Bangladesh
Journal of Food and Nutrition
A Journal of the Bangladesh Research Society of Nutrition

eISSN: 3078-6789 Volume-1, Issue-2

Original Research Article DOI: https://doi.org/10.70945/bjfn.2024.v01i02.012

Evaluating the Impact of N and P Fertilization on the Agronomic, Physiological, and Biochemical Properties of Castor (*Ricinus communis L.*) and Its Implications for Sustainable Oil Production

Hamid kheyrodin*

* Assistant Professor Semnan University -Iran

OPEN ACCESS

Citation:
Hamid kheyrodin (2024). Evaluating the Impact of N and P Fertilization on the Agronomic, Physiological, and Biochemical Properties of Castor (Ricinus communis L.) and Its Implications for Sustainable Oil Production. *Bangl J Food Nutr*, 1(2), 91-97.

Received: 14/08/2024
Accepted: 16/09/2024
Published: 29/11/2024

Abstract: Castor bean plant (Ricinus communis L.) belonging to the Euphorbiaceae family is an important oilseed crop all over the world. It is widely cultivated throughout tropical and subtropical regions, such as Brazil, India, China, Thailand, Ethiopia, and Philippines. Only one percent of the castor oil (Molecular Formula C57H104O9) produced worldwide is used for medicinal purposes or in the production of health products. Castor oil has various uses in medicine, industry, and pharmaceuticals. It is found in food, medication, and skin care and is also used as an industrial lubricant and biodiesel component Excessive use of castor oil in pregnant women can cause premature labor. Castor oil is a triglyceride, which chemically is a glycerol molecule with each of its three-hydroxyl group esterifies with a long-chain fatty acid. Its major fatty acid is the unsaturated, hydroxylated 12-hydroxy, 9-octadecenoic acid. Castor oil, made from the Ricinus communis plant's seeds, has been used for thousands of years. A heating process deactivates its toxic enzyme, ricin, making it safe to use. This research was conducted in the winter of 1403 in a randomized complete block design with three replications in the desert research greenhouse of the Faculty of Desert Semnan University. The number of treatments in the research design map is as follows. Control (without adding fertilizer) 2- Urea fertilizer 100 kg per hectare, 3- Phosphorus fertilizer 250 kg per hectare Ammonium phosphate 4- Animal manure 30 tons per hectare is considered in each replication. The experiment was started in winter and followed up and irrigation and maintenance were carried out in summer and irrigation was done by spraying. We concluded that species-specific responses to N and P and manure enrichment were significantly promoted net photosynthetic rate and growth factors and stem length, leaf area, number of capsules and number of seeds per capsule, number of clusters per plant, and amount of oil produced of castor.

Keywords: Ricinus genus, N, P enrichment, castor oil.

