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Impact of different pest management modules on the major insect pests and their predators on tomato

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ABSTRACT: Effect of three different pest management modules were evaluated against the major insect pests of tomato under Varanasi, Uttar Pradesh, India. Among the three tested modules, integrated pest management module (Module 3) comprised spraying of imidacloprid 17.8 % SL @ 0.33 ml/L, spiromesifen 22.9% SC @ 1.25 ml/L, indoxacarb 14.5% SC @ 0.8 ml/L, cyantraniliprole 10.26% OD @ 1.8 ml/L, chlorantraniliprole 18.5% SC @ 0.35 ml/L; Neem oil (0.5%) + *Lecanicillium lecanii* @ 2.5 g/L; and Neem oil (0.5%) + *Beauveria bassiana* @ 2.5 g/L and Neem seed kernel extract (NSKE) @ 4 ml/L from 30 DAT onwards to till 100 DAT at 10 days intervals each harboured lowest fruit damage (10.48%) along with maximum percent reduction over control (69.54). Integrated pest management module also registered lowest sucking pest population *viz*., leaf hoppers (0.19 leaf^{-1}), whiteflies (0.23 leaf^{-1}) and aphids (0.83 leaf^{-1}) than the other pest management modules with maximum per cent reductions over control of 77.10, 79.46 and 67.83, respectively. The numbers of predatory mirid bugs and polyphagous spiders were also higher in this module. Furthermore, the highest healthy fruit yields (513.7 q ha^{-1}) were recorded from the integrated pest management module. In terms of return, maximum net profit of ₹83875 was obtained from module 3 *i.e.,* integrated pest management module with highest cost benefit ratio of 1:4.13 followed by biointensive pest management module (1:3.92).

Keywords: Tomato, fruit borers, sucking pests, predators, pest management modules, economics

INTRODUCTION

Tomato (*Solanum lycopersicum* L.), a member of the Solanaceae family, is one of the world's most widely culticvated vegetable crops. It is one of the popular vegetable crops with higher contents of vitamins A, B and C including calcium and carotene (Bose and Som, 1990). In India, tomato was grown in 0.789 million ha of land with an annual production of 19759000 metric tons and productivity of 25.04 metric tons ha^{-1}during 2017-18 (Anonymous, 2018). India remains far behind many other countries in terms of productivity, which is fairly poor due to pest infestation, which is a major barrier in fulfilling the productivity potential of tomato. Several insect pests attack the crop throughout its growth period, including tomato fruit borer (*Helicoverpa armigera* (Hübner), *Spodoptera litura* Fabricius and *Tuta absoluta* Meyrick), Whitefly (*Bemisia tabaci* (Gennadius)), leaf hoppers (*Amrasca biguttula biguttula* Ishida) andAphids (*Aphis gossypii* Glover) are important in the region (Rai *et al*., 2014; Halder and Rai, 2021).

To control these nefarious tomato insects pests that cause significant harm, farmers of the region frequently rely on the use of chemical pesticides. It is not unusual for tomato growers to apply 10-15 chemical sprays per season, which are often needless and unjustifiable, especially when there is no discernible gain in yield (Roy *et al*., 2017). The desire for a faster control strategy against these pests, as well as the desire for higher yields, has resulted in the indiscriminate, injudicious, unnecessary, and excessive use of chemical pesticides, which has resulted in problems such as pesticide resistance, resurgence of target sucking insects accompanied by secondary pest outbreaks, residues problems in food and beverages, adverse effects on human health, and massive killing of non-target organisms (Halder *et al*., 2019, 2021).

The development of an appropriate Integrated Pest Management (IPM) package for ecofriendly insect pest management for sustainable tomato production is urgently needed. Furthermore, there is no information on the creation of such modules for the comprehensive management of insidious insect pests in a larger region in tomato. Numerous pest management measures for tomato crops have been devised, however they have generally been dealt with in isolation and individually. The combination of all pest management measures has the potential to reduce the use of harmful chemical pesticides to a greater level.

