	Bulb weight of onion	
		20 Bulb weight (kg)	Average bulb weight (g)
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	1.05	52.33
T2	Recommended NPKS:100-50-50-30 kg/ha	1.21	60.50
T3	NPKS:120-50-50-40 kg/ha	1.15	57.33
T4	NPKS:140-50-60-50 kg/ha	1.00	50.00
T5	NPKS:150-50-60-70 kg/ha	1.17	58.67
T6	20 tones EFYM	1.19	59.67
T7	75 % RDN+5 tons enriched FYM	1.27	63.50
T8	50% RDN+10 tones enriched FYM	1.07	53.33
T9	25% RDN+ 15 tones enriched FYM	1.32	66.00
SEM±		0.04	1.92
C.D.(0.05)		0.12	5.75
CV		5.74	5.74

Fig.4.5. Effect of organic and Inorganic nutrients on bulb weight of *Kharif* onion

**Number of double bulbs**

Number of double bulbs of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.6. The number of double bulbs was recorded after harvesting of *Kharif* onion and its graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.6.

The significantly minimum number of double bulbs taken after harvesting of *Kharif* onion (2.33) was recorded in treatments T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha, T<sub>7</sub>- 75% RDN + 5 tons enriched FYM., T<sub>8</sub>- 50 % RDN+ 10 tons enriched FYM and T<sub>9</sub>- 25 % RDN + 15 tons enriched FYM, while the maximum number of double bulbs (4.33) was recorded the treatment T<sub>5</sub>-NPKS:150-50-60-70 kg/ha. Among the treatment of organic and inorganic nutrients applied the minimum number of double bulbs (2.33) was recorded with treatment T<sub>4</sub>, T<sub>7</sub>, T<sub>8</sub> and T<sub>9</sub>. It was at par with, T<sub>2</sub>- NPKS: 100-50-50-30 kg/ha (3.00) and T<sub>1</sub>- NPKS: 70-40-40-30-0 kg/ha (3.67), T<sub>3</sub>- NPKS: 120-50-50-40 kg/ha (3.67).

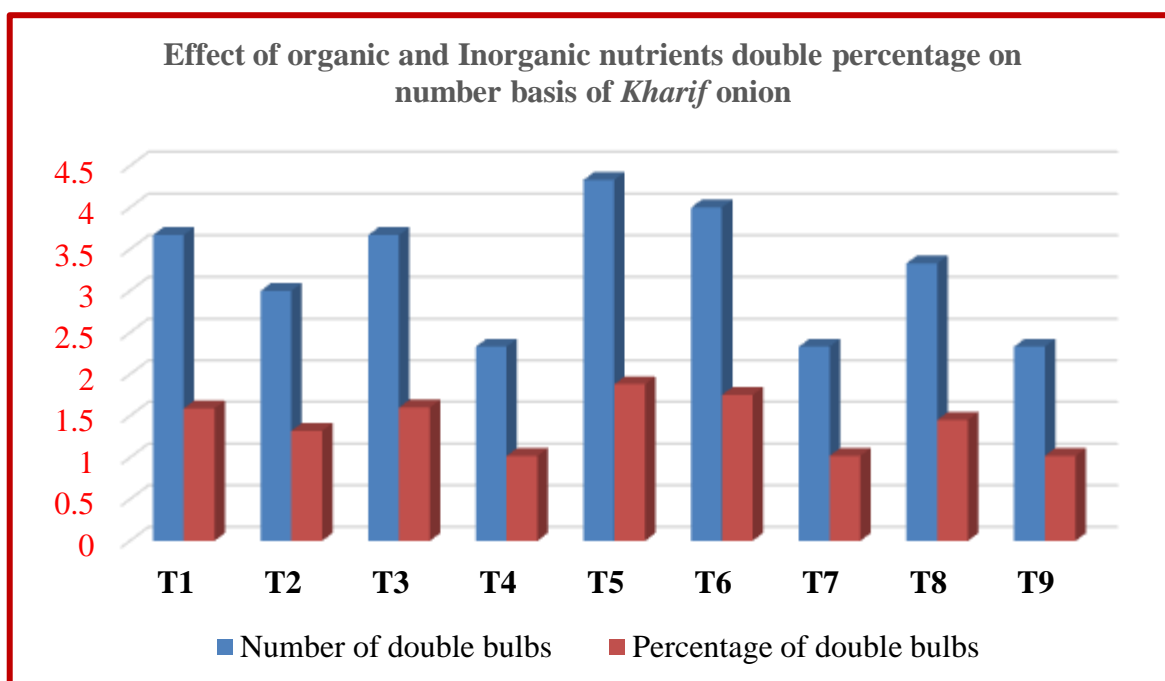
**Percentage of double bulbs**

Percentage double bulbs on number basis of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.6. Percentage of double bulbs on number basis was recorded after harvesting of *Kharif* onion. The graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.6.

The significantly minimum percentage of double bulbs on number basis taken after harvesting of *Kharif* onion (1.02) was recorded in treatments T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha, T<sub>7</sub>-75 % RDN +5 tons enriched FYM and T<sub>9</sub>-25% RDN + 15 tons enriched FYM. The maximum percentage of double bulbs on number basis (1.88) was recorded the treatment T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha. Among the treatment of organic and inorganic nutrients applied the minimum percentage of double bulbs on number basis (1.88) was recorded with treatment T<sub>4</sub>, T<sub>7</sub> and T<sub>9</sub> and it was at par with T<sub>2</sub>-NPKS: 100-50-50-30 kg/ha (1.32), T<sub>8</sub>-50 % RDN + 10 tons enriched FYM (1.45) and T<sub>1</sub>- NPKS: 70-40-30-0 kg/ha (1.32).

#### 4.6 Effect of organic and Inorganic nutrients double percentage on number basis of *Kharif* onion

Notation	Treatments	Double % on number basis	
		Number of double bulbs	Percentage of double bulbs
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	3.67	1.59
T2	Recommended NPKS:100-50-50-30 kg/ha	3.00	1.32
T3	NPKS:120-50-50-40 kg/ha	3.67	1.60
T4	NPKS:140-50-60-50 kg/ha	2.33	1.02
T5	NPKS:150-50-60-70 kg/ha	4.33	1.88
T6	20 tones EFYM	4.00	1.75
T7	75 % RDN+5 tons enriched FYM	2.33	1.02
T8	50% RDN+10 tones enriched FYM	3.33	1.45
T9	25% RDN+ 15 tones enriched FYM	2.33	1.02
SEM		0.38	0.17
C.D.(0.05)		1.15	0.52
CV		20.69	21.27



**Fig.4.6. Effect of organic and Inorganic nutrients double percentage on number basis of *Kharif* onion**

**Number of bolters**

Number of bolters of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.7. Number of bolters was recorded after harvesting of *Kharif* onion. The graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.7.

The significantly minimum bolters bulbs taken after harvesting of *Kharif* onion (2.33) was recorded in treatments T<sub>7</sub>-75 % RDN + 5 tons enriched FYM and T<sub>9</sub>- 25 % RDN + 15 tons enriched FYM, while the maximum number of bolters (4.67) was recorded the treatment T<sub>3</sub>-NPKS: 120-50-50-40 kg/ha. Among the treatment of organic and inorganic nutrients applied the minimum number of bolters (2.33) was recorded with treatment T<sub>7</sub> and T<sub>9</sub>. It was at par with, T<sub>1</sub>- NPKS: 100-40-40-0 kg/ha (3.00), T<sub>6</sub>- 20 tons enriched FYM (3.00) and T<sub>8</sub>. 50 % RDN + 10 tons enriched FYM (3.33), T<sub>2</sub>- Recommended NPKS:100-50-50-30 kg/ha (4.00) and T<sub>4</sub>- NPKS:140-50-60-50 kg/ha (4.33).

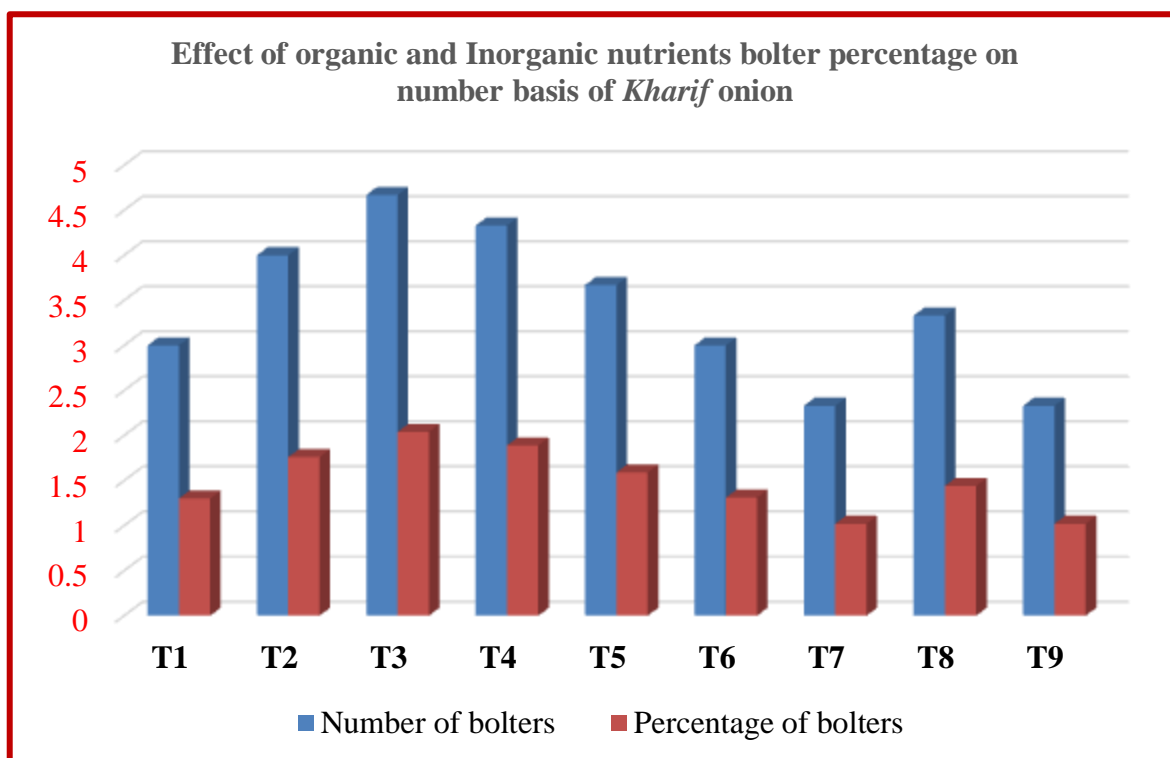
**Percentage of bolters on number basis**

Percentage of bolters of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.7. Percentage of bolters was recorded after harvesting of *Kharif* onion. The graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.7.

Significantly minimum percentage of bolters taken after harvesting of *Kharif* onion (1.02) was recorded in treatments T<sub>7</sub>-75% RDN + 5 tons enriched FYM and T<sub>9</sub>-25% RDN + 15 tons enriched FYM and it was at par with, T<sub>1</sub>-NPKS:100-40-40-0 kg/ha (1.30), T<sub>6</sub>-20 tones enriched FYM. (1.31), T<sub>8</sub>-50% RDN + 10 tons enriched FYM (1.44), T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha (1.59) and T<sub>2</sub>-NPKS: 100-50-50-30 kg/ha (1.76). While the maximum percentage of bolters (2.04) was recorded the treatment T<sub>3</sub>-NPKS: 140-50-60-50 Kg/ha.