INTRODUCTION

Castor (*Ricinas communis*) is a member of the Euphorbiaceae family. It is the only polytypic species of this family that is called castor in England. This plant is native to East Africa, but it is also widely distributed in other parts of the world, such as Iran, Afghanistan, the Soviet Union, Palestine, Southeast Asia, India, China, and the Arabian Peninsula. Castor has been of interest to humans since ancient times, with castor seeds found in tombs dating back to 4000 BC in Egypt, and the Chinese using castor oil in medicine. In the past, the use of castor was limited to collecting its seeds from wild species, but from the 18th century onwards, with the recognition of the importance of its oil in medicine and its cultivation and industry, scientific work on it began in the United States, the Soviet Union, England, and some other countries. Today, Brazil and India play a leading role in castor oil production, and its export is mostly done by these two countries. Castor oil is an annual plant with a long stem. Castor oil leaves are large, single, claw-shaped and composed of 5 to 11 deep lobes with long petioles with easily falling spatulae. The inflorescence is a cluster and appears in August and September. In which male and female flowers are observed separately. Its fruit is a capsule and covered with thorns or without thorns. There are three seeds in each fruit. The fruit may be blooming or indehiscent. Castor oil cultivation and planting is simple and can grow at different altitudes. However, from an economic point of view, the yield from its cultivation above 2000 meters is not economical and cost-effective. Extreme cold seriously damages castor oil Awaad and Mahdavi *et al*, And the growth period of castor oil should be free from cold, and castor oil is famous for its drought resistance and gives a good crop with relatively low rainfall [1, 2]. The role of seed organs and leaves in castor oil fig 1. The application of fertilizers in different ratios between N, P and K is a balanced fertilization method. Balanced fertilization refers to the application technology of reasonable fertilizer dosage and ratio based on the fertilizer demand characteristics of crops, soil fertilizer supply performance and fertilizer dosage to maintain nutrient balance between the proposed fertilizer dosage and ratio Zhang *et al*., Castor oil has many medical and therapeutic uses, as well as various other applications [3, 4]. The alcoholic extract of castor leaves has been shown to protect the liver from damage by toxins. One of the uses of castor oil medicinally is as a laxative, as castor oil is a natural and potent laxative. Methanolic extracts of the leaves have shown antimicrobial properties in antimicrobial tests against pathogenic bacteria. The shell of the bean-shaped castor seed has been shown to have an effect on the central nervous system at lower doses. Today, the use of inorganic fertilizers, especially nitrogen fertilizers, in agriculture to increase crop yields and provide food for the growing human population has caused problems, the most important of which is environmental pollution. Most important country product castor oil fig 2.

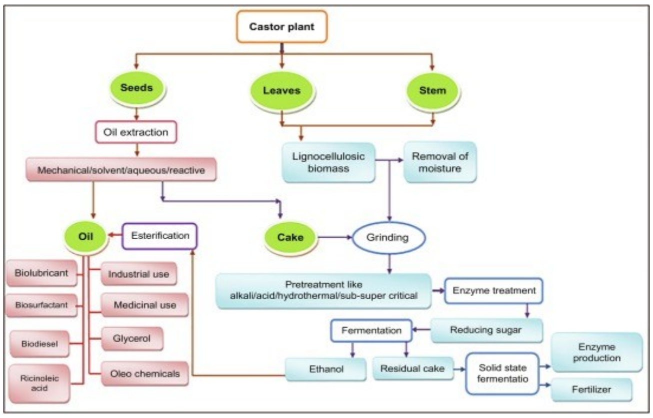

Figure 1: Potential and Perspective of Castor Biorefinery

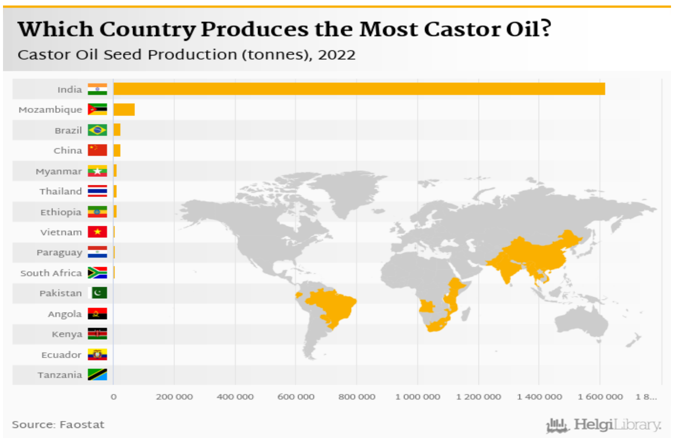

Figure 2: World country product the most castor oil

Since there is little information available about the response of castor oil plants to various types of animal and chemical fertilizers, this experiment will be conducted to investigate the effect of various fertilizer sources, including cattle and chemical fertilizers, on the physiological, agronomic, and morphological characteristics, as well as seed and oil yield of castor oil plants.