MATERIALS AND METHODS

Study area

The field experiments were carried out at experimental farm of Indian Council of Agricultural Research-Indian Institute Vegetable Research (ICAR-IIVR), Varanasi (82°52' E longitude and 25°12' N latitude), Uttar Pradesh, India during *rabi* season (September, 2020 to March, 2021) of 2020-21. The experimental site comes under the alluvial zone of Indo-Gangetic plains having soils silt loam in texture and low in organic carbon (0.43%) and available nitrogen (185 kg ha^{-1}).

Raising of the crops

Seeds of tomato (*cv*. Kashi Aman) are sown in fine-tilth nursery beds during the last week of September, 2020. The tomato seedlings were transplanted at spacing at 60 × 40 cm (row to row and plant to plant) during last week of October in a large plot size of 20 × 15 m^2 for each module. As such four such plots were prepared. From each plot, five fixed spots (5 x 4 m each, four in corners and one in centre of plot) were selected randomly considering one spot as one replication. Thus five replications were maintained for each module and flatbed system of cultivation was followed. The recommended doses of N, P, K fertilizers (100:60:60) and FYM 15-20 t ha^{-1} were applied. N, P and K were supplied through urea, single super phosphate and muriate of potash, respectively. Half of the nitrogen was applied at the time of sowing as basal dose and the rest half was equally split at vine development stage and at flower initiation stage. The full doses of both phosphorus and potassium were given at the time of final land preparation. Hand weeding and irrigations were provided as required and usual crop husbandry measures were undertaken except plant protection measures for insect pest management.

Pest management modules details

Module 1: Biointensive pest management module (BIPM)

- Spraying of *Lecanicillium* (= *Verticillium*) *lecanii* @ 5 g/lit at 30 days after transplanting (DAT)
- Spraying of Azadirachtin 300 ppm @ 5 ml/L at 40 DAT
- Spraying of *Beauveria bassiana*@ 5 g/L at 50 DAT
- Spraying of *Bacillus thuringiensis*@ 2 g/L at 60 DAT
- Spraying of *Lecanicillium lecanii* + Neem oil (1:1 ratio) @ 2.5 g/L + 2.5 ml/L at 70 DAT
- Spraying of *Beauveria bassiana* + Neem oil (1:1 ratio) @ 2.5 g/L + 2.5 ml/L at 80 DAT
- Spraying of *Lecanicillium lecanii* + Neem oil (1:1 ratio) @ 2.5 g/L + 2.5 ml/L at 90 DAT
- Spraying of Neem seed kernel extract (NSKE) @ 4 ml/L at 100 DAT

Module 2: Chemical pest management module (CPM)

- Spraying of Imidacloprid 17.8% SL @ 0.33 ml/L at 30 DAT
- Spraying of Spiromesifen 22.9% SC @ 1.25 ml/L at 40 DAT
- Spraying of Thiamethoxam 25% WG @ 0.4 g/L at 50 DAT
- Spraying of Indoxacarb 14.5% SC @ 0.8 ml/L at 60 DAT
- Spraying of Chlorantraniliprole 18.5% SC @ 0.3 ml/L at 70 DAT
- Spraying of Cyantraniliprole 10.26% OD @ 1.8 ml/L at 80 DAT
- Spraying of Novaluron10% EC @ 1.5 ml/L at 90 DAT
- Spraying of Chlorantraniliprole 18.5% SC @ 0.35 ml/L at 100 DAT

Module 3: Integrated pest management module (IPM)

- Spraying of Imidacloprid 17.8% SL @ 0.33 ml/L at 30 DAT
- Spraying of Spiromesifen 22.9% SC @ 1.25 ml/L at 40 DAT
- Spraying of Indoxacarb 14.5% SC @ 0.8 ml/L at 50 DAT
- Spraying of Cyantraniliprole 10.26% OD @ 1.8 ml/L at 60 DAT
- Spraying of Chlorantraniliprole 18.5% SC @ 0.35 ml/L at 70 DAT
- Spraying of *Beauveria bassiana* + Neem oil (1:1 ratio) @ 2.5 g/L + 2.5 ml/L at 80 DAT
- Spraying of *Lecanicillium lecanii* + Neem oil (1:1 ratio) @ 2.5 g/L + 2.5 ml/L at 90 DAT
- Spraying of Neem seed kernel extract (NSKE) @ 4 ml/L at 100 DAT

Module 4: Untreated control Data recording

For fruit borer damage, periodically fruits were harvested from the entire plots and cumulative per cent fruit damage by all the three borers (*H. armigera*, *S. litura* and *T. absoluta*) on tomato was calculated.