**Table 4.7 Effect of organic and Inorganic nutrients bolter percentage on number basis of *Kharif* onion**

Notation	Treatments	Bolter % on number basis	
		Number of bolters	Percentage of bolters
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	3.00	1.30
T2	Recommended NPKS:100-50-50-30 kg/ha	4.00	1.76
T3	NPKS:120-50-50-40 kg/ha	4.67	2.04
T4	NPKS:140-50-60-50 kg/ha	4.33	1.89
T5	NPKS:150-50-60-70 kg/ha	3.67	1.59
T6	20 tones EFYM	3.00	1.31
T7	75 % RDN+5 tons enriched FYM	2.33	1.02
T8	50% RDN+10 tones enriched FYM	3.33	1.44
T9	25% RDN+ 15 tones enriched FYM	2.33	1.02
SEM±		0.42	0.19
C.D.(0.05)		1.27	0.56
CV		21.51	21.81



**Fig.4.7. Effect of organic and Inorganic nutrients on bolter percentage on the number basis of *Kharif* onion**

**Number of rotten bulbs**

Number of rotten bulbs of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.8 and its graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.8.

Non-significantly nil number of rotten bulbs taken after harvesting of *Kharif* onion (00.0) was recorded in treatments T<sub>1</sub>-NPKS:70-40-40-0 kg/ha, T<sub>3</sub>-NPKS:120-50-50-40 kg/ha, T<sub>4</sub>-NPKS:140-50-60-50 kg/ha, T<sub>5</sub>-NPKS:150-50-60-70 kg/ha, T<sub>6</sub>-20 tons enriched FYM, T<sub>9</sub>-25% RDN +15 tons enriched FYM while the maximum number of rotten bulbs (0.33) was recorded the treatment T<sub>2</sub>-NPKS:100-50-50-30 kg/ha, T<sub>7</sub>- 75% RDN +5 tons enriched FYM and T<sub>8</sub>-50% RDN +10 tons enriched FYM.

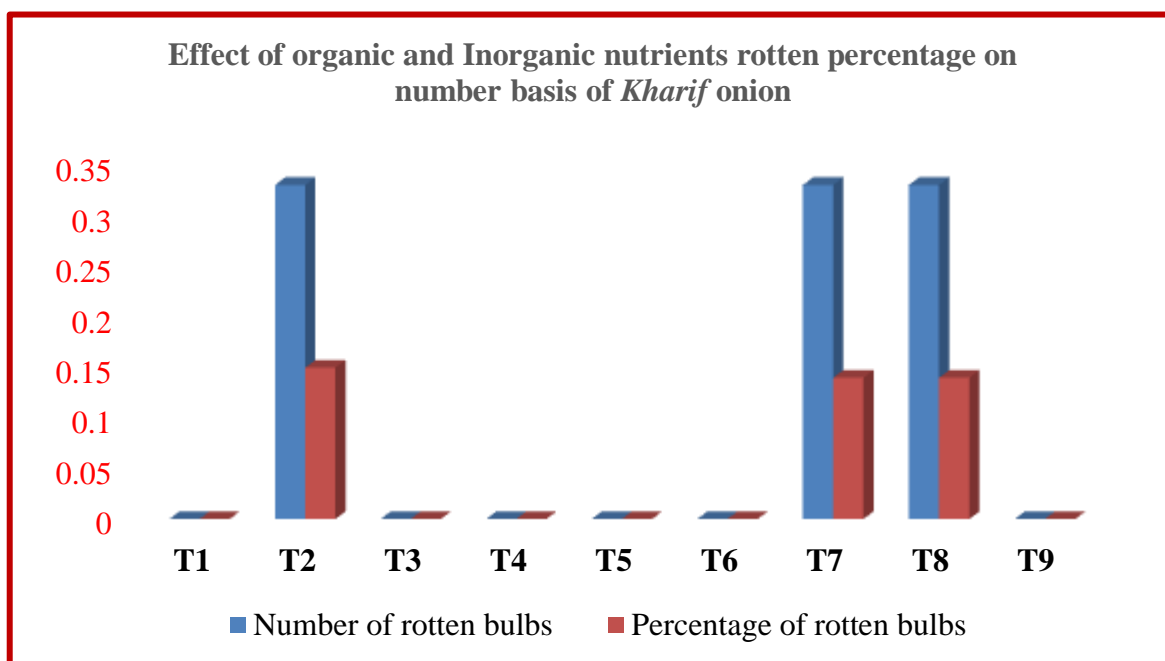
**Percentage of rotten bulbs on number basis**

Percentage of rotten bulbs of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.8 and its graphical presentation that was taken after harvesting of *kharif* onion presented in 4.8.

Non-significantly nil number of rotten bulbs taken after harvesting of *Kharif* onion (00.0) was recorded in treatments T<sub>1</sub>-NPKS:70-40-40-0 kg/ha, T<sub>3</sub>-NPKS:120-50-50-40 kg/ha, T<sub>4</sub>-NPKS:140-50-60-50 kg/ha, T<sub>5</sub>-NPKS:150-50-60-70 kg/ha, T<sub>6</sub>-20 tons enriched FYM, T<sub>9</sub>-25% RDN +15 tons enriched FYM while the maximum number of rotten bulbs (0.15 %) was recorded the treatment T<sub>2</sub>-NPKS:100-50-50-30 kg/ha and it was at par with, T<sub>7</sub>- 75% RDN + 5 tons enriched FYM (0.14 %) and T<sub>8</sub>- 50% RDN + 10 tons enriched FYM. (0.14%).

**Table 4.8 Effect of organic and Inorganic nutrients rotten percentage on number basis of *Kharif* onion**

Notation	Treatments	Rotten % on number basis	
		Number of rotten bulbs	Percentage of rotten bulbs
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	0.00	0.00
T2	Recommended NPKS:100-50-50-30 kg/ha	0.33	0.15
T3	NPKS:120-50-50-40 kg/ha	0.00	0.00
T4	NPKS:140-50-60-50 kg/ha	0.00	0.00
T5	NPKS:150-50-60-70 kg/ha	0.00	0.00
T6	20 tones EFYM	0.00	0.00
T7	75 % RDN+5 tons enriched FYM	0.33	0.14
T8	50% RDN+10 tones enriched FYM	0.33	0.14
T9	25% RDN+ 15 tones enriched FYM	0.00	0.00
SEM±		0.19	0.08
C.D(0.05)		NS	NS
CV		300.00	299.83



**Fig.4.8. Effect of organic and Inorganic nutrients on rotten percentage on the number basis of *Kharif* onion**

**Gross yield (kg/plot) and (q/ha)**

Gross yield (kg/plot) of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.9. Gross yield (kg/plot) and (q/ha) were recorded after harvesting of *Kharif* onion. The graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.9.

The significantly maximum gross yield was taken after harvesting (8.36 kg/plot) was recorded in treatment T<sub>9</sub>-25% RDN + 15 tons enriched FYM, while the minimum gross yield (5.86 kg/plot) was recorded in treatment T<sub>1</sub>-NPKS:70-40-40-0 kg/ha. Among the treatment of organic and inorganic nutrients applied the highest gross yield (kg/plot) that was taken after harvesting (8.36 kg/plot) was recorded with treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM and it was at par with T<sub>8</sub>-50 % RDN + 10 tons enriched FYM (8.15 kg/plot) and T<sub>7</sub>-75 % RDN + 5 tons enriched FYM, (7.65 kg/plot), T<sub>5</sub>-NPKS:150-50-60-70 kg/ha (7.65 kg/plot) of both the treatments remained the same.

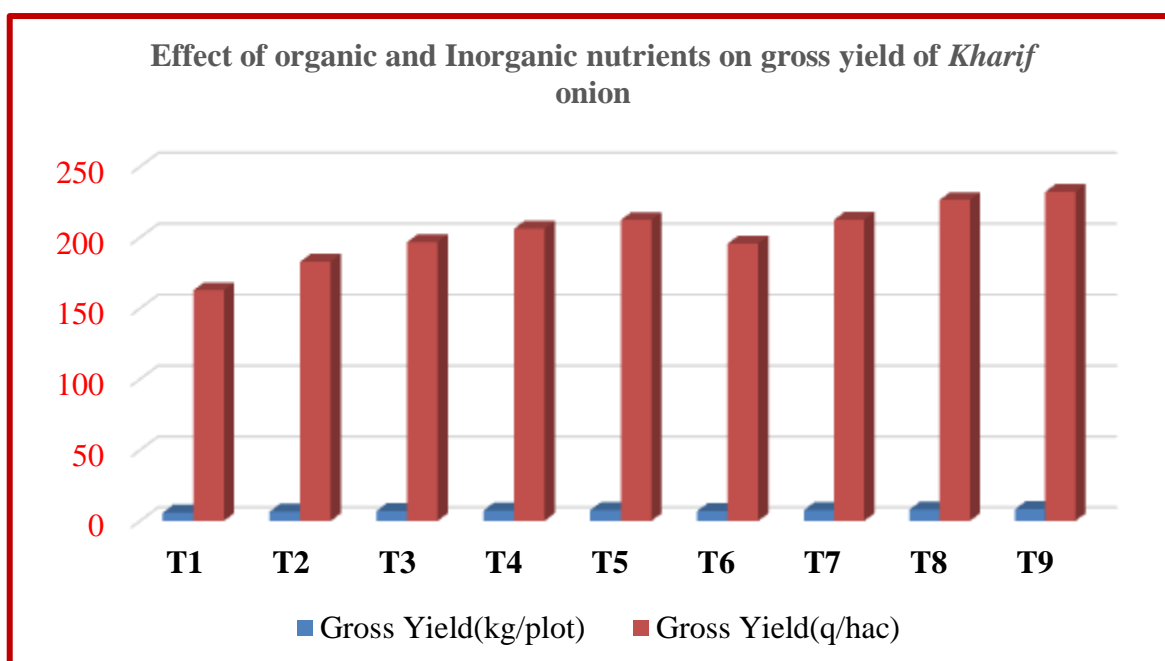
Significantly maximum gross yield was taken after harvesting (232.22 q/ha) was recorded in treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM. It was at par with T<sub>8</sub>-50% RDN + 10 tons enriched FYM (226.48 q/ha) T<sub>7</sub>-75 % RDN + 5 tons enriched FYM, (212.59 q/ha) and T<sub>5</sub>. NPKS: 150-50-60-70 kg/ha (212.41 q/ha). While the minimum gross yield (162.78 q/ha) was recorded in treatment T<sub>1</sub>- NPKS: 70-40-40-0 kg/ha.





Table 4.9 Effect of organic and Inorganic nutrients on gross yield of *Kharif* onion

Notation	Treatments	Gross yield of onion	
		Gross yield (kg/plot)	Gross yield (q/ha)
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	5.86	162.78
T2	Recommended NPKS:100-50-50-30 kg/ha	6.59	182.96
T3	NPKS:120-50-50-40 kg/ha	7.08	196.76
T4	NPKS:140-50-60-50 kg/ha	7.42	206.20
T5	NPKS:150-50-60-70 kg/ha	7.65	212.41
T6	20 tones EFYM	7.05	195.74
T7	75 % RDN+5 tons enriched FYM	7.65	212.59
T8	50% RDN+10 tones enriched FYM	8.15	226.48
T9	25% RDN+ 15 tones enriched FYM	8.36	232.22
SEM±		0.27	7.37
C.D.(0.05)		0.79	22.08
CV		6.28	6.28

Fig.4.9. Effect of organic and Inorganic nutrients on gross yield of *Kharif* onion

#### Marketable yield (kg/plot) and (q/ha)

Marketable yield (kg/plot) of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.10. The marketable yield (kg/plot) was recorded after harvesting of *Kharif* onion. Graphical presentation was taken

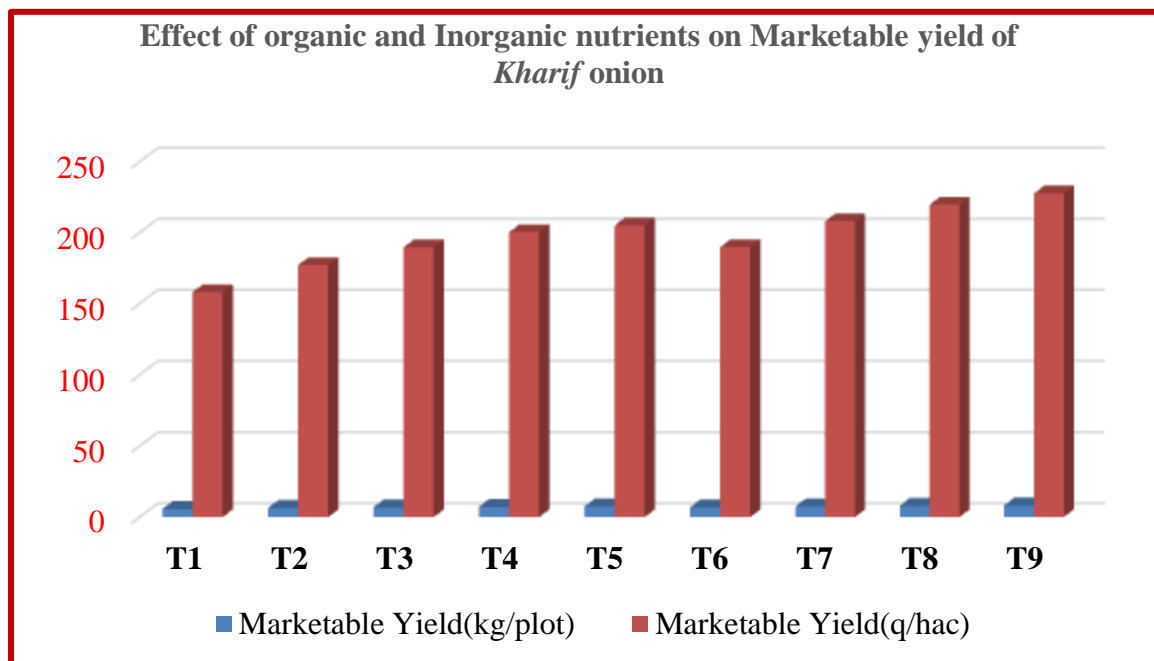
after harvesting of *Kharif* onion presented in 4.10.

The significantly maximum marketable yield (kg/plot) that was taken after harvesting (8.19 kg/plot) was recorded in treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM, while the minimum marketable yield (5.69 kg/plot) was recorded in treatment T<sub>1</sub>-NPKS:70-40-40-0 kg/ha. Among the treatment of organic and inorganic nutrients applied the highest Marketable yield (kg/plot) that was taken after harvesting (8.19 kg/plot) was recorded with treatment T<sub>9</sub>- 25% RDN + 15 tons enriched FYM. It was at par with T<sub>8</sub>- 50% RDN + 10 tons enriched FYM (7.91 kg/plot) and T<sub>7</sub>. 75 % RDN +5 tons enriched FYM (7.49 kg/plot).

Significantly maximum marketable yield (q/ha) was taken after harvesting (227.48q/ha) was recorded in treatment T<sub>9</sub>-25 % RDN +15 ton enriched FYM and was at par with T<sub>8</sub>-50 % RDN + 10 tons enriched FYM (219.65 q/ha), T<sub>7</sub>-75 % RDN + 5 tons enriched FYM (207.95 q/ha) and T<sub>5</sub>-NPKS:150-50-60-70 kg/ha (205.03 q/ha). However, the minimum marketable yield (158.06 q/ha) was recorded in treatment T<sub>1</sub> -NPKS: 70-40-40-0 kg/ha.

**Table 4.10 Effect of organic and Inorganic nutrients on Marketable yield of *Kharif* onion**

Notation	Treatments	Marketable Yield of onion	
		Marketable Yield(kg/plot)	Marketable Yield(q/ha)
<b>T1</b>	<b>Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha</b>	5.69	158.06
<b>T2</b>	<b>Recommended NPKS:100-50-50-30 kg/ha</b>	6.37	177.06
<b>T3</b>	<b>NPKS:120-50-50-40 kg/ha</b>	6.83	189.59
<b>T4</b>	<b>NPKS:140-50-60-50 kg/ha</b>	7.21	200.25
<b>T5</b>	<b>NPKS:150-50-60-70 kg/ha</b>	7.38	205.03
<b>T6</b>	<b>20 tones EFYM</b>	6.83	189.72
<b>T7</b>	<b>75 % RDN+5 tons enriched FYM</b>	7.49	207.95
<b>T8</b>	<b>50% RDN+10 tones enriched FYM</b>	7.91	219.65
<b>T9</b>	<b>25% RDN+ 15 tones enriched FYM</b>	8.19	227.48
	<b>SEM±</b>	0.27	7.37
	<b>C.D.(0.05)</b>	0.80	22.09
	<b>CV</b>	6.47	6.47



**Fig.4.10. Effect of organic and Inorganic nutrients on marketable yield of Kharif onion**

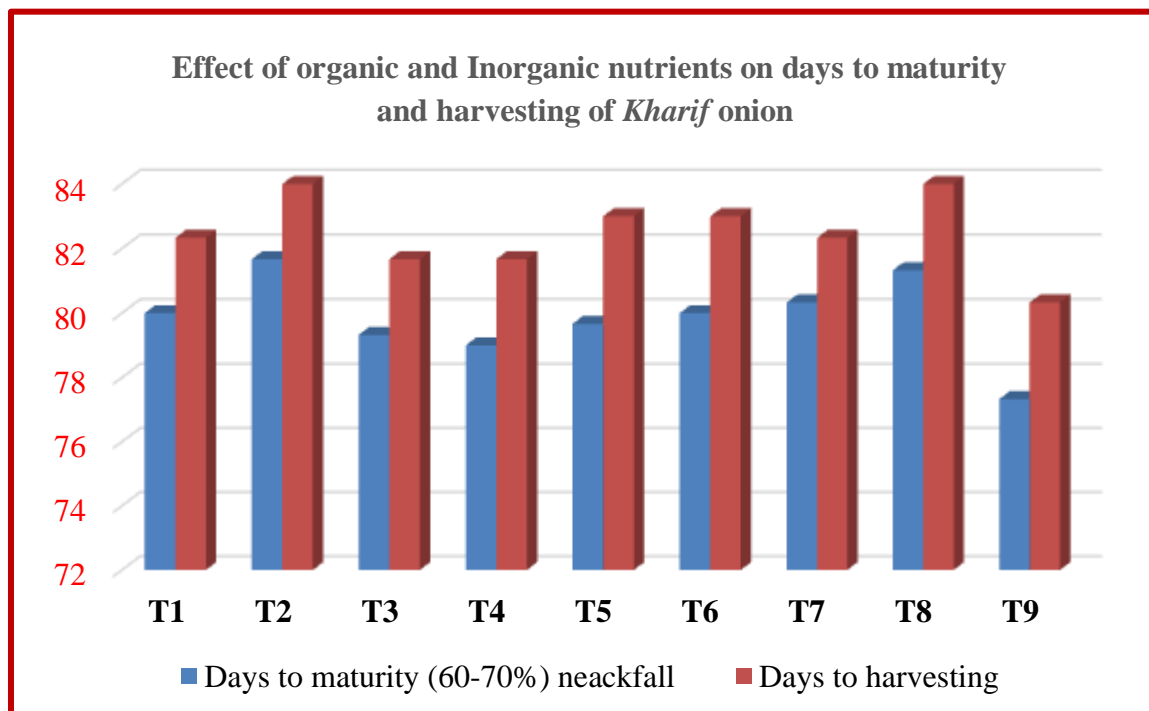
#### **Days to maturity after (60-70%) neck fall and harvesting**

Maturity of Kharif onion (60-70%) neck fall and harvesting as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.11. It recorded at (60-70%) neck fall and final harvesting after transplanting of Kharif onion. The graphical presentation maturity of Kharif onion presented in 4.11.

Non-significantly minimum maturity at (60- 70 %) neck fall after transplanting (77.33) was recorded in treatment T<sub>9</sub>-25 % RDN +15 tons enriched FYM, while the maximum maturity (60-70%) neck fall (81.67) was recorded the treatments T<sub>2</sub>-NPKS:100-50-50-40 kg/ha. Also non-significantly minimum days to harvesting after transplanting (80.33) was recorded in treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM, while the maximum days to harvesting (84.00) was recorded the treatments T<sub>2</sub>-NPKS:100-50-50-40 kg/ha.

**Table 4.11 Effect of organic and Inorganic nutrients on days to maturity and harvesting of *Kharif* onion**

Notation	Treatments	Days to maturity and harvesting	
		Days to maturity (60-70%) neck fall	Days to harvesting
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	80.00	82.33
T2	Recommended NPKS:100-50-50-30 kg/ha	81.67	84.00
T3	NPKS:120-50-50-40 kg/ha	79.33	81.67
T4	NPKS:140-50-60-50 kg/ha	79.00	81.67
T5	NPKS:150-50-60-70 kg/ha	79.67	83.00
T6	20 tones EFYM	80.00	83.00
T7	75 % RDN+5 tons enriched FYM	80.33	82.33
T8	50% RDN+10 tones enriched FYM	81.33	84.00
T9	25% RDN+ 15 tones enriched FYM	77.33	80.33
	SEM±	1.27	1.17
	C.D.(0.05)	N/S	N/S
	CV	2.76	2.46



**Fig.4.11. Effect of organic and Inorganic nutrients on days to maturity and harvesting of *Kharif* onion**

**Thrips per plant 60 days**

Thrips per plant 60 days of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.12. Thrips was recorded at 60 days after transplanting. The graphical presentation of 60 days after transplanting of *Kharif* onion presented in 4.12.

The significantly minimum thrips at 60 days after transplanting (6.30) was recorded in treatment T<sub>6</sub>-20 tons enriched FYM, while the maximum thrips (8.27) were recorded the both treatments T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha. Among the treatment of organic and inorganic nutrients applied the minimum thrips at 60 days after transplanting (6.30) was recorded with treatment T<sub>6</sub>- 20 tons enriched FYM. It was at par with, T<sub>9</sub>-25 % RDN + 15 tons enriched FYM (6.33), T<sub>8</sub>-50% RDN + 10 tons enriched FYM (6.87), T<sub>7</sub>. 75 % RDN + 5 tons enriched FYM (7.13), T<sub>1</sub>-NPKS:70-40-40-0 kg/ha (7.40), T<sub>2</sub>-NPKS:100-50-50-30 kg/ha (7.80) and T<sub>3</sub>-NPKS:120-50-50-40 kg/ha and T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha (7.93).

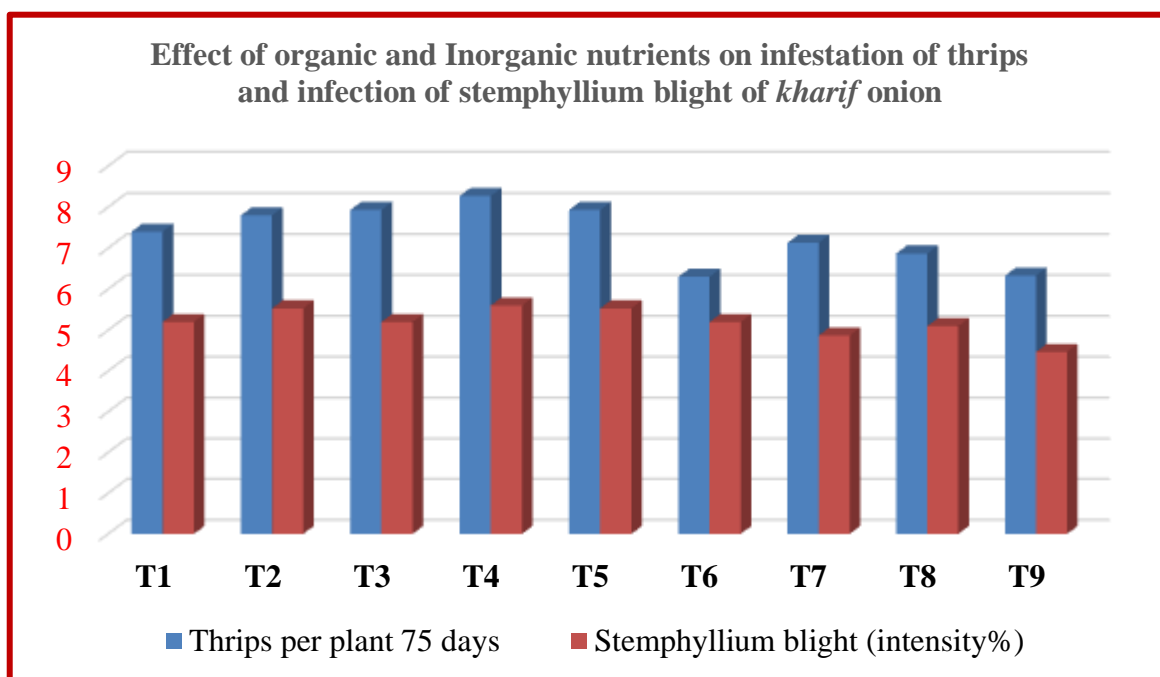
**Stemphylium blight intensity (%)**

Stemphylium blight intensity (%) of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.12. Stemphylium blight intensity (%) was recorded at 60 days after transplanting. The graphical presentation that was taken after transplanting of *Kharif* onion presented in 4.12.

The significantly lowest Stemphylium blight intensity (4.47 %) was recorded in treatment T<sub>9</sub>- 25 % RDN +15 tons enriched FYM, while the maximum Stemphylium blight intensity (5.60 %) recorded the treatment T<sub>4</sub>-NPKS:140-50-60-50 kg/ha. Among the treatment of organic and inorganic nutrients applied the lowest Stemphylium blight intensity (4.47 %) was recorded in treatment T<sub>9</sub>- 25 % RDN + 15 tons enriched FYM. It was at par with, T<sub>7</sub>- 75 % RDN + 5 tons enriched FYM (4.87 %), T<sub>8</sub>-50 % RDN +10 tons enriched FYM (5.10), T<sub>3</sub>-NPKS:120-50-50-40 kg/ha, T<sub>6</sub>-20 tons enriched FYM (5.20 %) both are same and T<sub>2</sub>-NPKS:100-50-50-30Kg/ha (5.53 %).

**Table 4.12 Effect of organic and Inorganic nutrients on infestation of thrips and infection of Stemphylium blight of *kharif* onion**

Notation	Treatments	Infestation of thrips and infection of Stemphylium blight	
		Thrips per plant 75 days	Stemphylium blight (intensity %)
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	7.40	5.20
T2	Recommended NPKS:100-50-50-30 kg/ha	7.80	5.53
T3	NPKS:120-50-50-40 kg/ha	7.93	5.20
T4	NPKS:140-50-60-50 kg/ha	8.27	5.60
T5	NPKS:150-50-60-70 kg/ha	7.93	5.53
T6	20 tones EFYM	6.30	5.20
T7	75 % RDN+5 tons enriched FYM	7.13	4.87
T8	50% RDN+10 tones enriched FYM	6.87	5.10
T9	25% RDN+ 15 tones enriched FYM	6.33	4.47
SEM±		0.29	0.32
C.D.(0.05)		0.85	N/S
CV		6.74	10.76



**Fig.4.12. Effect of organic and Inorganic nutrients on thrips and stemphylium blight of *Kharif* onion**

### 4.3 QUALITY PARAMETERS

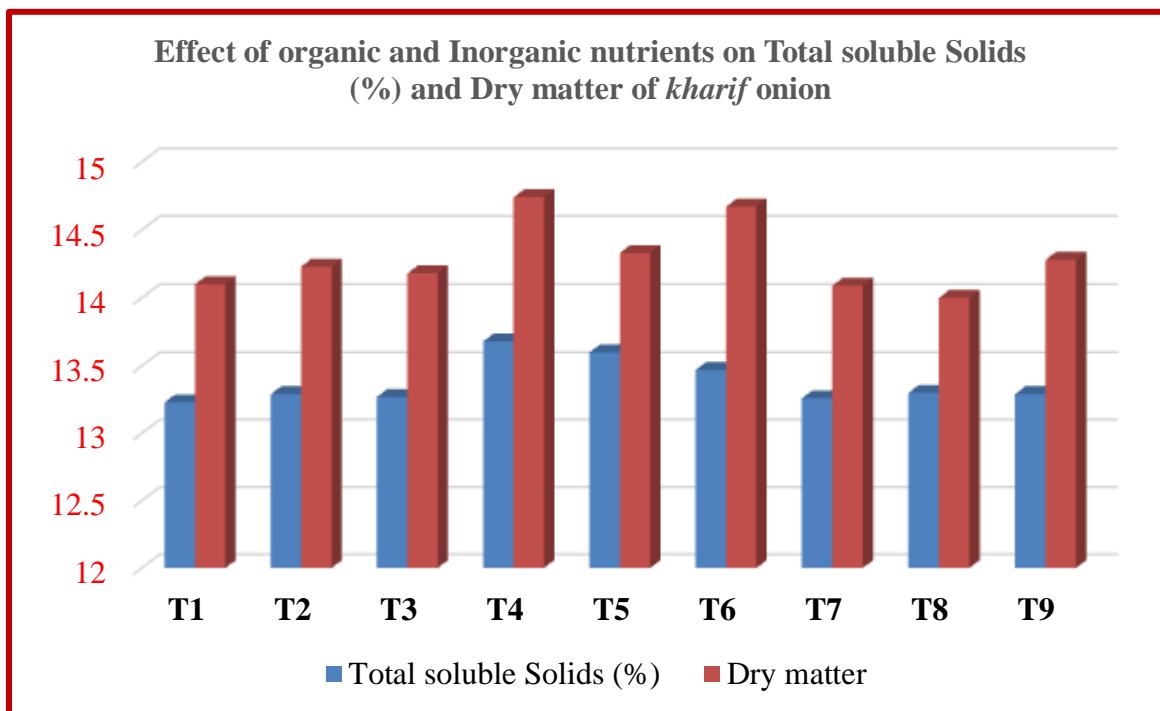
#### Total soluble solids (%) and Dry matter (%)

Total soluble solids of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.13. The trait TSS was recorded after harvesting of *Kharif* onion. The graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.13.

Non-significantly maximum total soluble solids that was taken after harvesting (13.68%) was recorded in treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha, while the minimum total soluble solids (13.23%) were recorded in treatment T<sub>1</sub>- NPKS: 70-40-40-0 kg/ha. Also, non-significantly maximum dry matter that was taken after harvesting (14.78 %) was recorded in treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha, while the minimum dry matter (14.00 %) was recorded in treatment T<sub>8</sub>-50 % RDN + 10 tons enriched FYM.

**Table 4.13 Effect of organic and Inorganic nutrients on Total soluble Solids (%) and Dry matter of *kharif* onion**

Notation	Treatments	TSS and Dry Matter	
		Total soluble Solids (%)	Dry matter
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	13.23	14.10
T2	Recommended NPKS:100-50-50-30 kg/ha	13.29	14.23
T3	NPKS:120-50-50-40 kg/ha	13.27	14.18
T4	NPKS:140-50-60-50 kg/ha	13.68	14.74
T5	NPKS:150-50-60-70 kg/ha	13.60	14.33
T6	20 tones EFYM	13.47	14.67
T7	75 % RDN+5 tons enriched FYM	13.26	14.09
T8	50% RDN+10 tones enriched FYM	13.30	14.00
T9	25% RDN+ 15 tones enriched FYM	13.29	14.28
SEM±		0.31	0.33
C.D.(0.05)		NS	NS
CV		3.97	4.06



**Fig.4.13. Effect of organic and Inorganic nutrients on TSS and Dry matter of *Kharif* onion**

#### 4.4. Economic parameter

##### 4.4.1 Total cost of cultivation (Rs ha<sup>-1</sup>)

The cost of cultivation of *Kharif* onion as influence by different treatments of organic manures and inorganic fertilizers is given in Table 4.14. Cost of cultivation was recorded after harvesting of *Kharif* onion. The graphical presentation that was taken after harvesting of *Kharif* onion presented in 4.14.

The cost of cultivation under different treatments varied from Rs. 95,448/- (T<sub>1</sub>- Farmers practice NPKS: 70-40- 40-0 kg/ha to Rs.1, 31,038/- in T<sub>6</sub>- 20 tons enriched FYM. The maximum total cost of cultivation Rs. 1,31,038/- was recorded with T<sub>6</sub> followed by Rs. 1,23,823/- in T<sub>9</sub>-25 % RDN + 15tons enriched FYM and Rs. 1,16,493/- in T<sub>8</sub>- 50 % RDN +10 tons enriched FYM. However, minimum cost of cultivation Rs. 95, 448/- was obtained with T<sub>1</sub> (Control).

#### **4.4.2 Gross return (Rs. ha<sup>-1</sup>)**

The estimated values of gross income of different treatments were presented in table 4.13 and fig. 4.13. The gross return was affected by various treatments varied from Rs. 4, 06, 050/-ha (T<sub>1</sub>- Farmers practice NPKS: 70-40- 40-0 kg/ha control) to Rs.5, 80, 550/-ha in T<sub>9</sub>-25 % RDN + 15 tons enriched FYM. Among the treatments applied in the present study the maximum gross income Rs. 5, 80, 550/- was recorded with T<sub>9</sub> which is at par with T<sub>8</sub>-50 % RDN + 10 tons enriched FYM (Rs. 5, 66, 200/-ha). However, minimum gross return Rs. 4, 06, 050/- was obtained with T<sub>1</sub> (Control).

#### **4.4.3 Net return (Rs. ha<sup>-1</sup>)**

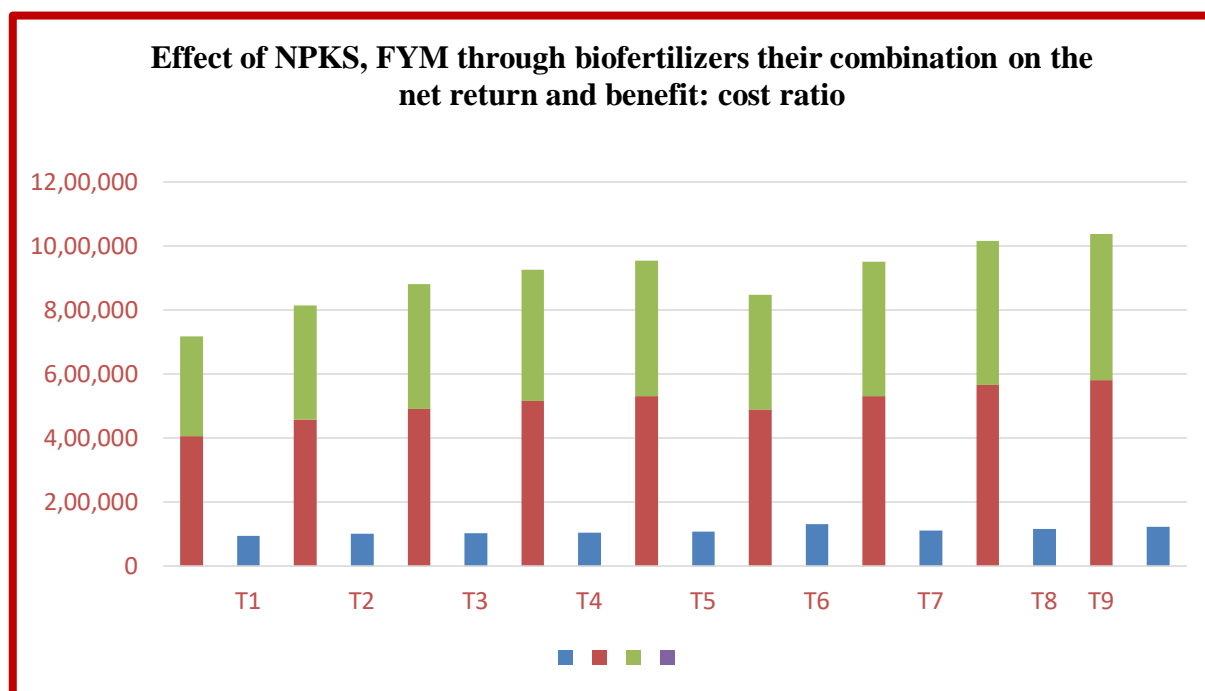
It is evident from the data presented in table 4.13 and fig. 4.13 that net return/ha in different treatments varied from Rs.3, 11, 502/-ha T<sub>1</sub>- Farmers practice NPKS: 70-40- 40-0 kg/ha (control) to Rs.4, 56, 727 per hectare in T<sub>9</sub>-25 % RDN + 15 tons enriched FYM. In the present study, maximum net return (Rs.4, 56, 727 /ha.) among all the treatments was recorded with T<sub>9</sub> followed by Rs.4, 49, 707/ha in T<sub>8</sub>-50 % RDN + 10 tons enriched FYM and Rs.4, 20, 322 /ha in T<sub>7</sub>-75 % RDN + 5 tons enriched FYM. However, control (T<sub>1</sub>) treatment registered the lowest net return/ha (Rs.3, 11, 502 /ha).

