



ECONOMIC EFFICIENCY OF AN INTEGRATED PEST MANAGEMENT (IPM) SYSTEM AGAINST THE MAJOR SUCKING PESTS OF WALNUT UNDER THE CONDITIONS OF TASHKENT REGION

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Abstract: This study evaluated the agronomic and economic efficiency of crop protection measures against major sucking pests of walnut under the conditions of Tashkent Region, Uzbekistan. The assessment included yield, yield losses caused by pests, yield preserved through protective measures, crop value, total production and protection costs, conditional net profit, additional economic benefit, and cost recovery. Under the conditions of Qibray District, application of Movento Energy and T-74 Pro against the California red scale resulted in additional preserved yields of 27.0 and 25.3 centners per hectare, respectively, compared with the untreated control. The yield reached 78.5 c/ha with Movento Energy and 76.8 c/ha with T-74 Pro. The additional economic benefit obtained from Movento Energy was 7,885.0 thousand UZS/ha, while the cost recovery ratio reached 11.3 times. Under the conditions of Bo'stonliq District, the application of Abomek Super 1.8% EC, Akramayt 48% SC, and Xeben Gold EC against phytophagous mites resulted in additional preserved yields of 26.4, 26.9, and 30.7 c/ha, respectively, compared with the control. The highest yield (79.1 c/ha), additional economic benefit (9,019.7 thousand UZS/ha), and cost recovery ratio (13.3 times) were recorded in the Xeben Gold treatment. The results demonstrated that the application of effective plant protection measures against sucking pests substantially reduced yield losses, increased marketable walnut production, and provided a high economic return. Among the tested treatments, Movento Energy against the California red scale and Xeben Gold against phytophagous mites were identified as the most economically efficient options under the studied conditions.

Keywords: walnut, *Juglans regia* L., sucking pests, California red scale, phytophagous mites, Movento Energy, T-74 Pro, Abomek Super, Akramayt, Xeben Gold, yield, preserved yield, economic efficiency, conditional net profit, additional economic benefit, cost recovery, plant protection, integrated pest management.

Introduction. The farm-level efficiency of the crop protection measures was assessed by comparing walnut yield in the untreated control and experimental treatments, the amount of yield lost as a result of pest infestation, and the quantity of yield preserved through the implementation of the respective protection measures. Economic efficiency was evaluated based on the protection costs incurred per hectare, the monetary value of the additional yield preserved, the net income generated, the payback ratio of the expenditures, and the corresponding profitability indicators.

The principal objective of the study was to substantiate the **farm-level and economic efficiency of an integrated pest management (IPM) system developed against the major sucking pests of walnut under the agroecological conditions of Tashkent Region**, and to identify the most economically advantageous treatment options suitable for practical application under commercial orchard conditions.

For the economic assessment, the conditional value of one centner of walnut production was assumed to be **UZS 300.0 thousand**. Under the untreated control, walnut yield amounted to **51.5 c/ha**, while the gross value of production obtained per hectare reached **UZS 15,450.0 thousand**. After deducting the basic production costs, the conditional net income amounted to **UZS 14,950.0 thousand/ha**.

In the treatment where **Movento Energy** was applied, walnut yield increased to **78.5 c/ha**, resulting in an additional **27.0 c/ha** of yield preserved compared with the untreated control. The monetary value of the additional yield amounted to **UZS 8,100.0 thousand/ha**. Expenditures associated with the pesticide application, crop protection operations, and harvesting of the additional yield amounted to **UZS 215.0 thousand/ha**. When combined with the principal costs of walnut production, the total expenditure reached **UZS 715.0 thousand/ha** (Table 1).

Under the Movento Energy treatment, the gross value of walnut production reached **UZS 23,550.0 thousand/ha**, while the conditional net income amounted to **UZS 22,835.0 thousand/ha**. Consequently, the additional economic return relative to the untreated control was **UZS 7,885.0 thousand/ha**. The ratio of the value of the additional yield to the total expenditure demonstrated that **each UZS 1.0 invested in production and crop protection generated approximately UZS 11.3 in additional product value**.

These results demonstrate that the application of Movento Energy not only substantially increased walnut yield but also ensured a considerable economic return relative to the untreated control. The combination of high yield preservation, increased gross production value, and a favourable expenditure payback ratio indicates the strong economic potential of this treatment as a component of an integrated pest management system against the major sucking pests of walnut under the conditions of Tashkent Region.