Similarly, the populations of leaf hoppers, aphids, and whiteflies were determined by counting the insects (including nymphs and adults for leaf hoppers, aphids and only adults for whiteflies) from three leaves (top, middle, and bottom region) sampled from each plant. As such twenty such plants were taken from each plot and expressed as number of sucking pests (leaf hoppers /

Table 1. Effect of different pest management modules against major insect pests in tomato

Treatments	Fruit damage (%)			Whitefly / leaf			Leaf hoppers / leaf			Aphids/ leaf		
	Before spray	After spray	PROC	Before spray	After spray	PROC	Before spray	After spray	PROC	Before spray	After spray	PROC
M1= Biointensive pest management module	--	13.65	60.33	1.69	0.35	68.75	1.05	0.32	61.45	2.46	1.07	58.53
M2= Chemical pest management module	--	17.99	47.72	1.57	0.23	79.46	1.17	0.23	72.29	2.61	0.96	62.79
M3= Integrated pest management module	--	10.48	69.54	1.36	0.23	79.46	1.08	0.19	77.10	2.39	0.83	67.83
Control	--	34.41	--	1.53	1.12	--	1.12	0.83	--	2.87	2.58	--
SEm(±)	--	1.84	--	--	0.10	--	--	0.07	--	--	0.13	--
LSD 5%	--	3.87	--	--	0.22	--	--	0.16	--	--	0.27	--

whitefly) leaf^{-1} plant^{-1}. The observations were recorded at weekly interval in each plot of different modules including untreated control. In case of predator population, number of predators present on tomato ecosystem *i.e.*, number of spiders and lady bird beetles (grubs/pupae/adults) were counted per plant during the month of February – March, 2021.

Two prominent polyphagous predators *viz*., spiders and mirid bugs (*Nesiodiocoris tenuis* (Reuter) (Hemiptera: Miridae) were recorded during the observation. Numbers of these predators per plant were noted and twenty plants from each pest management modules were taken. As regards the yield, different pickings made separately from entire plot after maintaining the waiting period from each module were added and converted to hectare basis.

Statistical analysis

The data were subjected to Analysis of Variance (ANOVA) with least significant difference (p=0.05) as test criterion using SAS software (version 9.3). The yield data were converted to hectare basis and the economics calculated.

RESULTS AND DISCUSSION

Effect of different pest management modules on major insect pests and its associated predators were presented in table 1. All the treatments were statistically significant than the untreated control plots. It is evident that lowest fruit damage (10.48%) was recorded from the integrated pest management (IPM) module with maximum percent reduction over control (69.54) followed by biointensive pest management (BIPM) module with 13.65% fruit damage and 60.33 PROC. It may be noted that all the three species *viz*., *H. armigera, S. litura* and *T. absoluta* were available as fruit borers on tomato during the observation. Similarly, population of adult whitefly, vector of dreaded *tomato leaf curl virus* (TLCV), was recorded and minimum whitefly population (0.23 whitefly leaf^{-1} and 79.46 PROC) was registered from the plots treated with integrated and chemical pest management modules. Similarly, the lowest leaf hopper population, comprising both nymphs and adults, was seen in integrated pest management module (0.19 leaf hoppers leaf^{-1}) which was statistically at par with the chemical pest management module. Population of polyphagous aphid *A. gossypii* was comparatively higher than the other two sucking pests of tomato *i.e*., whiteflies and leaf hoppers during January – March. Among the three tested pest management modules, maximum aphid population (1.07 leaf^{-1}) was noticed in biointensive pest management module whereas lowest (0.83 leaf^{-1}) was in integrated pest management module (Table 1).