MATERIALS AND METHODS

In order to study the effects of urea, phosphorus and livestock manure on the agronomic and physiological properties of castor oil and the possibility of its development in improving the green space of Semnan University in Semnan city, a research entitled Study of the effects of nitrogen and phosphorus fertilizers on various agronomic and physiological properties and the efficiency of castor oil and the possibility of its application in the development of the green space of Semnan University is being carried out. This research is carried out in the winter of 1403 in the form of a randomized complete block design with three replications in the Desert Research Greenhouse of the Faculty of Desertology of Semnan University. The number of treatments in the research design map is as follows. Control (without adding fertilizer) 2- Urea fertilizer 100 kg per hectare, 3- Phosphorus fertilizer 250 kg per hectare Ammonium phosphate 4- Livestock manure 30 tons per hectare is considered in each replication. The experiment was started in winter and its follow-up, irrigation and maintenance were carried out in summer and irrigation was done by spraying. . The seed used is from the local population of Semnan city. Before starting and planting the seeds, first the physical properties and texture of the soils and the chemical properties and exchangeable ions and micronutrients and a number of biochemical properties of enzymes such as urease are measured in the soil sample. Then the castor seeds are planted directly in the pot. After 4 months of storage in the fall.

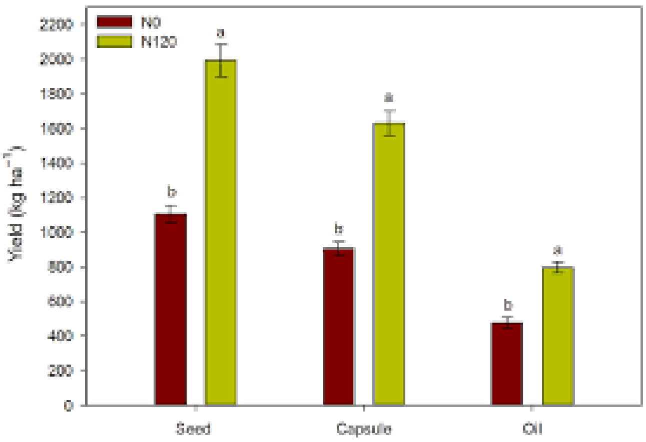

Figure 3: Castor seed, capsules and oil yield (kg ha^{-1} ± SE) under nitrogen

Before harvesting, the canopy height, the distance of the main inflorescence from the soil surface to the place of the beginning of the inflorescence, the number of lateral branches, the number of fertile inflorescences and the length of the main inflorescence and other inflorescences will be measured in three plants. Then the plants are harvested and the characteristics of the number of fertile capsules per plant, the number of seeds per plant, the weight of one hundred seeds and the weight of seeds per plant are measured. To determine the yield, the remaining plants are harvested and their seeds are threshed and weighed. Finally, the grain yield is calculated in kilograms per hectare. The percentage of oil in the seeds is also measured using a Soxhlet apparatus and the percentage of oil and the oil yield (the product of the grain yield and the percentage of oil) are calculated. The data from the experiment are analyzed using Excel software and the means are compared by Duncan's test at a probability level of 5%. And the relationships between growth components and the effects of the fertilizer regime will be examined.

RESULTS AND DISCUSSION

The project has several main objectives. The result show in fig 3 and 4 and 5 and table 1 and

2. P concentrations in terms of dry matter in leaf laminae of P-sufficient plants decreased strongly with leaf age and tended to decrease from the first to the second harvest. Also, Concentrations changed similarly in the P-deficient plants, but, as expected were consistently lower than in the controls, particularly in old leaves. However, P concentrations in young leaf laminae of P-deficient plants remained at levels comparable to those normally regarded in shoots as sufficient Andrews *et al*.

