iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** V **Month of publication:** May 2024

DOI: https://doi.org/10.22214/ijraset.2024.62281

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

Effect of Various Fertilization Methods on the Growth of Brassicaceae

Manish Kumar[1], Divyanshu Sharma[2], Kriti Bhandari[3]
UG Students, Department of Biotechnology, Delhi Technological University, New Delhi[1,2]
Professor, Department of Biotechnology, Delhi Technological University, New Delhi[3]

***Abstract:** When soil is used for agricultural purposes, plants absorb multiple nutrients from the soil such as nitrogen, potassium, phosphorus, etc. Overtime, the nutrients present in the soil start decreasing. This process is known as soil depletion and it can effect the growth of plants. Fertilizers are then added to soil in adequate amount to replenish the depleted nutrients. Fertilizers can be organic or inorganic. The usage of inorganic fertilizers has increased overtime and this can create many issues. This review evaluates the efficacy of different fertilization methods on the growth, yield, and health of Brassicaceae crops. It aims to provide an in-depth assessment of impact of fertilizers through recent studies and hopes to provide a holistic view of sustainable agricultural practices.*
***Keywords:** Fertilizers, Brassicaceae , chemical fertilizers, Biofertilizers and blended fertilizers*

I. INTRODUCTION

Brassicaceae, also known as Cruciferae in older terminology, is a mid-sized and economically significant family of flowering plants commonly referred to as the mustards, crucifers, or the cabbage family.
Cruciferous vegetables, integral to the human diet, are part of this family. Notable species include Brassica oleracea (cultivated as cabbage, kale, cauliflower, broccoli, and collards), Brassica rapa (turnip, Chinese cabbage, etc.), Brassica napus (rapeseed, etc.), Raphanus sativus (common radish), Armoracia rusticana (horseradish), and Matthiola (stock).

A. Nutritional Importance of Brassica Oleracea Crops

Brassica Oleracea crops are rich sources of essential nutrients, making them valuable contributors to human nutrition and health.

1) There are Vitamins and Minerals preesent in brassica crops like Vitamin c , Vitamin k and calcium that are essential for the health as the Vitamin c is abundant in mostly Brassica Oleracea crops which also contributes to the immune function, Vitamin k helps in supporting blood clotting and bone health too and calcium also helps in the bone health.
2) There are Phytochemicals like glucosinolates and Antioxidants that are bioactive compounds with have anticancer properties and they protect cells from oxidative stress which helps in reducing the risk of chronic disease.
3) Dietary Fiber are very supportive for digestive health and also improves the weight management and Brassica Oleracea crops are valuable for balanced diets as they have low in calories but high in essential nutrients.

B. Nutrient Requirements of Brassica Oleracea

The nutrient requirements of these crops are very crucial for the growth, development, and the production of high-quality crops.

1) There are Macro-Nutrients like Nitrogen , Phosphorous and Potassium which are very essential for vegetative growth of overall plant and for root establishment and overall plant health and also disease resistance:
2) Micro-Nutrients like Iron , Zinc, Manganese , Copper are also required for enzyme activities but in a smaller quantities but does plays a crucial role in various metabolic processes too.

II. SIGNIFICANCE OF THE REVIEW

In light of the increasing global food demand and the urgent need for sustainable agricultural practices, understanding the specific needs and responses of Brassicaceae to different fertilization methods is critical. The environmental cost of extensive chemical fertilizer use, including soil degradation, water pollution, and greenhouse gas emissions, has prompted a reevaluation of traditional agricultural practices.

This review aims to dissect and synthesize current research on the effects of various fertilization methods—specifically comparing biofertilizers and chemical fertilizers—on the growth, yield, and health of Brassicaceae crops. By integrating findings from multiple studies, this paper seeks to provide a comprehensive overview of how different fertilization practices influence plant physiological traits, crop productivity, and ecological sustainability. The ultimate goal is to identify best practices that can enhance crop yields and quality without compromising soil health and environmental safety.

Furthermore, the review addresses the gap in comprehensive comparative analyses of fertilization impacts on Brassicaceae, providing insights that could guide future agricultural policy and practice. By highlighting the advantages and limitations of biofertilizers and chemical fertilizers, this paper contributes to the ongoing discourse on how to balance productivity with environmental stewardship in agriculture.

III. OVERVIEW OF FERTILIZERS

Soil fertility tells us about the quality of soil in any area which is important as it helps us known if adequate amount of nutrients are present or not for the proper growth of plants. If the soil fertility is not good then it would need additional help in the form of added materials to supply the required nutrients. These added materials ate called fertilizers.