In addition, the population of associated beneficial fauna *viz*., polyphagous spiders and mirid bugs available in tomato ecosystem was also recorded. The spiders mainly lynx and jumping spiders were seen during the study. The spider population was available almost throughout the crop growth period from 30 DAT whereas population of predatory mirid bug (*Nesiodiocoris tenuis* (Reuter)) were recorded during February – March coinciding with the sucking pest incidence on tomato and retreating winter in the region. Populations of these

Table 2. Effect of IPM modules on predators and benefit cost ratio

Treatment	Spider / plant			Mirid bug/Plant			Yield of healthy fruits (q/ha)	C:B Ratio
	Before spray	After spray	PROC*	Before spray	After spray	PROC*		
M1= BIPMM	2.21	1.73	18.39	1.62	1.04	33.76	461.6	1:3.92
M2= CPMM	2.11	0.51	72.17	1.81	0.61	61.15	502.1	1:3.10
M3= IPMM	2.06	1.29	39.15	1.67	0.93	40.76	513.7	1:4.13
Control	2.35	2.12	--	1.93	1.57	--	409.5	--
SEm (±)	--	0.12	--	--	0.06	--	--	--
LSD 5%	--	0.2	--	--	0.14	--	--	--

* PROC= Per cent reduction over control

duo predators were most abundant (2.12 spiders plant^{-1} and 1.57 mirid bugs plant^{-1}) in untreated control plots. Amongst the treatments, highest predator populations were noted in biointensive pest management module (1.73 spiders plant^{-1} and 1.04 mirid bugs plant^{-1}). Interestingly, the chemical pest management module harboured lowest spiders (0.51 spiders plant^{-1}) and mirid bugs (0.61 mirid bugs plant^{-1}) population with maximum percent predator reduction over control.

The yields of tomato were computed for each of the pest management modules by periodical harvesting of the tomato fruits (Table 2). Maximum fruit yield was obtained from the integrated pest management module (513.7 q ha^{-1}) followed by chemical (502.1 q ha^{-1}) and biointensive pest management module (461.6 q ha^{-1}) whereas minimum healthy fruit yield was in untreated control plots (409.5 q ha^{-1}). The cost benefit (C: B) ratio of each module was also calculated and presented in table 2. The integrated pest management module had the highest C:B ratio of 1:4.13 followed by biointensive pest management module (1:3.92).

The integrated pest management module registered lowest fruit damage against tomato fruit borers. In tomato fruit settings generally started from 50 DAT. To address these fruit borers, tomato fruit borer specific insecticide *viz*., Indoxacarb 14.5 SC, Cyantrailiprole 10.26% OD, Chlorantarliprole18.5% SC etc were added in the IPM module in addition to the biopesticides like *Beauveria bassiana*, *Lecanicillium lecanii* and neem based biopesticides. Indoxacarb belongs to the oxadiazines group and act on voltage-dependent sodium channel blockers (Koadnadarm *et al*., 2010; Banik and Halder, 2013; IRAC, 2022). Similarly, Cyantrailiprole and Chlorantarliproleare are the new group of insecticides belongs to the diamides group which specifically act on insect ryanodine receptor modulators and thereby inhibit nerve and muscle actions (IRAC, 2022). The module 3 *i.e*., Integrated Pest Management module includes systemic insecticides like Imidacloprid 17.8% SL and Spiromesifen 22.9% SC targeting the sucking pests like whiteflies, leaf hoppers and aphids infesting tomato. Modes of actions of these molecules are completely different from each other. Spiromesifen being a tetronic and tetramicacid derivatives act as inhibitors of acetyl CoA carboxylase apart from affecting insect lipid biosynthesis and growth regulation. In enigma, the neonicotinoid insecticide Imidacloprid interferes the nicotinic acetylcholinereceptor (nAChR) as competitive modulators (Banik and Halder, 2013; IRAC, 2022). Integrated pest module also included biopesticides coinciding with fruit harvesting. The entomopathogenic fungi *Beauveria bassiana, Lecanicillium lecanii* and neem based biopesticides are the green ecofriendly pest management options against a wide range of insect pests ofmany agri-horticultural crops (Eken *et al*., 2006; Luce´lia *et al*., 2011; Bajya *et al*., 2015; Halder *et al*., 2021). Both the biointensive and integrated modules comprised the combinations of entomopathogenic fungi and neem seed oil at half of their recommended doses at 1:1 ratio. Compatibility and synergistic activity of these duo biopesticides against insect pest management are well documented (Depieri *et al*., 2005; Subbulakshmi *et al*., 2012; Halder *et al*., 2018). The plant origin insecticide neem and its derivatives have diverse mode of action like antifeedant, insect growth regulation, oviposition deterrent as well as lethal activity (Chowdhary *et al*., 2001; Prakash *et al*., 2008). The integrated pest management module combining newer green chemistry molecules having different side of actions, entomopathogens and botanicals like neem successfully controlled the nefarious insect pest of tomato by conserving the associated beneficial fauna in tomato ecosystem.