Table 1
Economic Efficiency of the Pesticide Treatments Applied against the California Red Scale (*Diaspidiotus perniciosus* Comstock) under the Conditions of Qibray District, Tashkent Region, 2024–2025

No.	Parameters	Untreated control	Movento Energy, SC	T-74 Pro, SC
1	Yield, c/ha	51,5	78,5	76,8
2	Preserved yield, c/ha	–	27,0	25,3
3	Amount of pesticide applied per hectare, L/ha	–	0,4	0,15
4	Cost of pesticide applied per hectare, thousand UZS/ha	–	135,0	92,2
5	Cost of crop protection services and machinery per hectare, thousand UZS	–	50,0	50,0
6	Cost of harvesting and transportation of the additional yield, thousand UZS/ha	–	30,0	30,0
7	Total cost of crop protection measures and harvesting of the additional yield, thousand UZS/ha	–	215,0	172,2
8	Basic production costs, thousand UZS/ha	500,0	500,0	500,0

9	Total production and protection costs, thousand UZS/ha	500,0	715,0	672,2
10	Gross value of production per hectare, thousand UZS	15 450,0	23 550,0	23 040,0
11	Value of additional yield, thousand UZS/ha	–	8 100,0	7 590,0
12	Conditional net profit, thousand UZS/ha	14 950,0	22 835,0	22 367,8
13	Additional economic return relative to the untreated control, thousand UZS/ha	–	7 885,0	7 417,8
14	Product value obtained per UZS 1.0 of total expenditure, UZS	–	11,3	11,3

In the **T-74 Pro** treatment, walnut yield reached **76.8 c/ha**, representing an additional **25.3 c/ha** of yield preserved compared with the untreated control. The monetary value of the additional yield amounted to **UZS 7,590.0 thousand/ha**. Expenditures associated with crop protection measures and the harvesting of the additional yield amounted to **UZS 172.2 thousand/ha**, while total production and protection costs reached **UZS 672.2 thousand/ha**.

Under the **T-74 Pro** treatment, the gross value of walnut production reached **UZS 23,040.0 thousand/ha**, while conditional net profit amounted to **UZS 22,367.8 thousand/ha**. The additional economic return relative to the untreated control was **UZS 7,417.8 thousand/ha**. Based on the ratio of the value of additional yield to total expenditures, approximately **UZS 11.3 in product value was generated per UZS 1.0 of expenditure**.

Thus, under the conditions of **Qibray District**, both pesticides applied against the California red scale demonstrated high farm-level and economic efficiency. However, the **Movento Energy** treatment produced superior economic performance, with a yield of **78.5 c/ha**, an additional preserved yield of **27.0 c/ha**, and an additional economic return of **UZS 7,885.0 thousand/ha**, exceeding the corresponding indicators obtained with **T-74 Pro**.

The protection measures applied against phytophagous mites exerted a substantial positive effect on both walnut yield and the quality composition of the harvested production.

In the treatment with **Abamectin Super 1.8% EC**, walnut yield reached **74.8 c/ha**, corresponding to an additional **26.4 c/ha** of yield preserved relative to the untreated control. The proportion of damaged fruits was reduced to **12.5%**. The harvested production consisted of **83.2% first-grade**, **14.5% second-grade**, and **2.3% non-marketable** produce.

The application of **Akramayt 48% SC** resulted in a walnut yield of **75.3 c/ha**, with **26.9 c/ha** of additional yield preserved compared with the control. The proportion of damaged fruits was **14.3%**, while first-grade, second-grade, and non-marketable produce accounted for **81.3%**, **14.8%**, and **2.9%**, respectively.

The highest yield was recorded in the **Xeben Gold EC** treatment, reaching **79.1 c/ha**, which represented an additional **30.7 c/ha** of yield preserved relative to the untreated control. The proportion of damaged fruits was reduced to **11.8%**. In this treatment, first-grade produce accounted for **73.3%**, second-grade produce for **23.4%**, and non-marketable produce for **3.3%**.

Table 2

Economic Efficiency of Protection Measures Applied against Phytophagous Mites in Walnut Orchards under the Conditions of Bo'stonliq District, Tashkent Region, 2025

No.	Parameters	Untreated	Abamectin	Akramayt	Xeben
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		control	Super 1.8% EC	48% SC	Gold EC
1	Yield, c/ha	48,4	74,8	75,3	79,1
2	Preserved yield, c/ha	–	26,4	26,9	30,7
3	Amount of pesticide applied per hectare, L/ha	–	0,4	1,0	1,5
4	Cost of pesticide applied per hectare, thousand UZS/ha	–	218,5	78,5	110,3
5	Cost of crop protection services and machinery per hectare, thousand UZS	–	50,0	50,0	50,0
6	Cost of harvesting and transportation of the additional yield, thousand UZS/ha	–	30,0	30,0	30,0
7	Total cost of crop protection measures and harvesting of the additional yield, thousand UZS/ha	–	298,5	158,5	190,3
8	Basic production costs, thousand UZS/ha	500,0	500,0	500,0	500,0
9	Total production and protection costs, thousand UZS/ha	500,0	798,5	658,5	690,3
10	Gross value of production per hectare, thousand UZS	14 520,0	22 440,0	22 590,0	23 730,0
11	Value of additional yield, thousand UZS/ha	–	7 920,0	8 070,0	9 210,0
12	Conditional net profit, thousand UZS/ha	14 020,0	21 641,5	21 931,5	23 039,7
13	Additional economic return relative to the untreated control, thousand UZS/ha	–	7 621,5	7 911,5	9 019,7
14	Product value obtained per UZS 1.0 of total expenditure, UZS	–	9,9	12,2	13,3

By comparison, the untreated control recorded a substantially lower yield of **48.4 c/ha**, while the proportion of damaged fruits reached **84.6%**. Only **12.6%** of the harvested production was classified as first-grade, **21.1%** as second-grade, and as much as **66.3%** was considered non-marketable (Table 2).

