Effects of certain mineral fertilizers on the biological mass of \textit{Indigofera Tinctoria} and \textit{Impatiens Balsamina} plants

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Abstract. The article describes the effect of mineral fertilizers on the cultivation of dyed \textit{Indigofera} (\textit{Indigofera tinctoria} L.) and henna (\textit{Impatiens balsamina} L.), the amount of their application and the ratio of basic nutrients (nitrogen, phosphorus and potassium) related. It has been established that the adequate development of \textit{Indigofera} and henna plants depends on the ratio of mineral fertilizers used.

1. Introduction
A key indicator of the development and independence of the local pharmaceutical industry is the cultivation and production of import-substituting and export-oriented medicinal plant raw materials in those areas. In this regard, the Resolution of the President of the Republic of Uzbekistan dated April 10, 2020 No PP-4670 "On measures for the protection, cultivation, processing and rational use of available resources of wild-growing medicinal plants" was adopted. This document was a practical application to radically change the industry.

In accordance with this resolution, in order to further develop the cultivation and processing of medicinal plants, increase the export potential of the industry, as well as the integration of education, science and production processes, the Ministry of Agriculture, Ministry of Innovation Development, From May 1, 2020, the State Committee for Agriculture, the Agency for Development of the Pharmaceutical Industry under the Ministry of Health will establish clusters for the cultivation, storage, primary or deep processing of medicinal plants (hereinafter - the pharmaceutical industry). Proposals for the establishment of a "cluster of plants" and the specialization of the regions in the cultivation of medicinal plants were approved.

Today's demand requires the cultivation of multifaceted plants (medicinal, spice, dye, technical) and the creation of their raw material base. \textit{Indigofera} (\textit{Indigofera tinctoria} L.) and henna (\textit{Impatiens balsamina} L) are among such plants [1, 2]. These plants are medicinal and dyed. Their drugs have a protective, emollient and anti-inflammatory, expectorant and analgesic effect on the human body.

\textit{Indigofera} (\textit{Indigofera tinctoria}) belongs to the family Fabaceae and is an annual semi-shrub 1-1.5 m tall. The plant is not found naturally in the flora of Uzbekistan, it can be grown only in culture [2]. The raw material from the Indigofera plant is a valuable antibacterial and antifungal agent that is used when a person is bitten by a snake or a dog [3, 4]. This herb has been used as a drug in epilepsy, skin ulcers, liver toxicosis, as an antidepressant, and even as a raw material in the production of drugs against some types of cancer [5]. The raw material of the Indigofera plant is a valuable antibacterial
and antifungal agent for dyeing wool, silk and cotton products in the textile industry of Asia and Europe, and the leaves of the Indigofera plant produce Indigo dye [2].

Henna (Impatiens balsamina L) is an annual herb of 30-120 cm tall, belonging to the family Balsaminaceae (Balsamins). It occurs naturally in tropical countries like Africa, India, Iran and other countries. In Uzbekistan conditions it is cultivated.

The raw material of the henna plant is used as a remedy for kidney stones and urinary tract infections [6, 7]. Henna has long been used in folk medicine. In ancient times, henna was used for wounds, bone and skin diseases, headaches, to lower blood pressure, to stop bleeding. Henna has cleansing, protective and healing properties. Henna has a rejuvenating and softening effect on the face and body. Henna improves hair structure, prevents hair loss, eliminates dandruff, strengthens the hair follicles (by nourishing the hair follicles), gives a natural shine, ventilates the hair, gives it a thick appearance and makes it easier to style. Henna helps to reduce inflammation and irritation, cleanses and softens the skin, relieves itching, purulent wounds, helps to treat fungal infections. In addition, henna is a very good antiseptic (antimicrobial agent). Henna protects the skin from active ultraviolet rays. Henna contains organic acids, tannins, polysaccharides, resins and fats, vitamins C and K, essential oil residues [8].

Henna is a powerful dye. The practice of coloring hair in cosmetology has been around for thousands of years. The beauties of ancient Egypt and Babylon, India and the Arab East used henna for this purpose. It is no coincidence that Indian and Oriental women dye not only their hair, but also their feet and palms. Plant-based dyes are not compatible with chemical dyes [9]. Today, henna is also used in the manufacture of shampoos and conditioners. Unlike most detergents, henna does not disturb the acid-base balance of the scalp and is a good cleanser at the same time. Taking a bath with henna gives the skin a beautiful golden glow.

2. Methods

Non-traditional medicinal, dyed Indigofera (Indigofera tinctoria L.) and henna (Impatiens balsamina L) plants were selected as the scientific object of the research, and the research was conducted in the experimental fields of Uzbekistan Forestry Research Institute.

The soils of the experimental field were typical gray soils with humus content of 3.19%, total nitrogen content of 25.5%, total phosphorus content of 47.3 mg / kg and potassium content of 756 mg / kg.

![Figure 1. Field experimental options and the process of conducting biometric and phenological observations](image-url)
Common methods were used to study the data on seed germination, growth and development, bioecological properties, and cultivation techniques [10-14].

Fertilizers were used in the following variants:
- Variant 1 - without fertilizer;
- Variant 2 - N30P60K40;
- Variant 3 - N60P60K40;
- Variant 4 N90P60K40 was given in pure form. The growth rates of each plant (in wet and dry mass) were determined.