Fertilizers are substances added to soil to enhance or increase the fertility of soil and add any nutrients that soil lacks. They can be natural or artificial (containig chemical elements).

A. Historical Context of Fertilizer use in Agriculture

The practice of fertilization dates back to ancient agriculture but has seen significant advancements since the onset of the Green Revolution. Initially, organic materials such as manure and compost were the primary sources of nutrients. However, the mid-20th century marked a shift towards synthetic chemical fertilizers, driven by the need to meet the increasing food demands of a growing global population. These fertilizers provided targeted and immediate nutrient availability, leading to dramatic increases in crop productivity.

In the context of Brassicaceae, which are known for their high nutrient demands, the adoption of chemical fertilizers has been particularly intense. Studies from the late 20th century highlight the responsiveness of Brassicaceae species like Brassica napus and Brassica oleracea to nitrogen, phosphorus, and potassium applications, noting significant improvements in growth rates and yield metrics.

B. Classification Of Fertilizers

Fertilizers can be broadly classified in three types:

1) Organic Fertilizers

Organic fertilizers are derived from natural sources such as plant or animal manure and compost and other organic matter. These fertilizers are very important for sustainable agriculture as it improves soil health and provides the required nutrients and at the same time do not cause a lot of environment damage.

Types of organic fertilizers are:

a) Animal Manure: Includes cow, horse, poultry, and sheep manure. Manure is rich in nitrogen, phosphorus, potassium, and other micronutrients.

b) Compost: Decomposed organic matter, such as vegetable scraps, garden waste, and other biodegradable materials. Compost enriches the soil with a wide range of nutrients and improves soil structure.

c) Vermicompost: Compost produced using earthworms, which break down organic matter into nutrient-rich castings. Vermicompost improves soil fertility and structure.

2) Inorganic Fertilizers

Inorganic fertilizers or chemical fertilizers are chemical substances that are manufactured using natural origin elements and they help in providing all the essential nutrients that is needed for the growth and development of plants.

There are different types of inorganoic fertilsers and they are often referred to as NPK fertilizers:

a) Nitrogen (N) based Fertiliser: The most commonly used N-based fertilizers are ammonium nitrate and calcium ammonium nitrate. It is quite useful for vegetative growth and provides support to the plant in leafing out.

b) Phosphorus(P) based fertiliser: Some widely used P-based fertilizers are single superphosphate (SSP), triple superphosphate (TSP), and diammonium phosphate (DAP). Phosphorus is essential for root development, flowering and seed production.

c) Potassium (K) based fertiliser: some common K-based fertilizers are Potassium chloride and potassium sulfate. It regulates water balance, enzyme activation, and disease resistance.

The use of chemical fertilizers significantly enhances yield and biomass. It is also very beneficial for commercial farming as fertilizers improve the size, colour, taste and uniformity of plants.

3) Mixed Fertilizers

Mixed fertilizers, also known as integrated or blended fertilizers, combine the benefits of chemical and organic fertilizers to provide a balanced nutrient supply and enhance soil health. They enhance plant growth, improve crop quality, and support soil health, making them particularly beneficial for Brassicaceae crops.

Some examples are:

a) Biofertilizer-Enriched Chemical Fertilizers: Combining chemical fertilizers with biofertilizers, which contain living microorganisms that enhance nutrient availability and soil health.

b) Organomineral Fertilizers: Blends of organic materials such as compost or manure with mineral nutrients like urea, phosphates, and potash.

c) Humic Acid-Enriched Fertilizers: Chemical fertilizers enhanced with humic acids derived from organic matter, which improve nutrient uptake and soil structure.

IV. MATERIALS AND METHODS

A. Source Selection

The studies included in this review were selected based on their relevance to the fertilization of Brassicaceae species, with a focus on peer-reviewed articles published within the last two decades. Preference was given to research that provided clear data on growth metrics, yield outcomes, and biochemical responses to different fertilization treatments. Databases such as PubMed, Scopus, and Web of Science were utilized to gather a comprehensive array of studies, ensuring a broad representation of global research efforts.

B. Collected Data Overview

The study taken from "Comparative Effects of Biofertilizers, Chemical Fertilizer and Fungicide on Growth of Brassica nigra " by the authors Rabia Badar and Shamim A.Qureshi investigates the effects of microbial inoculants (biofertilizers) and chemical treatments on the growth and biochemical parameters of Brassica nigra (black mustard) plants.Microbial inoculants used include Trichoderma hamatum, rhizobium, and bradyrhizobium isolates, both alone and in combinations. Additionally, NPK (chemical fertilizer) and carbendazim (chemical fungicide) were applied as positive controls. The plants were analyzed at 30 and 60 days for physical (root length, shoot length, biomass) and biochemical (chlorophyll, carbohydrates, crude protein, nitrogen, and phosphorus content) parameters.