From the table 2 it is shown that maximum CB ratio was obtained from integrated pest management module followed by biointensive and chemical pest management modules. The module 3 *i.e.*, integrated module had registered highest fruit yield which caused its highest CB ratio. Interestingly, the module 1 *i.e.,* biointensive pest management module had the second highest CB ratio of 1: 3.92. Lower cost of IPM inputs like Azadirachtin, neem oil, entomopathogenic fungi *viz*., *Beauveria bassiana*, *Lecanicillium* (=*Verticillium*) *lecanii* etc. compared to newer chemical insecticides could be the reason for higher cost benefit ratio of biointensive pest management module than the corresponding chemical module. In a similar vein, Kumari *et al*., 2021 documented that integrated module (seed treatment with Thiamethoxam 70% WS, removal of damaged cotyledonary leaves, spraying of Emamectin benzoate, spraying of neem oil, installation of cuelure traps, spraying of Spinosad) had recorded highest bitter gourd fruit yield (16 t ha^{-1}) and highest benefit cost ratio (2.61:1) along with lowest fruit fly damage in Hyderabad, India. In another study, in okra the integrated pest management module comprising sprayings of chlorantraniliprole, NSKE, Emamectin benzoate, *Bacillus thuringiensis* and nimbecidine their need based rotation was most effective in reducing the fruit borer damage (71.74 per cent) and yellow vein mosaic disease (17.75 per cent) with significant increase in the yield (177.7 q ha^{-1}) over control (Kodandaram *et al*., 2017).

CONCLUSION

Three different pest management modules were synthesized and evaluated against the major sucking insect pests of tomato. The integrated pest management module comprised spraying of imidacloprid, spiromesifen, indoxacarb, cyantraniliprole, chlorantraniliprole, *Beauveria bassiana* + Neem oil (1:1), *Lecanicillium lecanii* + Neem oil (1:1) and neem seed kernel extract (NSKE) starting from 30 DAT at 10 days intervals each harboured lowest fruit borer incidence accompanied with minimum whiteflies, leaf hoppers and aphid population with maximum PROC. Furthermore, the highest healthy fruit yields were recorded from the integrated pest management module accompanied with higher predatory mirid bugs and polyphagous spider populations. In terms of return, maximum net profit was obtained from this module with highest cost benefit ratio.

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REFERENCES

Anonymous. 2018. Horticultural statistics at a glance. Published by Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare, Government of India, 10.

Bajya, D. R., Ranjith, M. and Raza, S. K. 2015. Evaluation of *Beauveria bassiana* against chickpea pod borer, *Helicoverpa armigera* and its safety to natural enemies. *Indian Journal of Agricultural Sciences,* **85** (3): 378–381.

Banik, S. and Halder, J. 2013. Protection of Crop Plants with Newer Chemical Molecules.*In*. Current Concepts in Crop Protection. Edited by Susanta Banik, ISBN: 978-93-80012-42-1, Published by Studium Press (India) Pvt. Ltd., New Delhi-110002, India, 307-349.

Bose, T. K. and Som, M. G. 1990.Vegetable Crops in India. Naya Prokash, 206 Bidhan Sarani, Calcutta, India. 249.

Chowdhary, H., Walia, S. and Dhingra, S. 2001. Bio-efficacy of azadirachtin, turmeric oil and their mixtures against bihar hairy caterpillar, *Spilosoma obliqua* (Walker). *Pesticide Research Journal,* **13** (2): 165–172.

Depieri, R. A., Martinez, S. S. and Menezes, A. O. Jr. 2005. Compatibility of the fungus, *Beauveria bassiana* (Bals.) Vuill. (Deuteromycetes) with extracts of neem seeds and leaves and the emulsible oil. *Neotropical Entomology,* **34** (4): 601–606.