1- Investigating the success of the issue of the possibility of producing castor oil in Semnan province. And determining the exact date of planting.
2- Identifying the appropriate soil texture for planting castor oil in Semnan city is possible.
3- Determining important physiological parameters of castor oil related to increasing oil production.
4- Measuring micronutrients and divalent metals in the rhizosphere of castor oil roots and presenting a mathematical model related to chlorophyll and leaf photosynthesis.
5- Identifying the characteristics and traits affecting oil yield and (photosynthesis level and structural status) using germplasm identification and physiology and phenotype of castor oil varieties for Semnan city and province.
6- Identifying important unknown and little-known pests and diseases of castor oil in Semnan province.
7- Studying the identification of castor oil yield in different soils and identifying its relationship with water requirements in Semnan.
8- Determining the accuracy of measuring chlorophyll content by extracting the extract and based on the Grass 1991 method
9- The ultimate goal of this research is to investigate the extent and degree of effect of using appropriate fertilizer on growth responses and functional capacity of castor oil in Semnan University and city
10- Performing regression and presenting a mathematical model for all traits and their determining role such as panicle and stem length, stem number, leaflet width in the performance of castor oil genotypes

The castor bean (*Ricinus communis L.*), is an oilseed of relevant economic and social importance [5]. From its seeds is extracted an oil of excellent properties, having wide use as industrial input and several applications Our results of analysis of variance showed the effect of biofertilizer and superabsorbent treatments at the level of 5% probability on plant height, number of seeds per plant, main cluster length, number of capsules per plant, 1000-seed weight, biological yield, grain yield, harvest index Oil percentage, oil yield, castor oil were significant. Also, the interaction effect of biosorbent and superabsorbent on plant height, number of seeds per plant, main cluster length and oil yield at the level of 5% probability and on grain yield, harvest index at the level of 1% probability was significant Egamberdieva and Saharan *et al.* [6-10].

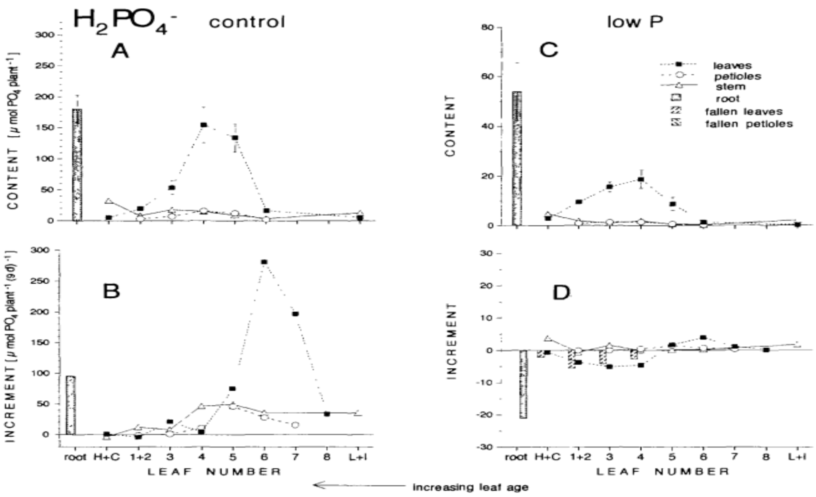

Figure 4: Effect of Low and high P application on stem and leaves Andrews 1985.

Table 1: Correlation analysis between biomass and photosynthetic indexes of true leaves under stresses.

Correlations	FW	DW	Water content	P_N	g_s	*Tr*	Chl a	Chl b	Car	Fv/Fm	ΦPSII	q_p	NPQ
FW	1												
DW	0.753	1											
Water content	0.980**	0.805*	1										
P_N	0.971**	0.703	0.981**	1									
g_s	0.967**	0.619	0.958**	0.984**	1								
Tr	0.906**	0.561	0.903**	0.951**	0.971**	1							
Chl a	0.502	0.389	0.43	0.507	0.43	0.46	1						
Chl b	−0.505	−0.012	−0.499	−0.517	−0.626	−0.568	0.311	1					
Car	0.949**	0.662	0.964**	0.991**	0.987**	0.980**	0.459	−0.554	1				
Fv/Fm	−0.303	0.182	−0.338	−0.418	−0.496	−0.461	0.27	0.818*	−0.458	1			
ΦPSII	0.383	0.381	0.248	0.155	0.192	0.058	0.223	−0.012	0.086	0.361	1		
q_p	0.789*	0.385	0.716	0.726	0.735	0.601	0.44	−0.56	0.663	−0.322	0.464	1	
NPQ	−0.705	−0.208	−0.673	−0.754	−0.752	−0.66	−0.458	0.578	−0.712	0.615	−0.057	−0.871*	1