C. Key findings include

1) Growth Performance

a) T. hamatum (JUF1): Increased root and shoot lengths by less than 50% at both 30 and 60 days. Improved fresh weight significantly at 60 days.

b) Rhizobial Isolates:

- JUR3: Enhanced root length by 22-26% and shoot length by 27-66% at 30 days. Increased fresh weight by 179% at 30 days and 30% at 60 days.
- JUR4: Promoted root length by 16-34% and shoot length by 19-22%. Increased fresh weight by 86% at 30 days.
- Combinations with FTZ: Improved fresh weight and shoot length more effectively.

2) Photosynthetic Pigments

a) T. hamatum (JUF1): Increased total chlorophyll and its fractions by 16-105% at 30 days and 35-132% at 60 days.

b) Rhizobial Isolates:

- JUR3: Boosted total chlorophyll by 66% and its fractions by 102-131% at 30 days; chl-b by 112% at 60 days.
- JUR4: Increased chl-a by 78% at 30 days and chl-b by 84% at 60 days.
- Combinations with FTZ: Enhanced total chlorophyll and its fractions significantly.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

3) Biochemical Parameters

a) Carbohydrate Content:

- T. hamatum (JUF1): Increased carbohydrates by 215% at 30 days.
- JUR3 and JUR4: Improved carbohydrate content significantly, with JUR4 showing the highest increase (146-240%).
- Combinations with FTZ and FGD: Significantly boosted carbohydrate content.

b) Crude Protein Content:

- T. hamatum (JUF1): Increased crude protein by 87%.
- JUR3 and JUR4: Enhanced protein content significantly, with JUR4 being more effective.
- Combinations with FTZ and FGD: Improved protein content substantially.

4) Mineral Content

a) Nitrogen Content:

- T. hamatum (JUF1): Increased nitrogen content, especially when co-inoculated with JUR3 and JUR4.
- JUR3 and JUR4: Substantially boosted nitrogen levels, with JUR4 being the most effective.
- Combinations with FTZ and FGD: Enhanced nitrogen content.

b) Phosphorus Content:

- T. hamatum (JUF1) + JUR3/JUR4: Improved phosphorus content significantly.
- JUR3 and JUR4: Increased phosphorus levels markedly.

The treatments with microbial inoculants, both alone and in combination, generally showed positive effects on growth, photosynthetic pigments, carbohydrate, protein, and mineral contents of the Brassica nigra plants.

Another study named “Nitrogen and sulfur fertilizers effects on growth and yield of Brassica carinata in South Dakota” by the authors “Dwarika Bhattarai, Sandeep Kumar, Thandiwe Nleya” studies the effects of Nitogen and sulfur fertilizers on Brassica carinata.

The experiment was a randomized complete block design with 12 treatments, including four nitrogen (N) rates (56, 84, 112, and 140 kg N/ha) and three sulfur (S) rates (0, 22, and 45 kg SO4-S/ha) arranged factorially. Plots were 1.62 by 9.14 m, with each treatment in three adjacent plots. N and S were applied using ammonium sulfate and urea. Weeds were managed with herbicides and manual removal. Fertilizers were applied in two equal splits: post-planting and at bolting stage. Data collected included plant stands, nutrient content, flowering and maturity dates, plant height, branch and pod counts, and seed and oil yields. Seed oil content was analyzed using hexane extraction and NMR. The study examined the effects of different nitrogen (N) and sulfur (S) fertilizer rates on carinata plants in 2017 and 2018. Weather data showed variations in temperature and rainfall, impacting planting and harvesting times. Leaf tissue analysis revealed that S fertilizer significantly increased leaf S concentrations. N and S fertilizers significantly affected plant height and the number of primary and secondary branches, with higher rates promoting greater growth. Lodging was more severe with higher fertilizer rates due to increased plant height. The number of pods per plant, pod length, and seed count were also influenced by N and S rates, with optimal fertilizer combinations enhancing these traits. Overall, the study highlighted the importance of N and S in improving carinata growth and yield.

We gathered more information from study “An Evaluation of the Physical and Chemical Parameters in Brassica Seedlings Grown on Various Organic Substrates” by the authors “Krzysztof Konrad Jadwisie´nczak , Joanna Majkowska-Gadomska , Anna Francke and Zdzisław Kaliniewicz ”.