Overall, the results demonstrate that the application of effective protection measures against phytophagous mites considerably reduced fruit damage, increased the proportion of marketable walnut production, and substantially increased yield compared with the untreated control. Among the tested treatments, **Xeben Gold EC** provided the highest yield and the greatest amount of preserved production, confirming its strong potential for inclusion in an integrated pest management system for walnut orchards under the conditions of Tashkent Region.

Thus, implementation of protection measures against phytophagous mites resulted in an additional **26.4–30.7 c/ha** of yield being preserved compared with the untreated control. The highest yield was recorded in the treatment with **Xeben Gold EC**.

The economic calculations demonstrated that all protection treatments applied against phytophagous mites provided higher economic efficiency than the untreated control.

In the untreated control, walnut yield amounted to **48.4 c/ha**, the value of production obtained per hectare was **UZS 14,520.0 thousand**, and conditional net profit amounted to **UZS 14,020.0 thousand/ha**.

In the treatment with **Abamectin Super 1.8% EC**, walnut yield reached **74.8 c/ha**, resulting in an additional **26.4 c/ha** of yield preserved relative to the untreated control. The value of production obtained per hectare amounted to **UZS 22,440.0 thousand**, while total expenditures were **UZS 798.5 thousand/ha** and conditional net profit reached **UZS 21,641.5 thousand/ha**. The additional economic return relative to the control was **UZS 7,621.5 thousand/ha**, while the expenditure payback ratio was **9.9-fold**.

In the treatment with **Akramayt 48% SC**, walnut yield amounted to **75.3 c/ha**, corresponding to an additional **26.9 c/ha** of yield preserved compared with the untreated control. The value of production obtained per hectare was **UZS 22,590.0 thousand**, total expenditures amounted to **UZS 658.5 thousand/ha**, and conditional net profit reached **UZS 21,931.5 thousand/ha**. The additional economic return relative to the control amounted to **UZS 7,911.5 thousand/ha**, while the expenditure payback ratio reached **12.2-fold**.

The **Xeben Gold EC** treatment produced the highest yield, reaching **79.1 c/ha**, which represented an additional **30.7 c/ha** of yield preserved compared with the untreated control. The value of production obtained per hectare amounted to **UZS 23,730.0 thousand**, total expenditures were **UZS 690.3 thousand/ha**, and conditional net profit reached **UZS 23,039.7 thousand/ha**. The additional economic return relative to the control was **UZS 9,019.7 thousand/ha**, while the expenditure payback ratio amounted to **13.3-fold**.

Thus, under the conditions of **Bo'stonliq District**, among the pesticides applied against phytophagous mites, the **Xeben Gold EC** treatment demonstrated the highest farm-level and economic performance. In this treatment, walnut yield reached **79.1 c/ha**, the additional yield preserved relative to the control amounted to **30.7 c/ha**, the additional economic return reached **UZS 9,019.7 thousand/ha**, and the expenditure payback ratio was **13.3-fold**.

Overall, under the conditions of **Bo'stonliq District**, the application of protection measures against phytophagous mites resulted in an additional economic return of **UZS 7,621.5–9,019.7 thousand/ha** compared with the untreated control, while the expenditure payback ratio ranged from **9.9 to 13.3-fold**.

SCIENTIFIC CONCLUSION

The study established that the application of effective plant protection measures against major sucking pests significantly increased walnut yield and economic efficiency under the conditions of Tashkent Region, Uzbekistan. Against the California red scale, Movento Energy demonstrated the highest efficiency, providing a yield of 78.5 c/ha, an additional preserved yield of 27.0 c/ha, an additional economic benefit of 7,885.0 thousand UZS/ha, and a cost recovery ratio of 11.3 times. Against phytophagous mites, Xeben Gold showed the best results, with a yield of 79.1 c/ha, an additional preserved yield of 30.7 c/ha, an additional economic benefit of 9,019.7 thousand UZS/ha, and a cost recovery ratio of 13.3 times. Therefore, Movento Energy and

Xeben Gold were identified as the most economically efficient treatments and are recommended as promising components of an integrated pest management system for walnut orchards under the studied conditions.

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