**Represented significant correlation ($P < 0.05$), **represented extremely significant correlation ($P < 0.01$).*

The results suggested that alkali stress could cause much more damage to the castor bean seedlings, and different physiological responses and adaptive strategies are found in cotyledons and true leaves under salt-alkali stress. This study will help us develop a better understanding of the adaptation mechanisms of cotyledon and true leaf during early seedling stage of castor bean plant, and also provide new insights into the function of cotyledon in *Ricinus communis* under salt-alkali stress conditions.

Figure 5: Castor oil growing in Semnan University greenhouse

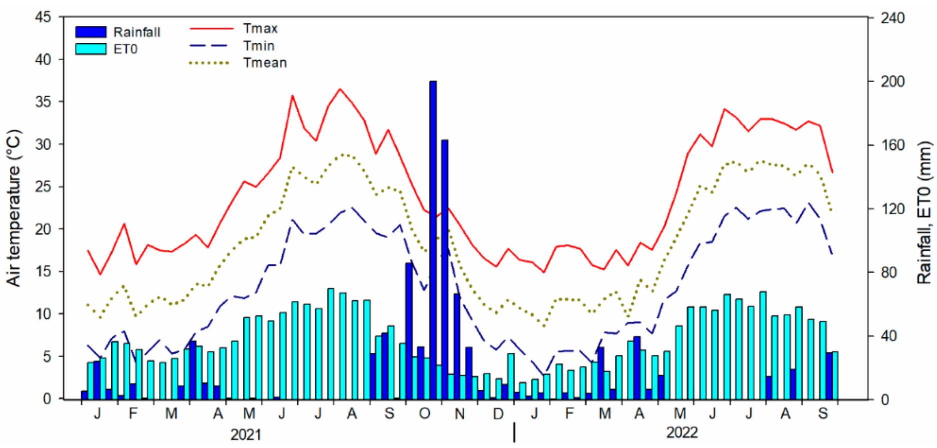

Figure 6: Effects of Nitrogen Fertilization and Soil Water Content on Seed and Oil Yield

Table 2: Analysis variance of the effects of N and P and Nd manure on the growth of potato fresh weight leaves

Source of vatiation	DF	SS	Ms
Replication	2	2.00	0.04
treatment	3	66	12
errore			
Significant at 1% level			No significant at 5 % level

CONCLUSION

This paper first reported the different adaptation strategies (from the viewpoint of growth, photosynthesis and chlorophyll fluorescence) of cotyledon and true leaf in Ricinus communis under salt stress and alkali stress. The results clearly showed that alkali stress caused more damage to castor bean seedlings than salt stress. The decrease in the biomass of cotyledons is lower than that in true leaves. Salt-alkali stress only reduced photosynthetic pigments and ΦPSII in cotyledons, but did not affect those in true leaves. Additionally, Fv/Fm and NPQ both decreased in cotyledons but increased in true leaves with increasing salinity-alkalinity. Different physiological responses and adaptive strategies were found in cotyledons and true leaves of this species under salt-alkali stress. The results will help us develop a better understanding of the adaptation mechanisms of cotyledon and true leaf during early seedling stage of castor bean plant, and provide new insights into the function of cotyledon in Ricinus communis under salt-alkali stress conditions. Castor oil is a vegetable oil obtained by pressing the seeds of the castor oil plant (*Ricinus communis L.*) mainly cultivated in India, South America, Africa, and China. Castor oil is a rich source of [DB02955], which represents up to 90% of the total castor oil content. It also consists up to 4% linoleic, 3% oleic, 1% stearic, and less than 1% linolenic fatty acids. [DB02955] has a hydroxyl group that provides a functional group location for various chemical reactions, making it a favorable substance in industrial applications. Castor oil does not contain ricin, which is a natural poison found in the castor oil plant; the toxic lectin remains in the bean pulp following oil isolation. Due to its renewability and high versatility in addition to being the only commercial source of a hydroxylated fatty acid, castor oil has been used as a vital raw material for the chemical industry. Castor oil was mainly used in the manufacturing of soaps, lubricants, and coatings. It is an FDA-approved food additive directly added to food products for human consumption. It can also be found in hard candies as a release agent and anti-sticking agent, or supplementary vitamins and mineral oral tablets as an ingredient for protective coatings. Castor oil is found in over-the-counter oral liquids as a stimulant laxative, and is also added in commercial cosmetic, hair, and skincare products. We concluded that the low P availability decreased the gas-exchange parameters such as the net photosynthetic rate, transpiration rate, and stomatal conductance, and increased the intercellular CO_2 concentration. Chlorophyll a fluorescence demonstrated that the leaves' absorption and trapped-energy flux were largely steady. In contrast, considerable gains in absorption and trapped-energy flux per reaction center resulted from decreases in the electron transport per reaction center under low-P conditions. In addition, low P availability reduced the activities of antioxidant enzyme

Acknowledgment

We thank Semnan university directure Dr. Sadodin from collaboration laboratory assistant in this

Research.

Funding: No funding sources

Conflict of interest: None declared

REFERENCES

1. Awaad MS, El-Shazely MA, Taha MB, Abdalla IM. Effect of different nitrogen sources combination with bio-fertilizers on yield and chemical composition of canola and sesame crop. Journal of Soil Sciences and Agricultural Engineering. 2020 Dec 1;11(12):809-16.
2. Mahdavi Khorami A, Masoud Sinaki J, Amini Dehaghi M, Rezvan S, Damavandi A. Sesame (Sesame indicum L.) biochemical and physiological responses as affected by applying

chemical, biological, and nano-fertilizers in field water stress conditions. Journal of Plant Nutrition. 2020 Feb 7;43(3):456-75.

3. Zhang X, Li S, An X, Song Z, Zhu Y, Tan Y, Guo X, Wang D. Effects of nitrogen, phosphorus and potassium formula fertilization on the yield and berry quality of blueberry. Plos one. 2023 Mar 16;18(3): e0283137.
4. Sadeghi-Bakhtavari AR, Hazrati S. Growth, yield, and fatty acids as affected by water-deficit and foliar application of nitrogen, phosphorus, and sulfur in castor bean. Journal of Crop Improvement. 2021 Jul 4;35(4):453-68.
5. Andrews M, Morton JD, Lieffering M, Bisset L. The partitioning of nitrate assimilation between root and shoot of a range of temperate cereals and pasture grasses. Annals of Botany. 1992 Sep 1;70(3):271-6.
6. Egamberdieva D, Wirth S, Bellingrath-Kimura SD, Mishra J, Arora NK. Salt-tolerant plant growth promoting rhizobacteria for enhancing crop productivity of saline soils. Frontiers in microbiology. 2019 Dec 18; 10:2791.
7. Saharan BS, Nehra V. Plant growth promoting rhizobacteria: a critical review. Life Sci Med Res. 2011 Jan 1;21(1):30.
8. Nahar K, Pan WL. Urea fertilization: Effects on growth, nutrient uptake and root development of the biodiesel plant, Castor Bean (*Ricinus communis L.*). American Journal of Experimental Agriculture. 2014 Oct 17;5(4):320-35.
9. Liang D, Zhang Q, Zhang W, Liu L, Liang H, Quirino RL, Chen J, Liu M, Lu Q, Zhang C. Tunable thermo-physical performance of castor oil-based polyurethanes with tailored release of coated fertilizers. Journal of cleaner production. 2019 Feb 10; 210:1207-15.
10. Osati F, Mahmoudi TM, Eslam BP, Seta SY, Monirifar H. Effect of irrigation levels and foliar application of fertilizers on some agronomic and oil characteristics of castor bean (*Ricinus communis L.*). Plant Science Today. 2022 Jan 1;9(1):1-8.

Corresponding Author: Hamid kheyrodin