3. Results and Discussions
The results of the study showed that mineral fertilizers have a positive effect on selected objects (Table 1). In particular, in the control variant, the variant without the use of mineral fertilizers, wet mass of Indigofera plant organs averaged 19.3 g on leaf, 9.2 g at the base, 1.8 g at the root, the total wet mass, 30.3g and for henna plant organs these values were: 24.1g in leaves, 74.2g in stems, 7.8g in roots and 106.1 g in total wet mass.

There are two 3-phase electricity meters for electricity metering. One electricity meter records the electricity transmitted to the grid of the solar power plant, and second electricity meter records the electricity received from the grid of the solar power plant for its own needs at night. Experiments have shown that plant growth and development depend on the amount and proportion of mineral fertilizers, and in the variants these values increased by about 1.5-2 times (Table 1). In the second variant (N30P60K40), the organs of the Indigofera plant were 21.1 g of leaves, 10.3 g of stems and 2.5 g of roots. The total wet mass weighed 33.9g. In the henna plant, the leaves weighed 28.7 g, the stems 89.66 g and the roots 11.5 g, and the total wet mass weighed about 129.86 g. In the third variant (N60P60K40) the leaves of the Indigofera plant are 22.2g; the stem was 11g, the root 2.9g and the total wet mass was 36.1g. In henna, the figures were 31.2 g for leaves, 92.4 g for stems, 12.8 g for roots and a total mass of 136.4 g.

In the fourth variant (N90P60K40) the figures are even higher, in the Indigofera plant - 27.4 g of leaves, 13.2 g of stems, 3.2 g of roots and a total wet mass of 43.8 g, and in the henna plant - 36.5 leaves, 27.4 g, stem 110.7 g, root 15.4 g and a total of 162.6 g were recorded. If we analyze these figures numerically, we can see an increase of 44.5% in Indigofera and 53% in henna.

| Table 1. Effect of mineral fertilizers on the wet mass of Indigofera and henna plants (in grams) |
| Variants | Norm of mineral fertilizers kg / ha | Leave | Stem | Root | Total | % |
|-----------|-----------------------------------|-------|------|------|-------|---|
| 1         | Control                           | 19.3  | 9.2  | 1.8  | 30.3  | 100 |
| 2         | N30P60K40                         | 21.1  | 10.3 | 2.5  | 33.9  | 111 |
| 3         | N60P60K40                         | 22.2  | 11   | 2.9  | 36.1  | 119 |
| 4         | N90P60K40                         | 27.4  | 13.2 | 3.2  | 43.8  | 144.5 |
|           | Indigofera                        |       |      |      |       |     |
| 5         | Control                           | 24.1  | 74.2 | 7.8  | 106.1 | 100 |
| 6         | N30P60K40                         | 28.7  | 89.66| 11.5 | 129.86| 122.3|
| 7         | N60P60K40                         | 31.2  | 92.4 | 12.8 | 136.4 | 128.5|
| 8         | N90P60K40                         | 36.5  | 110.7| 15.4 | 162.6 | 153 |
|           | Henna                             |       |      |      |       |     |

The study also examined the effects of different doses of mineral fertilizers on dyed Indigofera and henna plants. Experiments have shown that in the control variant, the weight of the Indigofera leaf was 17.2 g, the stem 6.4 g, and the root 1.1 g, while in the henna plant, respectively, these figures were around 2 g, 3.6 g, 1.5 g noted. The total dry mass was 24.7 g in Indigofera and 7.1 g in henna.

In the second, third and fourth variants using different norms of mineral fertilizers in Indigofera plant - leaves 21.6g, 24.6g, 28.3 g, stems 8.6g, 8.9g, 9.1 g, roots 1.4g, 1.6g, 1.9 g, and the total dry mass is...
31.6g, 35.1g, 39.3g, and in the henna plant - leaves 4g, 8g, 13g, stem 5.5g, 10.5g, 15.9g, root 2g, 2.5g, 3.3g and total dry mass 1.5g, 21g, 32.2 g were found to increase. A relatively good development was recorded in the N90P60K40 variant, which is 1.8-2 times more than the control variant (Table 2).

### Table 2. Effect of mineral fertilizers on the dry mass of Indigofera and Henna plants (in grams)

| Variants | Norm of mineral fertilizers kg / ha | The dry mass of a single model plant, grammes |
|----------|-----------------------------------|---------------------------------------------|
|          | Indigofera                        |                                             |
| 1        | Control                           | 17.2                                        |
| 2        | N90P60K40                         | 21.6                                        |
| 3        | N60P60K40                         | 24.6                                        |
| 4        | N80P60K40                         | 28.3                                        |
| 1        | Henna                             | 2                                            |
| 2        | N90P60K40                         | 4                                            |
| 3        | N60P60K40                         | 8                                            |
| 4        | N80P60K40                         | 13                                           |
|          | Total                             | 24.7                                         |
|          |                                    | 31.6                                         |
|          |                                    | 35.1                                         |
|          |                                    | 39.3                                         |
|          |                                    | 7.1                                          |
|          |                                    | 11.5                                         |
|          |                                    | 21                                           |
|          |                                    | 32.2                                         |

4. Conclusions

In summary, the rapid development of the Indigofera (Indigofera tinctoria L.) and henna (Impatiens balsamina L) plants in the soil and climatic conditions of the Tashkent region depends on the amount and proportion of mineral fertilizers. In particular, the N90P60K40 standard had a significant effect on the rapid growth of plants. The application of N90P60K40 provides an increase in the wet mass of Indigofera plants by 1-1.5 times (average 150%, dry weight 135%) per 1 m². In the case of henna (Impatiens balsamina L), the study found that these values increased by 4-5 times (average 450-500% and dry weight by 453%) per 1 m² of control.

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