Eken, C., Tozlu, G., Dane, E., Corhu, S. and Demirci, E. 2006. Pathogenicity of *Beauveria bassiana* (Deuteromycotina: Hypomycetes) to larvae of small poplar longhorn beetle, *Saperda populnea* (Coleoptera: Cerambycidae). *Mycopathologia,* **162**: 69–71.

Halder, J. and Rai, A. B. 2021. Emergence of new insect pests on vegetables during the last decade: a case study. *Current Horticulture*, **9** (1): 20-26.

Halder, J., Khushwaha, D., Rai, A. B., Nagendran, K. and Singh, B. 2018. Host plant mediated susceptibility of *Phenacoccus solenopsis* (Tinsley) to *Lecanicillium lecanii* (Zimmermann) Zare and Gams, neem oil and their combination. *Proceedings of National Academy of Sciences,* *India, Section- B: Biological Sciences,* **88** (1): 241-248. (DOI 10.1007/s40011-016-0750-y).

Halder, J., Divekar, P. A. and Rani, A.T. 2021. Compatibility of entomopathogenic fungi and botanicals against sucking pests of okra: an ecofriendly approach. *Egyptian Journal of Biological Pest Control*, **31**:30. doi.org/10.1186/s41938-021-00378-6.

Halder, J., Kushwaha, D., Rai, A. B. and Singh, B. 2019. Biology and biorational management of *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae): A global challenge to tomato production. *Proceedings of the Zoological Society*, **72** (2): 107-110. (DOI 10.1007/s12595-017- 0232-0).

Halder, J., Majumder, S. and Rai, A. B. 2021. Compatibility and combined efficacy of entomopathogenic fungi and neonicotinoid insecticides against *Myzus persicae* (Sulzer): An ecofriendly approach. *Entomologia Hellenica,* **30** (1): 24–32. https://doi.org/10.12681/eh.25417.

IRAC. 2022. Insecticide Resistance Action Committee (IRAC) mode of action classification scheme. Issued, March 2022; Version 10.2

Kodandaramm, M. H., Rai A. B. and Halder J. 2010. Novel insecticides for management of insect pests in vegetable crops: a Review. *Vegetable Science*, **37**(2): 109-123.

Kodandaram, M. H., Halder, J., Singh, N. and Rai, A. B. 2017. Pest management modules against major insect pests of okra. *Pesticide Research Journal*, **29** (2): 153-157.

Kumari, D. A., Suresh, V., Nayak, M. H., Lavanya, A. V. N. and Mamatha, A. 2021. Evaluation of different pest management modules in bitter gourd. *International Journal of Chemical Studies,* **9**(1): 587-590.

Luce´lia, S., Silva, L. A. D., da Silva, W.O.B., Corre^a, A. P. F., Rangel, D.E.N., Carlini, C.R., Schrank, A. and Vainstein, M. H. 2011.Virulence of the entomopathogenic fungus *Metarhizium anisopliae* using soybean oil formulation for control of the cotton stainer bug, *Dysdercus peruvianus*. *World Journal of Microbiology and Biotechnology,* **27** (10): 2297–2303.

Prakash, A., Rao, J. and Nandagopal, V. 2008. Future of botanical pesticide in rice, wheat, pulses and vegetable pest management. *Journal of Biopesticides,* **1**: 154-169.

Rai, A. B., Loganathan, M., Halder, J., Venkataravanappa, V. and Naik, P. S. 2014. Eco-friendly approaches for sustainable management of vegetable pests. Technical Bulletin, Indian Institute of Vegetable Research, Varanasi - 221305, Uttar Pradesh,104.

Roy, S., Halder, S., Singh, N., Rai, A.B., Prasad, R.N. and Singh, B. 2017. Do vegetable growers really follow the scientific plant protection measures? An empirical study from eastern Uttar Pradesh and Bihar. *Indian Journal of Agricultural Sciences*, **87** (12): 1668–1672.

Subbulakshmi, N., Ramarathinam, S., Anburaj, J., Sundaravadivelan, C., Kuberan, T., Kumar, P., Starlin, T. and Marimuthu, S. 2012. Compatibility of neem based oil nimbicidine with entomopathogenic fungi. *International Journal of Applied Biology,* **4**:12–15.

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