The experiment followed integrated production methodologies and Polish regulations on plant protection products. Two factors were considered: Brassica species (Broccoli, White cabbage, Cauliflower) and substrate type (Aura, PRO1, PRO2, PRO3). Seedlings were grown in a greenhouse under controlled conditions. The chemical properties of substrates were analyzed before the experiment. Greenhouse conditions were controlled for temperature, humidity, and light. Seedlings were watered and fertilized according to specific protocols.Parameters such as leaf greenness (SPAD index), seedling height, number of leaves, and biomass were measured. Leaves and roots were weighed, and SPAD index was measured twice during the experiment.Data were processed statistically using descriptive statistics, analysis of variance (ANOVA), and Tukey's test to identify significant differences. The significance level was set at $\alpha = 0.05$. Substrate type significantly influenced SPAD values, with broccoli showing the highest values on PRO2. Cauliflower was less affected by substrate type compared to broccoli and white cabbage. Root mass varied among species and substrates, with PRO2 showing the most stimulatory effect on root development.

The chemical composition of the plants, particularly macronutrient and micronutrient content in leaf dry matter, was also assessed. Macronutrient content (nitrogen, phosphorus, potassium, magnesium, calcium) was influenced by substrate type and species, with variations observed in different substrates. Similarly, micronutrient content (iron, zinc, boron, manganese, copper) varied across species and substrates, with significant interactions between substrate and species.

Overall, the study highlights the importance of substrate selection in influencing the growth, development, and nutrient composition of Brassica seedlings, with implications for optimizing agricultural practices and enhancing crop quality and yield

V. CONCLUSION

There is a critical need for review of the effects of fertilizers on Brassicaceae that can be beneficial to guide future agricultural strategies and regulatory policies. There should be focus on both the merits as wells as demerits of using organic and inorganic fertilizers along with mixed fertilizers.

The usage of chemical fertilizers increased with the modern times as it showed immediate benefits along with being budget friendly in most cases. But the rising environmental awareness amongst the general public has challenged it's use in the recent years. This has pushed the interest towards organic fertilizers to new heights. The more natural products which are enriched with microorganisms enhance plant growth and also improves soil fertility overtime.

Also, the evolution of agricultural science in response to global challenges is shifting towards innovative biofertilizer application after the usage of synthetic chemical for decades. The development and implementation of the said sustainable and environmentally friendly fertilization practices are crucial for the growth of Brassicaceae crops.

The focus on future research in this field pf study should be on developing versatile and effective organic fertilizers that can be operated across various environmental settings and crop types.

The advantages of integration of organic and chemical fertilizers are highlighted in this review. It can be a viable solution to enhance the production of Brassicaceae crops. There can be multiple benefits of this approach. It not only helps in enhancing the crop yield but also contributes to the long-term sustainability of farming practices. The dependence on chemical fertilizers can be reduced significantly and soil health will also be improved.

REFERENCES

[1] "Research progress on Brassicaceae plants: a bibliometrics analysis" by "Ruixue Zhou, Xinsheng Qin, Junjun Hou and Yining Liu"

[2] "Brassica Genus Seeds: A Review on Phytochemical Screening and Pharmacological Properties" by " Jawaher Ayadi, Mohamed Debouba, Rami Rahmani and Jalloul Bouajila"

[3] "Brassica Seedlings Grown on Various Organic Substrates" by "Krzysztof Konrad Jadwisie´nczak, Joanna Majkowska-Gadomska, Anna Francke and Zdzisław Kaliniewicz"

[4] "A Review on the Effect of Organic and Chemical Fertilizers on Plants" by "Ameeta Sharma, Ronak Chetani"

[5] "Nitrogen and sulfur fertilizers effects on growth and yield of Brassica carinata in South Dakota" by "Dwarika Bhattarai Sandeep Kumar Thandiwe Nleya"