#### **4.4.4 Benefit cost ratio**

The benefit: cost ratio of *kharif* onion was presented in Table 4.13 and fig4.13. The B: C ratio in different treatments differed due to the variation in cost of inputs and gross return under different treatments during the investigation. The benefit: cost ratio under different treatments varied from 1:3.26 (T<sub>1</sub>-Farmers practice NPKS: 70-40- 40-0 kg/ha (control) to 1:3.94 in T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha. Among the treatments applied in the present study the maximum cost: benefits ratio 1:3.94 was recorded with T<sub>5</sub> which is at par with, T<sub>4</sub> NPKS: 140-50-60-50 kg/ha. (1:3.93), T<sub>8</sub>- 50 % RDN + 10 tons enriched FYM (1:3.86) and T<sub>7</sub>. 75 % RDN + 5 tons enriched FYM (1:3.78). However, minimum benefit: cast ratio 1:3.26 was obtained with T<sub>1</sub> (Control).

**Table 4.14 Effect of NPKS, FYM through bio-fertilizer their combination on the net return and benefit: cast ratio**

Nation	Treatments	Total cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net return (Rs/ha)	Benefit: cost ratio
T1	Farmers practice (N-P-K-S) 70-40- 40-0 kg/ha	95, 448/-	4,06,950/-	3,11,502/-	1:3.26
T2	Recommended NPKS:100-50-50-30 kg/ha	1,00,843/-	4,57,400/-	3,56,557/-	1:3.53
T3	NPKS:120-50-50-40 kg/ha	1,02,338/-	4,91,900/-	3,89,562/-	1:3.80
T4	NPKS:140-50-60-50 kg/ha	1,04,433/-	5,15,500/-	4,11,067/-	1:3.93
T5	NPKS:150-50-60-70 kg/ha	1,07,328/-	5,31,025/-	4,23,697/-	1:3.94
T6	20 tones EFYM	1,31,038/-	4,89,350/-	3,58,312/-	1:2.73
T7	75 % RDN+5 tons enriched FYM	1,11,153/-	5,31,475/-	4,20,322/-	1:3.78
T8	50% RDN+10 tones enriched FYM	1,16,493/-	5,66,200/-	4,49,707/-	1:3.86
T9	25% RDN+ 15 tones enriched FYM	1,23,823/-	5,80,550/-	4,56,727/-	1:3.68



**Figure 4.14 Effect of organic and inorganic nutrients on benefit cost ratio of *Kharif* onion**

## **4.5 Soil parameter**

### **4.5.1 pH**

The data on  $P^H$  was summarized in table no. 4.15 and serenity of data revealed that the maximum and minimum  $P^H$  was observed where farmers practice, different doses of fertilizers and  $T_5$ . NPKS: 150-50-60-70kg/ha applied to the field. However,  $P^H$  is mention that the differences between the highest and lowest value of  $P^H$  had non- significant variation. The  $P^H$  of soil has non-significantly changed where organic manure applied. It was at par with,  $T_2$ . Recommended (NPKS): 100-50-50-30 kg/ha (7.50),  $T_7$ . 75% RDN+5 tons enriched FYM (7.40),  $T_9$ . 25% RDN+15 tons enriched FYM (7.40) and  $T_8$ . 50% RDN+10 tons enriched FYM. (7.37),

### **4.5.2 EC**

The data on EC was summarized in table no. 4.15 and serenity of data revealed that the maximum and minimum EC were observed where farmer practice (NPKS): 70-40-40-0 kg/ha) and organic manure (20 tones enriched FYM only) applied to the field. However, EC is mention that the differences between the highest and lowest value of EC had non-significant variation. The EC of soil has non-significantly changed where organic manure applied. It was at par with,  $T_4$ . NPKS: 140-50-60-50 kg/ha (0.33),  $T_8$ . 50% RDN+10 tons enriched FYM (0.33), both are same,  $T_2$ . recommended (NPKS):100-50-50-30 kg/ha (0.32),  $T_7$ . 75% RDN+5 tons enriched FYM (0.32) both are same.

### **4.5.3 Organic Carbon (%)**

The data on OC was summarized in table no. 4.15 and serenity of data revealed that the maximum and minimum OC were observed where (25% RDN+ 15 tons enriched FTM) and inorganic fertilizer (NPKS: 150-50-60-70 kg/ha) and (Farmer practice) applied to the field. However, OC is mention that the differences between the highest and lowest value of OC had significant variation. The OC of soil has significantly changed where organic manure applied. It was at par with,  $T_6$ . 20 tons enriched FYM,  $T_8$ . 50% RDN+10 tons enriched FYM (0.52%) both are same and  $T_3$ . NPKS:120-50-50-40 kg/ha  $T_4$ . NPKS:140-50-60-50 kg/ha (0.47%) both are same.

**4.5.4 Available N (kg ha<sup>-1</sup>)**

The data on available N was summarized in table no. 4.15 and serenity of data revealed that the maximum and minimum available N were observed where (Farmer practice NPKS:70-40-40-0 kg/ha) and organic manure (25% RDN+15 tons enriched FYM only) applied to the field. However, available N is mention that the differences between the highest and lowest value of available N had significant variation. The available N of soil has significantly changed where organic manure applied. It was at par with, T<sub>8</sub>. 50% RDN+10 tons enriched FYM (331.00 kg ha<sup>-1</sup>), T<sub>3</sub>. NPKS: 120-50-50-40 kg/ha (316.33 kg ha<sup>-1</sup>), T<sub>7</sub>. 75% RDN+5 tons enriched FYM (310.00 kg ha<sup>-1</sup>), T<sub>4</sub>. NPKS: 140-50-60-50 kg/ha (293.00 kg ha<sup>-1</sup>) and T<sub>6</sub>. 20 tons enriched FYM (292.00 kg ha<sup>-1</sup>).

**4.5.5 Available P<sub>2</sub>O<sub>5</sub> (kg ha<sup>-1</sup>)**

The data on available P<sub>2</sub>O<sub>5</sub> was summarized in table no. 4.15 and serenity of data revealed that the maximum and minimum available P<sub>2</sub>O<sub>5</sub> were observed where (Recommended dose of NPKS: 100-50-50-30 kg/ha) and organic manure (20 tons enriched FYM only) applied to the field. However, available P<sub>2</sub>O<sub>5</sub> is mention that the differences between the highest and lowest value of available P<sub>2</sub>O<sub>5</sub> had significant variation. The available P<sub>2</sub>O<sub>5</sub> of soil has significantly changed where organic manure applied. It was at par with, T<sub>7</sub>. 75% RDN+5 tons enriched FYM (23.50 kg ha<sup>-1</sup>), T<sub>8</sub>. 50% RDN+10 tons enriched FYM (22.97 kg ha<sup>-1</sup>), T<sub>1</sub>. Farmer practice (NPKS):70-40-40-0 kg/ha (22.67 kg ha<sup>-1</sup>) and T<sub>9</sub>. 25% RDN+15 tons enriched FYM (20.83 kg ha<sup>-1</sup>).

**4.5.6 Available K<sub>2</sub>O (kg ha<sup>-1</sup>)**

The data on available K<sub>2</sub>O was summarized in table no. 4.15 and serenity of data revealed that the maximum and minimum available K<sub>2</sub>O were observed where (Recommended dose of NPKS: 100-50-50-30 kg/ha) and organic manure (20 tons enriched FYM only) applied to the field. However, available K<sub>2</sub>O is mention that the differences between the highest and lowest value of available K<sub>2</sub>O had significant variation. The available K<sub>2</sub>O of soil has significantly changed where organic manure applied. It was at par with, T<sub>2</sub>. NPKS: 100-50-50-30kg/ha (299.00 kg ha<sup>-1</sup>), T<sub>7</sub>. 75% RDN + 5 tons enriched FYM (292.00 kg ha<sup>-1</sup>), T<sub>1</sub>. Farmer practice (NPKS): 70-40-40-0 kg/ha (290.67 kg ha<sup>-1</sup>), T<sub>8</sub>.

50% RDN+10tons enriched FYM ( $282.33 \text{ kg ha}^{-1}$ ) and T<sub>9</sub>. 25% RDN+15 tons enriched FYM ( $268.33 \text{ kg ha}^{-1}$ ).

#### **4.5.7 Available sulphur ( $\text{kg ha}^{-1}$ )**

The data on available sulphur was summarized in table no. 4.15 and serenity of data revealed that the maximum and minimum available sulphur were observed where (Recommended dose of NPKS: 100-50-50-30 kg/ha) and organic manure (20 tons enriched FYM only) applied to the field. However, available sulphur is mention that the differences between the highest and lowest value of available sulphur had significant variation. The available sulphur of soil has significantly changed where organic manure applied. It was at par with, T<sub>7</sub>. 75% RDN+5tons enriched FYM ( $16.57 \text{ kg ha}^{-1}$ ), T<sub>8</sub>. 50% RDN+10 tons enriched FYM ( $15.87 \text{ kg ha}^{-1}$ ), T<sub>9</sub>. 25% RDN+15 tons enriched FYM ( $15.53 \text{ kg ha}^{-1}$ ) and T<sub>1</sub>. Farmer practice (NPKS): 70-40-40-0 kg/ha ( $14.97 \text{ kg ha}^{-1}$ ).

4.15 Effect of organic and Inorganic nutrients on soil parameters of *kharif* onion

Treatments		P <sup>H</sup>	EC (ds m <sup>-1</sup> )	Organic Carbon (%)	Available Nitrogen (kg ha <sup>-1</sup> )	Available Phosphorus (kg ha <sup>-1</sup> )	Available Potassium (kg ha <sup>-1</sup> )	Available Sulphur (kg ha <sup>-1</sup> )
<b>T1</b>	Farmers practice (N-P-K-S) 70-40-40-0 Kg/ha.	7.57	0.34	0.41	260.00	22.67	290.67	14.97
<b>T2</b>	Recommended NPKS: 100-50-50-30Kg/ha.	7.50	0.32	0.42	275.00	24.67	299.00	17.23
<b>T3</b>	NPKS: 120-50-50-40Kg/ha.	7.57	0.29	0.47	316.33	24.80	307.00	19.90
<b>T4</b>	NPKS: 140-50-60-50Kg/ha.	7.57	0.33	0.47	293.00	24.37	313.67	20.57
<b>T5</b>	NPKS: 150-50-60-70Kg/ha.	7.33	0.30	0.41	302.67	25.70	320.00	25.17
<b>T6</b>	20 tones EFYM	7.47	0.27	0.52	292.00	19.77	266.00	14.23
<b>T7</b>	75 % RDN+5 tons enriched FYM	7.40	0.32	0.48	310.00	23.50	292.00	16.57
<b>T8</b>	50% RDN+10 tones enriched FYM	7.37	0.33	0.52	331.00	22.97	282.33	15.83
<b>T9</b>	25%RDN+ 15 tones enriched FYM	7.40	0.28	0.54	354.00	20.83	268.33	15.53
<b>SEM±</b>		<b>0.07</b>	<b>0.02</b>	<b>0.02</b>	<b>2.74</b>	<b>0.84</b>	<b>2.24</b>	<b>0.42</b>
<b>C.D. (0.05)</b>		<b>N/S</b>	<b>N/S</b>	<b>0.05</b>	<b>8.22</b>	<b>2.52</b>	<b>6.73</b>	<b>1.27</b>
<b>CV</b>		<b>1.59</b>	<b>8.52</b>	<b>6.42</b>	<b>1.56</b>	<b>6.27</b>	<b>1.33</b>	<b>4.13</b>

## DISCUSSION

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### 5.1 Effect of different treatments of organic manure and inorganic fertilizers on growth parameters of *Kharif* onion.

Among growth parameter, the plant height, number of leaves per plant and neck thickness were studied in *Kharif* onion.

The plant height increased significantly with the different treatments of organic manures and inorganic fertilizers up to 60 and 75 DAT. Significantly maximum plant height was recorded in treatment T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha, T<sub>7</sub>-75 % RDN +5 tones enriched FYM both are same and T<sub>9</sub>-25 % RDN + enriched FYM. However, the plant height up to 30 DAT recorded non-significant. This could be as a result of the application of both major and minor nutrients, enhanced photosynthetic activity, chlorophyll production, nitrogen metabolism, and auxin contents in the plants, all of which improve plant height. These results are consistent with those of Jayathilake *et al.* (2003), Reddy and Reddy (2005), Mozumder *et al.* (2007), Singh and Singh (2009), Gasti *et al.* (2011), Abedin *et al.* (2012), Tripathy *et al.* (2013), Manna *et al.* (2014), Sachin *et al.* (2017), Kaur *et al.* (2019), Vishvkarma *et al.* (2020).

The data clearly show that the number of leaves per plant of *Kharif* onion responded significantly to various treatments of organic manures and inorganic fertilizers under study. The significantly maximum number of leaves per plant were recorded up to 60 and 75 days of transplanting in the treatments T<sub>9</sub>-25 % RDN + 15 tones enriched FYM and T<sub>5</sub>-150-50-60-70 kg/ha, which were at par with each other. However, the minimum number of leaves per plant was counted in T<sub>1</sub>-70-40-40-0 kg/ha at 60 and 75 DAT. However, the number of leaves up to 30 DAT is non-significant. Possible explanations for the increased number of leaves include the favourable effects of macro and micronutrients on vegetative growth, which in turn resulted in an increase in photosynthetic activity. These findings are in agreement with the findings of Jayathilake *et al.* (2002), Jayathilake *et al.* (2003), Reddy and Reddy (2005), Patel *et al.* (2008), Suresh *et al.* (2008), Fraihat (2009), Islah (2010), Dubey *et al.* (2011), Chanchan *et al.* (2013), Acharya *et al.* (2015), Kaur *et al.* (2019), Kumar *et al.* (2021).

The neck thickness was influenced by various treatments of organic manures and inorganic fertilizers to 30 and 60 DAT. The minimum neck thickness was recorded in treatment T<sub>9</sub>-25 % RDN + 15 tones enriched FYM for same, and which were at par with each other, while, the highest neck thickness was recorded with treatment T<sub>4</sub>-NPKS:140-50-60-50 kg/ha and T<sub>1</sub>-(Farmer practice) NPKS:70-40-40-0 kg/ha. However, the neck thickness up to 75 days of transplanting showed non-significant effect. Variation in neck thickness might be due to the inherent genetic make-up of the genotypes, doses of nitrogen at the growth period leads to increased neck thickness of the bulb. Similar results have been reported by Islah (2010), Dubey *et al.* (2011), Kumar *et al.* (2019), Khan *et al.* (2019) and Kalirawna *et al.* (2022).

Significantly minimum bolting percentage on number basis were observed in treatments T<sub>7</sub>-75% RDN + 5 tones enriched FYM and T<sub>9</sub>-25 % RDN + 15 tones enriched FYM (check) and which were at par with each other. Therefore, it was noted maximum number of bolting per plot under the treatment T<sub>3</sub>-NPKS: 120-50-50-40 kg/ha. Probable reasons for this may be due to the doses of macro and micro nutrient. These findings are in agreement with the findings of Katung *et al.* (2005) suggested that the significant reduction in the number of bolters was observed at 120 kg/ha NPK and also reported by Suresh *et al.* (2008).

## **5.2 Effect of application of organic manure and inorganic fertilizers on yield parameters of *Kharif* onion.**

Among yield parameter, Equatorial diameter of bulb, Polar diameter of bulb, 20 bulbs weight, Average bulb weight, Percentage of rotten bulbs on number basis, percentage of double bulb on number basis, total bulb yield per hectare and days to maturity were studies in *kharif* onion.

It is obvious from the data that the average polar diameter of bulb was significantly influenced by the different treatments of organic manures and inorganic fertilizers in onion. The significantly maximum polar diameter of bulb was recorded in treatment T<sub>9</sub> 25 % RDN + 15 tones enriched FYM (check) and which were at par with each other. The lowest polar bulb diameter was recorded in T<sub>3</sub>-NPKS: 120-50-50-40 kg/ha. This might be the result of the application of major and minor nutrients, increased photosynthetic activity, chlorophyll synthesis, nitrogen metabolism, and auxin contents, which improved the polar

diameter of bulb. Similarly, results have been reported by Dubey *et al.* (2011), Tripathy *et al.* (2013), Acharya *et al.* (2015), Singh *et al.* (2014), Kaur *et al.* (2019), Kumar *et al.* (2021), Sahoo *et al.* (2022).

Among the nutrient variables studied none of the treatment non-significant laid variation on equatorial diameter of bulb during field study however, the maximum equatorial diameter & minimum equatorial diameter of bulb recorded by the treatments where T<sub>9</sub>-25 % RDN + 15 tones enriches FYM and T<sub>4</sub>- NPKS: 140-50-60-50 kg/ha. It might be due to the reason bulb size in onion increase in two directions. That is either lateral (equatorial) or in vertical (polar) in both the cases ultimate bulb weight increase which may lead to increase in yield, increase of the soil having high clay content generally it is found increase in bulb size in polar direction. Further, than horizontal direction which leads to increase the defences in polar diameter of bulb as compare to equatorial diameter.

The combined effect of organic and inorganic nutrients in P: E ratio was found non-significant. The maximum P: E ratio of bulb were exhibited in the treatment T<sub>4</sub>-NPKS: 140-5-60-50 kg/ha (check) and which were at par with each other. However, the minimum P: E ratio of bulb was observed in T<sub>3</sub>-NPKS: 120-50-50-40 kg/ha. This could be as a result of the application of major and minor nutrients, increased photosynthetic activity, chlorophyll synthesis, nitrogen metabolism, and auxin contents in the plants, all of which improved the P: E ratio of the bulb. These findings are in agreement with the findings of Dubey *et al.* (2011), Tripathy *et al.* (2013), Acharya *et al.* (2015), Singh *et al.* (2014), Kaur *et al.* (2019), Kumar *et al.* (2021), Sahoo *et al.* (2022).

Significantly maximum 20 bulbs weight (kg) and average bulb weight (g) were exhibited in the treatment T<sub>9</sub>-25 % RDN + 15 tones enriched FYM, which were at par with each other, whereas, the minimum 20 bulbs weight (kg) and average bulb weight (g) was observed in T<sub>4</sub>- NPKS:140-50-60-50 kg/ha. Increased activity of hydrolysing and oxidising enzymes is the most likely explanation for the increased fresh weight of bulbs per plant, which is likely to be caused by organic and inorganic fertilizers. Similar results have been reported by Dubey *et al.* (2011), Rodriguez *et al.* (2012), Tripathy *et al.* (2013), Singh *et al.* (2014), Acharya *et al.* (2015), Shah *et al.* (2016), Sachin *et al.* (2017), Bhati *et al.* (2018), Kaur *et al.* (2019), Kumar *et al.* (2019), Kumar *et al.* (2021), Sahoo *et al.* (2022).

Treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha, T<sub>7</sub>-75 % RDN + 5 tones enriched FYM and T<sub>9</sub>-25 % RDN + 15 tones enriched FYM was observed minimum (1.02 %) per cent of double bulb. While the maximum (1.88 %) of double bulb was found in treatment T<sub>5</sub>-NPKS: 150-50-50-60 kg/ha. Similar results have been reported by Rohidas *et al.* (2011) and Mishu *et al.* (2013).

The combined effect of organic and inorganic nutrients in percentage of rotten bulbs was found non-significant. Treatment T<sub>1</sub>-NPKS: 70-40-40-0 kg/ha, T<sub>3</sub>-NPKS: 120-50-50-40 kg/ha, T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha., T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha., T<sub>6</sub>- 20 tones enriched FYM, T<sub>9</sub>-25 % RDN +15 tones enriched FYM was observed minimum (0.00%) per cent of rotten. While the maximum (0.15%) per cent of rotten bulb was found in treatment T<sub>2</sub>- NPKS: 100-50-50-30 kg/ha. Similar results have been reported by Tumbare and Pawar (2003).

The yield of any crop is the final index of the experiment which indicates the success or failure of any treatment with this view the bulb yield of onion was recorded. Treatment T<sub>9</sub>- 25 % RDN + 15 tons enriched FYM was recorded the maximum Gross yield (kg/plot.) and Gross yield (q/ha.), which was at par, with each other. However, lowest Gross yield (kg/plot.) and Gross yield (q/ha.) was noted in T<sub>1</sub>-Farmer practice (NPKS):70-40-40-0 kg/ha. The higher yield might be due to increase in plant height, number of leaves, and yield attributes viz., polar and equatorial diameter of bulb, 20 bulb weight. This might be as a result of the nutrients being presents in easily accessible forms at the C: N ratio being higher than expected. Similar results have been reported by Dubey *et al.* (2011), Rodriguez *et al.* (2012), Tripathy *et al.* (2013), Singh *et al.* (2014), Acharya *et al.* (2015), Shah *et al.* (2016), Sachin *et al.* (2017), Bhati *et al.* (2018), Kaur *et al.* (2019), Kumar *et al.* (2019), Kumar *et al.* (2021) and Sahoo *et al.* (2022).

Treatment T<sub>9</sub>-25 % RDN+15 tons enriched FYM was recorded the maximum Marketable yield (kg/plot.) and Marketable yield (q/ha.). Which was at par with each other. However, lowest Marketable yield (kg/plot) and Marketable yield (q/ha.) was noted in T<sub>1</sub>- (Farmer practice NPKS):70-40-40-0 kg/ha. This may be because the nutrients are present in easily accessible forms and the C: N ratio is higher than expected. Similar results have been reported by Sankar *et al.* (2008), Kandil *et al.* (2013), Manna *et al.* (2014), Banjare *et*

*al.* (2015), Shah *et al.* (2016), Sachin *et al.* (2017), Bhati *et al.* (2018), Kaur *et al.* (2019), Kalirawna *et al.* (2022).

The combined effect of organic and inorganic nutrients in early maturity and days to harvesting was found non-significant differences. Early maturity and harvesting were recorded on 77.33 and 80.33 days in treatments T<sub>9</sub>-25 % RDN + 15 tones enriched FYM and which were at par with each other. While, the late maturity and harvesting 81.67 days and 84.00 days exhibited in treatment T<sub>2</sub>-recommended NPKS: 100-50-50-30 and T<sub>2</sub>-recommended NPKS: 100-50-50-30, T<sub>8</sub>-50 % RDN + 10 tones enriched FYM as compared to other treatment combinations. As a result, the plant continued to grow vegetatively, which caused an imbalance in the C: N ratio and delayed maturity at higher nutritional levels. The findings are in agreement with findings of Fikru Tamiru Kenea and Fikreyohannes Gedamu (2018) and Singh *et al.* (2019).

### **5.3 Effect of different treatments of organic manures and inorganic fertilizers on quality parameters of *Kharif* onion.**

Among quality parameter, Total Soluble Solid (%) and Dry matter (%) were studied in *Kharif* onion.

Among the nutrient variables studied none of the treatment non-significant laid variation on TSS during field study however, the maximum total soluble solids and minimum total soluble solids are recorded by the treatment where T<sub>4</sub>-NPKS:140-50-60-50 kg/ha (13.68%) & T<sub>1</sub>-Farmer practice (NPKS):70-40-40-0 kg/ha (13.23%). These findings are in agreement with the findings of Hari *et al.* (2009), Meena *et al.* (2015), Kumar *et al.* (2021), Haleem *et al.* (2022).

The combined effect of organic and inorganic nutrients in dry matter was found non-significant. The maximum (14.78 %) dry matter was observed in Treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha. (check) as compared to other treatments. Therefore, the minimum dry weight of bulb was noted in treatment T<sub>8</sub>-50 % RDN + 10 tons enriched FYM (14.00 %). Probable reason for increased dry matter recovery per cent due to FYM and macro nutrient substances present in organic manure. Parallely results have been reported of Manna *et al.* (2014), Jayathilake *et al.* (2003), Kumar *et al.* (2017).

#### **5.4 Effect of different treatments of organic manures and inorganic fertilizers on pest and disease parameters of *Kharif* onion.**

Significantly minimum thrips per plant were observed in treatments T<sub>6</sub>-20 tones enriched FYM. Therefore, it was noted maximum thrips per plot under the treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha. Probable reasons for this may be due to the doses of macro and micro nutrient. These findings are in agreement with the findings of Acharya *et al.* (2015), Gupta *et al.* (2020), Maida *et al.* (2021).

The combined effect of organic and inorganic nutrients in Stemphylium blight intensity % was found non-significant. The minimum Stemphylium blight intensity (4.47 %) was recorded at maturity time in treatment T<sub>9</sub>-25 % RDN + 15 tons enriched FYM, while the maximum Stemphylium blight intensity (5.60 %) recorded the treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha. Similarly, results have been reported by Bhati *et al.* (2018), Pal *et al.* (2020).

#### **5.6 Effect of different treatments of organic manures and inorganic fertilizers on economic parameters of *Kharif* onion.**

Higher money value and less cost of cultivation are desirable traits for getting higher returns. Hence economics of the treatments was work out.

It is revealed form the data obtained that a significantly maximum bulb yield 232.22 q/ha was obtained in onion variety Line-883. The highest net returns of Rs 4, 56,727/ha was obtained in treatment T<sub>9</sub>-25 % RDN +15 tons enriched FYM followed by T<sub>8</sub>-50 % RDN+ 10 tones enriched FYM (Rs. 4, 49, 707/ha) and T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha (check) (Rs. 4, 23, 697/ha) but maximum cost benefit ratio 1:3.94 was observed under the treatment T<sub>5</sub> due to low cost of cultivation followed by T<sub>4</sub>-(1: 3.93) and T<sub>8</sub>-(1: 3.86). While, lowest bulb yields 162.78q/ha and net return of (Rs 3, 11, 502/ha) along with cost benefit ratio 1:3.26 was observed in treatment T<sub>1</sub>-Farmer practice (NPKS): 70-40-40-0 kg/ha. Similar results have been reported by Singh *et al.* (2011), Jawadagi *et al.* (2012), Verma *et al.* (2013), Damse *et al.* (2014), Sekhon *et al.* (2016), Patel *et al.* (2019), Vishvkarma (2020), Gupta *et al.* (2021), Sahoo *et al.* (2022).

### 5.7 Effect of different treatments of organic manures and inorganic fertilizers on soil and its status after harvesting of *kharif* onion

The highest soil organic carbon (54%) was obtained by the application of enriched FYM 15 tons, 10 tons and 20 tons might be due to the mineralization FYM increase the soil organic carbon status. In comparison to alone application to inorganic fertilizers. Similarly, Acharya *et al.* (2015), Gupta *et al.* (2020), Maida *et al.* (2021) reported that application of organic manures along with inorganic fertilizers improves the soil organic carbon status.

In case of the available nitrogen, the significant higher status of available nitrogen was recorded with treatment T<sub>9</sub>. 25%RDN+15 tons enriched FYM (354 kg ha<sup>-1</sup>) followed by treatment T<sub>8</sub>. 50% RDN+ 10tonne enriched FYM (331kg ha<sup>-1</sup>), while the minimum available nitrogen was obtained with application of sole application of inorganic fertilizers i.e., T<sub>1</sub>-Farmer practice (NPKS): 70-40-40-0 kg/ha (260 g ha<sup>-1</sup>), and T<sub>2</sub>. Recommended (NPKS): 100-50-50-30 kg/ha (respectively). The effect of inorganic fertilizer and organic manure application on soil nitrogen status could be ascribed to higher microbial activity in FYM applied plots as compared to sole application of inorganic fertilizers improved the concentration of nitrogen in soil solution. Similar results were reported by Dillon *et al.* (2020), Rai *et al.* (2014), Sharma *et al.* (2017).

The build of available phosphorus in soil was recorded with T<sub>3</sub>. NPKS: 120-50-50-40 Kg /ha (24.80 kg ha<sup>-1</sup>) and T<sub>7</sub>. 75% RDN+ 5tonne enriched FYM. (23.50 kg ha<sup>-1</sup>) treatments as compare to farmer practice 20 tons enriched FYM of application and reduction of 50 and 25% application of recommended dose of nutrient. This result might be due to the application of inorganic fertilizer build up the phosphorus in concentration in soil thereby increased the available phosphorus. Results were in confirmation with the Dillon *et al.* (2020), Rai *et al.* (2014), Sharma *et al.* (2017).

Similar trend was recorded with available potassium. The highest available potassium status was found after harvesting T<sub>5</sub>. NPKS: 150-50-60-70 kg/ha (320 kg ha<sup>-1</sup>) followed by T<sub>4</sub>. NPKS: 140-50-60-50 Kg/ha (313.67 kg ha<sup>-1</sup>) and T<sub>3</sub>. NPKS: 120-50-50-40 Kg/ha (307.00kg ha<sup>-1</sup>) (Respectively). While the minimum available potassium was recorded with application of 20tonnes enriched FYM. The potassium was applied through MOP fertilizer which releases slow potassium to soil solution. Hence the higher

availability of available fertilizer was obtained with the treatments in which inorganic fertilizers applied. Similarly reported by Dillon *et al.* (2020), Rai *et al.* (2014), Sharma *et al.* (2017).

The highest available sulphur status was found after harvesting T<sub>5</sub>. NPKS: 150-50-60-70 kg/ha (25.17kg ha<sup>-1</sup>) followed by T<sub>4</sub>.NPKS:140-50-60-50 Kg/ha (20.57kg ha<sup>-1</sup>) and T<sub>3</sub>. NPKS:120-50-50-40 Kg/ha (19.90kg ha<sup>-1</sup>) (Respectively). While the minimum available sulphur was recorded with application of 20tonnes enriched FYM was applied through bentonite fertilizer which is slow in soil and the availability of sulphur is higher in soil solution. Similarly reported by Dillon *et al.* (2020), Rai *et al.* (2014), Sharma *et al.* (2017).



## SUMMARY AND CONCLUSIONS

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The present investigation entitled “Performance of *kharif* onion under organic and inorganic fertilizer nutrient level”. was carried out during *kharif* season of 2022 Vegetable Research Farm of College of Horticulture, Banda University of Agriculture and Technology Banda (UP). The experimental material for the present investigation was comprised of nine treatments of organic manure and inorganic fertilizers on onion. These treatments were arranged in Randomized Block Design with three replications, to observe growth, yield, soil status and quality parameters to estimate the economics of the treatments. Observations were recorded on the basis of ten random competitive plants taken from each treatment separately for growth; yield and quality parameters were evaluated as per standard procedure and also estimate the economics. The treatments comprised of i.e., T<sub>1</sub>. Farmer practice (NPKS): 70-40-40-0 kg/ha, T<sub>2</sub>. NPKS:100- 50-50-30 kg/ha, T<sub>3</sub>. NPKS: 120-50-50-40 kg/ha, T<sub>4</sub>. NPKS: 140-50-60-50 kg/ha, T<sub>5</sub>. NPKS: 150-50-60-70 kg/ha, T<sub>6</sub>. 20 tons enriched FYM, T<sub>7</sub>. 75% RDN + 5 tons enriched FYM, T<sub>8</sub>. 50 % RDN + 10 tons enriched FYM, T<sub>9</sub>. 25 % RDN + 15 tons enriched FYM. On the basis of results, the present investigation is summarized given below:

The soil of the experimental field was silty clay loam in texture having moderate basicity (pH 8.2, E.C. 0.31) and poor fertility. Overall, the soil holds organic carbon of 0.38 %, available nitrogen of 254 kg ha<sup>-1</sup>, available phosphorus of 17.3 kg ha<sup>-1</sup>, potassium of 259.3 kg ha<sup>-1</sup> and Sulphur of 13.96, respectively.

The plant height significantly increased with the different treatments of organic manures and inorganic fertilizers up to 75 DAT. The maximum plant height was recorded in treatment T<sub>9</sub>-25 % RDN + 15 tones enriched FYM. Significantly maximum number of leaves per plant were recorded up to 75 DAT in the treatments T<sub>5</sub>-150-50-60-70 kg/ha. Significantly minimum bolting percentage per plot were observed in treatments T<sub>7</sub>-75% RDN + 5 tones enriched FYM and T<sub>9</sub>- 25 % RDN + 15 tones enriched FYM and they were at par with each other. The early maturity and harvesting 77.33 and 80.33 days were observed in treatments T<sub>9</sub>-25 % RDN + 15 tones enriched FYM. While, the late maturity and harvesting 81.67 days and 84.00 days exhibited in treatment T<sub>2</sub>-Recommended NPKS: 100-50-50-30 kg/ha. The maximum polar and equatorial diameter of bulb was recorded in

treatment T<sub>9</sub>-25% RDN + 15 tones enriched FYM (check) and which were at par with each other. The lowest polar and equatorial diameter of bulb was recorded in T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha.

Significantly maximum P: E ratio of bulb were exhibited in the treatment T<sub>4</sub>-NPKS: 140-5-60-50 kg/ha and which were at par with each other. However, the minimum P: E ratio of bulb was observed in T<sub>3</sub>. NPKS: 120-50-50-40kg/ha. The significantly maximum 20 bulbs weight (kg) and average bulb weight (g) were exhibited in the treatment T<sub>9</sub>-25 % RDN + 15 tones enriched FYM, which were at par with each other, whereas, the minimum 20 bulbs weight (kg) and average bulb weight (g) per plot was observed in T<sub>4</sub>-NPKS:140-50-60-50 kg/ha.

The treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha, T<sub>7</sub>-75 % RDN + 5 tones enriched FYM and T<sub>9</sub>- 25 % RDN + 15 tones enriched FYM was observed minimum (1.02%) per cent of double bulb. While the maximum (1.88%) of double bulb was found in treatment T<sub>5</sub>-NPKS: 150-50-50-60 kg/ha. Treatment T<sub>1</sub>-NPKS: 70-40-40-0 kg/ha, T<sub>3</sub>-NPKS: 120-50-50-40 kg/ha, T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha, T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha, T<sub>6</sub>-20 tonnes enriched FYM, T<sub>9</sub>-25 % RDN +15 tones enriched FYM was observed minimum (0.00%) per cent of rotten bulb. While the maximum (0.15%) of rotten bulb was found in treatment T<sub>2</sub>- NPKS: 100-50-50-30 kg/ha.

Significantly maximum gross yield (kg/plot) and (q/ha) was recorded the treatment T<sub>9</sub>- 25 % RDN +15 tons enriched FYM and was at par with each other. However, lowest Gross yield (kg/ha.) and gross yield (q/ha) was noted in T<sub>1</sub>-Farmer practice (NPKS): 70-40-40-0 kg/ha. Significantly maximum marketable yield (kg/plot) and (q/ha.) was recorded the treatment T<sub>9</sub>- 25 % RDN + 15 tons enriched FYM. The maximum (13.68%) total soluble solids were observed under the treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha followed by T<sub>5</sub>-NPKS: 150-50-60-70 kg/ha. (13.60%), T<sub>6</sub>-20 tons enriched FYM, (13.47%), T<sub>8</sub>-50 % RDN + 10 tones enriched FYM (13.30%), T<sub>9</sub>-25 % RDN + 15 tones enriched FYM (13.29 %) as compared to other treatment. The maximum (14.78) dry matters were observed in Treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha.

Significantly minimum thrips per plant were observed in treatments T<sub>6</sub>-20 tonnes enriched FYM. Therefore, it was noted maximum thrips per plant under the treatment T<sub>4</sub>-NPKS: 140-50-60-50 kg/ha. Probable reasons for this may be due to the doses of macro and micro nutrient. The minimum stemphylium blight intensity (4.47 %) was recorded at

maturity time in treatment T<sub>9</sub>- 25 % RDN +15 tones enriched FYM, while the maximum stemphylium blight intensity (5.60 %) recorded the treatment T<sub>4</sub>- NPKS: 140-50-60-50 kg/ha.

Higher money value and less cost of cultivation are desirable traits for getting higher returns. Hence economics of the treatments was work out. It is revealed form the date obtained that a significantly maximum bulb yield 232.22 q/ha was obtained in onion variety Line-883. The highest net return of Rs 4, 56, 727/ha was obtained in treatment T<sub>9</sub>- 25 % RDN +15 tones enriched FYM followed by T<sub>8</sub>-50 % RDN + 10 tones enriched FYM. (4,49,707/ha) and T<sub>5</sub>- NPKS: 150-50-60-70 kg/ha (4,23,697/ha) but maximum cost benefit ratio 1:3.94 was observed under the treatment T<sub>5</sub> due to low cost of cultivation followed by T<sub>4</sub>-(1: 3.93) and T<sub>8</sub>-(1: 3.86). While, lowest bulb yield 162.78 q/ha and net return of (Rs 3, 11,502/ha) along with cost benefit ratio 1:3.26 was observed in treatment T<sub>1</sub>-Farmer practice (NPKS): 70-40-40-0kh/ha.

### **Conclusion**

On the basis of present investigation, it is concluded that the onion variety Line-883 well in terms of growth and yield during *kharif*. Application of 25 % RDN + 15 tones enriched FYM were recorded the highest growth i.e., plant height and number of leaves per plant, yield attributing characters viz., polar and equatorial diameter of bulb, Neck thickness, Gross yield, Marketable Yield, and 20 bulb weight. It is revealed form the data obtained that a significantly maximum bulb yield of (232.22q/ha) was obtained in onion variety Line-883. The highest net return of (Rs. 4, 56, 727/ha) along with cost benefit ratio1:3.60 was obtained in treatment T<sub>9</sub>- 25 % RDN + 15 tones enriched FYM but maximum cost benefit ratio 1:3.90 was observed under the treatment T<sub>5</sub> due to low cost of cultivation. However, we can see the soil status in treatment T<sub>9</sub>-25 % RDN + 15 tones enriched FYM, that is significantly improve the soil health and fertility. The highest net return of (Rs. 4, 56,727/ha) along with cost benefit ratio1:3.60 was obtained in treatment T<sub>9</sub>-25 % RDN + 15 tones enriched FYM



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## APPENDIX

### Common cost of cultivation per hectare during - 2022

SN	Practices	Cost (Rs.)
1.	Nursery Preparation 10 labour@Rs.201/-per day	2,010/-
2.	Cost of seed 8 kg	8,000/-
3.	Seed sowing 12 labour @Rs.201/-per day	2,412/-
4.	Nursery managements 10 labour @Rs.201/-per day	2,010/-
5.	Application of Fungicide and Insecticides nursery	500/-
6.	2 ploughing with disc harrow &1 ploughing with cultivator followed by planking@ Rs.2000/-per ploughing	8,000/-
7.	Layout15 labor's @ Rs.201/-per day	3,015/-
8.	Uprooting onion nursery 20 labour @ Rs.201/-per day	4,020/-
9.	Transplanting in main field 70 labour@ Rs.201/-per day	14,070/-
10.	Irrigation through drip system 2 labour @ Rs.201/-per day	402/-
11.	Weeding and hoeing +application of Weedicides @ Rs.1000/-, 25 labour@ Rs.201/-per day	6,025/
12.	Micro nutrients spray 3 times 20 labour @ 201	4,020/-
13.	Harvesting 45 labour	9,045/-
14.	Neck cutting 55 labour	11,055/-
15.	Other expenses	4,000/-
16.	Transportation charges	2,500/-
17.	Land rent@15000/-per hectare/year	7,500/-
	Total	88,584/-

## Cost of different treatments per hectares during-2022

Notations	Treatments	Treatment Cost (Rs)/ha	Labor rate	Treatment Application charge (Rs)	Total Cost (Rs)
T <sub>1</sub>	<b>Farmers practice (N-P-K-S) 70-40-40-0 Kg/ha</b>	6,060	2 labor/application@ 201/- per day (2 application)	804/-	6,864
T <sub>2</sub>	<b>Recommended NPKS:100-50-50-30Kg/ha</b>	11,455	2 labor/application@ 201/- per day (2 application)	804/-	12,259
T <sub>3</sub>	<b>NPKS:120-50-50-40Kg/ha</b>	12,950	2 labor/application@ 201/- per day (2 application)	804/-	13,754
T <sub>4</sub>	<b>NPKS:140-50-60-50Kg/ha</b>	15,045	2 labor/application@ 201/- per day (2 application)	804/-	15,849
T <sub>5</sub>	<b>NPKS:150-50-60-70Kg/ha</b>	17,940	2 labor/application@ 201/- per day (2 application)	804/-	18,744
T <sub>6</sub>	<b>20 tones enriched FYM</b>	41,650	2 labor/application@ 201/- per day (2 application)	804/-	42,454
T <sub>7</sub>	<b>75%RDN+5 tones enriched FYM</b>	21,765	2 labor/application@ 201/- per day (2 application)	804/-	22,569
T <sub>8</sub>	<b>50% RDN+10 tones enriched FYM</b>	27,105	2 labor/application@ 201/- per day (2 application)	804/-	27,909
T <sub>9</sub>	<b>25%RDN+15 tones enriched FYM</b>	34,435	2 labor/application@ 201/- per day (2 application)	804/-	35,239

**Effect of NPK, FYM through bio-fertilizers their combination on the cost of cultivation of kharif onion**

<b>Treatments</b>	<b>Common expenditure (Rs/ha)</b>	<b>Cost of Different treatments (Rs/ha)</b>	<b>Total cost of cultivation (Rs/ha)</b>
T <sub>1</sub>	88,584/-	6,864/-	95,448/-
T <sub>2</sub>	88,584/-	12,259/-	1,00,843/-
T <sub>3</sub>	88,584/-	13,754/-	1,02,338/-
T <sub>4</sub>	88,584/-	15,849/-	1,04,433/-
T <sub>5</sub>	88,584/-	18,744/-	1,07,328/-
T <sub>6</sub>	88,584/-	42,454/-	1,31,038/-
T <sub>7</sub>	88,584/-	22,569/-	1,11,153/-
T <sub>8</sub>	88,584/-	27,909/-	1,16,493/-
T <sub>9</sub>	88,584/-	35,239/-	1,23,823/-

**Effect of NPK, FYM Through bio-fertilizers combinations on the gross income of *Kharif* onion**

<b>Treatments</b>	<b>Bulb yield(q/ha)</b>	<b>Rate (Rs/q)</b>	<b>Gross income (Rs/ha)</b>
T <sub>1</sub> (control)	162.78	2500.00/-	4,06,950/-
T <sub>2</sub>	182.96	2500.00/-	4,57,400/-
T <sub>3</sub>	196.76	2500.00/-	4,91,900/-
T <sub>4</sub>	206.20	2500.00/-	5,15,500/-
T <sub>5</sub>	212.41	2500.00/-	5,31,025/-
T <sub>6</sub>	195.74	2500.00/-	4,89,350/-
T <sub>7</sub>	212.59	2500.00/-	5,31,475/-
T <sub>8</sub>	226.48	2500.00/-	5,66,200/-
T <sub>9</sub>	232.22	2500.00/-	5,80,550/-

**Effect of NPK, FYM through bio-fertilizers their combination on the net return and benefit: cast ratio**

Notation	Treatments	Total cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net return (Rs/ha)	Benefit : cost ratio
T1	<b>Farmers practice (N-P-K-S) 70-40-40-0 Kg/ha</b>	95,448/-	4,06,950/-	3,11,502	1:3.26
T2	<b>Recommended NPKS:100-50-50-30Kg/ha</b>	1,00,843/-	4,57,400/-	3,56,557	1:3.53
T3	<b>NPKS:120-50-50-40Kg/ha</b>	1,02,338/-	4,91,900/-	3,89,562	1:3.80
T4	<b>NPKS:140-50-60-50Kg/ha</b>	1,04,433/-	5,15,500/-	4,11,067	1:3.93
T5	<b>NPKS:150-50-60-70Kg/ha</b>	1,07,328/-	5,31,025/-	4,23,697	1:3.94
T6	<b>20 tonnes enriched FYM</b>	1,31,038/-	4,89,350/-	3,58,312	1:2.73
T7	<b>75%RDN+ 5 tonneenriched FYM</b>	1,11,153/-	5,31,475/-	4,20,322	1:3.78
T8	<b>50% RDN+10tonne enriched FYM</b>	1,16,493	5,66,200	4,49,707	1:3.86
T9	<b>25%RDN+15tonne enriched FYM</b>	1,23,823	5,80,550	4,56,727	1:3.68

## CURRICULUM VITAE

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<b>Examination</b>	<b>Passing Year</b>	<b>Institute/ School</b>	<b>Board/University</b>	<b>Percentage/ OGPA</b>
<b>High School (Science)</b>	2015	Govt Girls Inter College Banda	U.P.Board	69.8%
<b>Intermediate (PCM)</b>	2017	Govt Girls Inter College Banda	U.P.Board	69.4%
<b>B.Sc. (Horticulture)</b>	2020	Zila parishad Krishi Mahavidyalaya, Banda	Bundelkhand University, Banda	70.40%
<b>M.Sc. (Horti.) Vegetable Science</b>	2023	College of Horticulture, BUAT, Banda	Banda University of Agriculture & Technology, Banda, U.P.	-

**Place: BUAT, Banda**

**Date: .....**