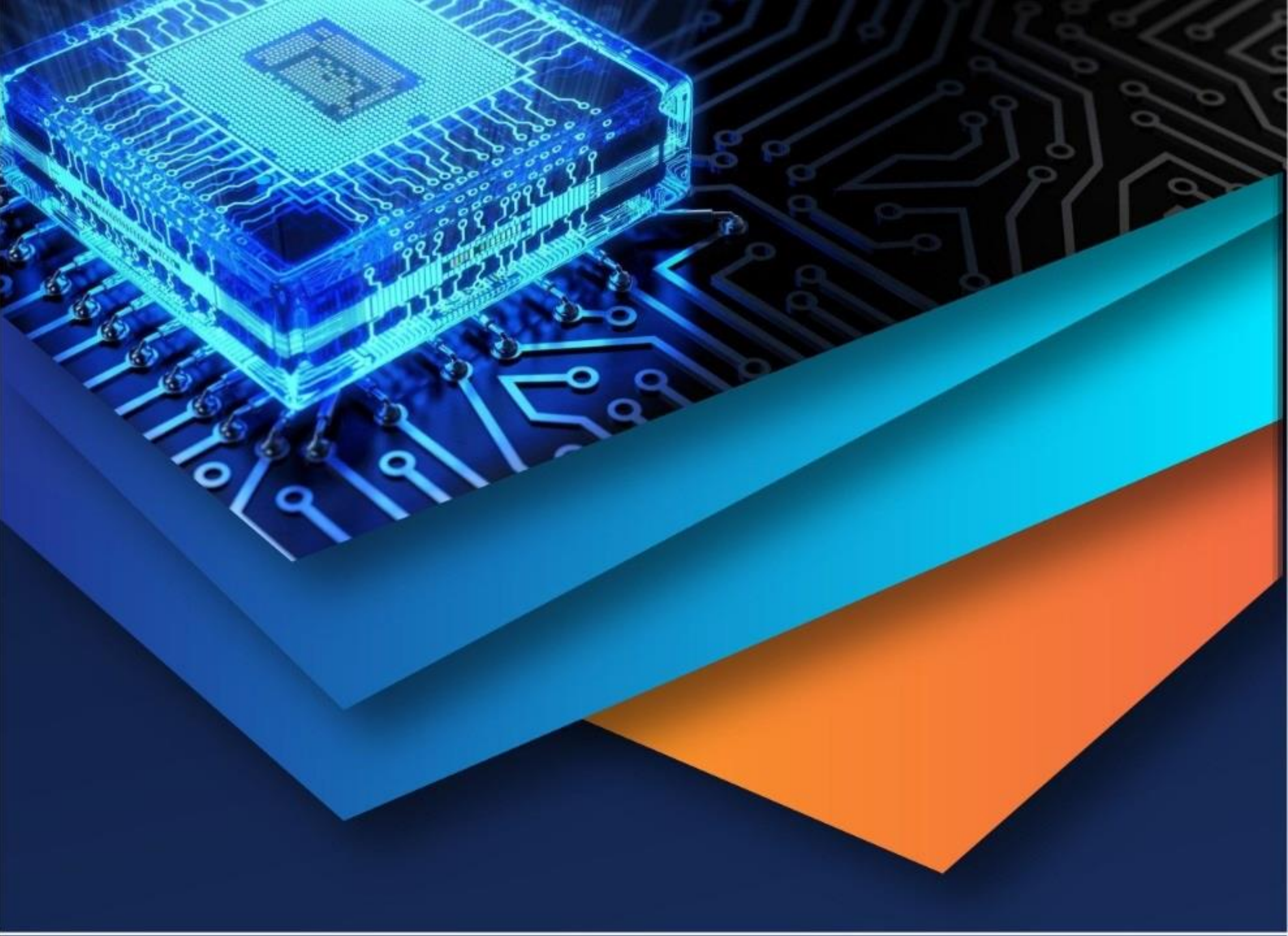
[6] "Botanical Description Of Six Brassica Species With Relevance To Their Quantitative And Morphological Characteristics" by "Adila Hanif, Muhammad Rizwan Ashraf, Ashir Masroor, Masood Iqbal Awan, Ghulam Mustafa, Shabbir Ahmad And Shoukat Zaman Khan"

[7] "Comparative Effects of Biofertilizers, Chemical Fertilizer and Fungicide on Growth of Brassica nigra" by "Rabia Badar and Shamim A.Qureshi"

[8] "Changes in Growth and Nutrient Uptake in Brassica oleracea Exposed to Atmospheric Ammonia" by "ANA CASTRO, INEKE STULEN, FREEK S. POSTHUMUS and LUIT J. DE KOK"

[9] " Effect of Fertilizers on Growth, Yield, Yield Components, Quality and Certain Nutrient Contents in Broccoli (Brassica oleracea)" by "BASEL A. OUDA AND ATIF Y. MAHADEEN"

[10] "EFFECT OF VARIOUS CONCENTRATIONS OF DIFFERENT FERTILIZERS ON GROWTH AND OTHER PARAMETERS OF BRASSICA NIGRA L." by "Jha S. S., Watakhere D. N. and Jakhi P. S"



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY