Efficacy of applied of kinetin with some biological and chemical agents on controlling green peach aphid (*Myzus persicae*) and there affects on some yield of cauliflower.

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Abstract

In this study, the effect of integrating the bacterium Pseudomonas fluorescens, Pseudomonas syringae and the insecticides Sivanto Prime and Movento with each other and each of them with the chemical insecticide Lambda cyhalothrin were conducted on the Research Station of the College of Agriculture / University of Tikrit during the 2025 agricultural season, to determine the relative efficacy of controlling the green peach aphid Myzus persicae, polyphenol oxidase enzyme activity and head weight of cauliflower Brassica oleracea var. in the Research Station of the College of Agriculture / University of Tikrit. Under semi field conditions, the species, botrytis, occurs. A Randomized Complete Block Design (RCBD) was used, and the treatments were single, binary and ternary. The data were statistically analysed by Least Significant Difference (LSD) test at 0.05 probability level. Results showed that treatments of formulation give higher mean than single treatments.

Insect control, which was measured by the relative efficacy, was the highest for the ternary interaction treatments of kinetin (1g) + P. fluorescens + Sivanto Prime (100%) on day 3 and remained till day 9. The highest average head weight (1351 g) was also obtained from kinetin (1 g) + P. syringae + Sivanto Prime treatment, while the same treatment had the highest polyphenol oxidase enzyme activity (3.06 U/g fresh plant tissue). The outcomes showed that the integration of kinetin, plant growth-promoting bacteria and systemic insecticides helped to better utilize the efficiency of aphid control, induce plant defense responses and increase productivity, thus confirming the potential of this integration in the system of integrated pest management (IPM) for cauliflower.

Keywords: Cauliflower, *Myzus persicae*, Kinetin, *Pseudomonas fluorescens*, *Pseudomonas syringae*, Integrated Pest Management, Polyphenol Oxidase Enzyme.

Introduction

Cauliflower *Brassica oleracea* var. Cruciferous crops are important nutritive and economical crops and botrytis is one of them. It is characterized by its high nutritional value caused by the presence of the vitamins, minerals, phenolic compounds and antioxidants in addition to its use in different food industries and fresh consumption. This makes improving its productivity and maintaining its quality among the main objectives of modern agricultural programs (1).

The green peach aphid, Myzus persicae (Sulzer), is an important aphid pest of cauliflower plants because of its broad host range and high potentials for reproduction and dispersal. Moreover, it is also a direct cause of damage by feeding on the plant sap and causing deformity in new growths, as well as indirect by secreting honeydew and acting as a vector for a variety of viral

ISSN 2072-3857

pathogens which cause loss of yield quantity and quality (2).

Chemical pesticides have been used for years as a control program for this insect. However, the repeated use of these has resulted in some issues such as insect resistance, harmful effects on non-target organisms and the environment, and pesticide residues in crops. Thus, recent research has focused on developing integrated pest management (IPM) approaches, in which several agents of pest control are combined that have different modes of action to improve the efficacy of pest control and decrease the use of chemical pesticides and increase the sustainability of agricultural production (3).

Kinetin is one of cytokinin plant hormone that promote cell division, delay leaf aging, and stop chlorophyll and proteins from breaking down so the leaves stay green longer. In addition,

It also plays a role in inducing resistance by controlling the expression of defense-response genes, and enhancing the activity of a few defense enzymes (4)(5).

Various studies have demonstrated the significant contribution and the important functions of species of the genus Pseudomonas in stimulating induced resistance mechanisms and increasing the plant response to biotic stresses. Others help to lessen the detrimental effects of insect pests directly or indirectly by producing bioactive compounds and triggering plant defense pathways (6)(7). The use of modern systemic insecticides, like Sivanto Prime and Movento, are an important part of aphid control programs because of their high efficacy in reducing insect density and their different mode of action. In combination with plant growth regulators and biological control agents, however, they can help increase control effectiveness and decrease the number of heavy pesticide applications, and also improve the physiological and productive qualities of the plant (8)(9).

Therefore, the present study was aimed at assessing the relative efficiency of the green peach aphid control, polyphenol oxidase enzyme activity and head weight of cauliflower under semi field conditions by incorporating kinetin, the bacteria Pseudomonas fluorescens and Pseudomonas syringae and the insecticides Sivanto Prime and Movento. To determine the most effective treatments in integrated pest management (IPM) systems, which integrate the use of chemical, biological and plant growth regulator methods to increase the effectiveness of controlling pests, decrease reliance on chemical pesticides, and provide more sustainable agricultural production.

Materials and Methods

The present study was carried out in 2025 agricultural season at the Research Station of the College of Agriculture / University of Tikrit to estimate the relative efficacy of controlling the green peach aphid (*Myzus persicae*) along with seed set (head weight) of cauliflower and polyphenol oxidase enzyme activity under the combination of kinetin with some biological and chemical agents. The experiment was designed using a Randomized

Complete Block Design (RCBD) with the following treatments: single, binary, and ternary treatments with kinetin at 0.5 g L^{-1} and 1 g L^{-1}, the

ISSN 2072-3857

two bacterial isolates Pseudomonas fluorescens and Pseudomonas syringae, and the two insecticide treatments Sivanto Prime and Movento at 0.5 ml L^{-1} each, and a control treatment. The general principles recommended for the culture of cauliflower were followed for all the agricultural operations.

The effectiveness of the treatment that has been studied in controlling M. *persicae*.

The relative efficacy of insect control was determined by covering plants with muslin cloth bags to exclude insect movement between treatments. Prior to application of the treatment, 10 aphids of the green peach aphid were planted on each plant. Direct counts of live individuals were made at (3, 6 and 9) days after treatment and relative efficacy was determined from the Henderson and Tilton equation (10).

The estimation of polyphenol oxidase enzyme activity is shown.

The activity of polyphenol oxidase (PPO) enzyme in the leaves of cauliflower was estimated by preparing crude enzyme extract from the leaves. The rate of catechol oxidation was determined at 470 nm with a UV-Visible Spectrophotometer. After extracting the enzymes (11), enzyme activity was expressed as units per gram of fresh plant tissue (U/g FW) as described in (12).

To measure the weight of the cauliflower head.

Cauliflower plants were harvested and their fresh weight of curds and heads was determined immediately after harvest. Samples were picked up from the mentioned plants at random and were weighed directly on a precise digital digital weight balance. The data were presented as g.plant^{-1} (13).

Statistical Analysis

Analysis of Variance (ANOVA) was used in the statistical analysis of the data suitable for Randomized Complete Block Design (RCBD). Means were compared using the Least Significant Difference (LSD) test at 5% probability level, using the statistical software package (GenStat, Release 10.3DE).

Results and Discussion

The relative effectivness of controlling the Green Peach Aphid, *Myzus persicae*, in the presence of incorporation of Kinetin with some biological and chemical agents.

The present investigation revealed that the relative effectiveness of the various treatments against M. persicae on B. oleracea var. differed. Depending on the type of treatment and exposure time, it is either called botrytis or another name. After three days of treatment, the ternary treatments Kinetin (1 g/L) + P. fluorescens + Sivanto Prime, Kinetin (1 g/L) + P. syringae + Sivanto Prime and Kinetin (1 g/L) + P. syringae + Movento showed the highest relative efficacy (100%). The ternary interaction treatments were not significantly different because they had the same relative efficacy. With increasing time of exposure, the relative efficacy increased in most treatments up to 100% after 6 days of treatment and remained at this level until the 9th day.

As far as the effect of the individual bacteria were concerned, it

ISSN 2072-3857

was seen that there is a significant difference between the two species of bacteria. For P. fluorescens the relative efficacies were 20, 20 and 30% after 3, 6 and 9 days of treatment respectively, while for P. syringae they were 30, 40 and 55% respectively, which were significantly higher than P. fluorescens. Relative efficacy of the use of the plant growth regulator kinetin was also found to vary with concentrations alone. The concentration (1 g/L) was able to achieve a relative efficacy of 35% after three days of treatment which was much better than the concentration (0.5 g/L) with 25% relative efficacy. The efficacy improved with the duration of exposure, and reached 65 and 50% after 6 days, and 100% after 9 days of treatment.

As far as insecticide effectiveness is concerned, the results indicated that Sivanto Prime was the fastest acting when used alone with a relative cure rate of 60% after three days' treatment while Movento had a rate of 55% after the same treatment period. Both insecticides, however, had a relative efficacy of 100% after 6 d, and this increased further with time up to 9 d, which shows their high efficacy with increasing exposure time.

Table(1)·The relative effectivness of controlling the Green Peach Aphid, *Myzus persicae*, in the presence of incorporation of Kinetin with some biological and chemical agents.

Relative Efficacy (%) against *Myzus persicae*			
Treatment	**After 3days**	**After 6 days**	**After 9 days**
Kinetine 5.0	**25**	**50**	**100**
kinetine 1	**35**	**65**	**100**
P· fluorescens	**20**	**20**	**30**
P· syringae	**30**	**40**	**55**
Sivanto Prime	**60**	**100**	**100**
Movento	**55**	**100**	**100**
Kinetine 5.0 + P· fluorescens	**30**	**90**	**100**
Kinetine 5.0+ P· syringae	**40**	**100**	**100**
kinetine 1+ P· fluorescens	**35**	**100**	**100**
kinetine 1 + P· syringae	**45**	**95**	**100**
Kinetine 5.0+ Sivanto Prime	**75**	**100**	**100**
Kinetine 5.0+Movento	**85**	**100**	**100**
kinetine 1 + Sivanto Prime	**90**	**100**	**100**
kinetine 1 + Movento	**85**	**100**	**100**
P· fluorescens + Sivanto Prime	**40**	**100**	**100**
P· fluorescens + Movento	**50**	**100**	**100**
P· syringae+ Sivanto Prime	**75**	**100**	**100**
P· syringae+ Movento	**60**	**100**	**100**

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Kinetine 0.5+P· fluorescens+ Sivanto Prime	**85**	**100**	**100**
Kinetine 0.5+ P· fluorescens+ Movento	**70**	**100**	**100**
Kinetine 0.5+ P· syringae+ Sivanto Prime	**90**	**100**	**100**
Kinetine 0.5+ P· syringae+ Movento	**85**	**100**	**100**
Kinetine 1+P· fluorescens+ Sivanto Prime	**100**	**100**	**100**
Kinetine 1+ P· fluorescens+ Movento	**90**	**100**	**100**
Kinetine 1+ P· syringae+ Sivanto Prime	**100**	**100**	**100**
Kinetine 1+ P· syringae+ Movento	**100**	**100**	**100**
0.05L.S.D	**1.947**	**0.931**	**0.559**

The high relative efficacy of the treatments even with the plant growth-promoting bacteria is because of the ability of these bacteria to enhance plant growth and trigger plant defense mechanisms, as well as the different capacity of the strains to colonize and to produce virulence factors that have an insecticidal effect, in some cases, or to have an indirect effect. (14) demonstrated that certain strains of Pseudomonas syringae can impact aphids, including M. persicae. The efficacy of the bacterial strains used in this study was different, as another study (15) suggested that some strains of P. fluorescens produce extracellular enzymes and compounds that aid in insect control.

This high RER is attributed to the mode of action (MOA) of the active ingredient Flupyradifurone of these treatments, which targets nicotinic acetylcholine receptors in the insect nervous system causing disruption in the neuronal activity and making the insect less able to feed. Movento, which is active with Spirotetramat, however, works by blocking the production of fatty acid, and has a slow effect on insect growth and development. The study by (16) revealed good efficacy of Flupyradifurone against the populations of M. persicae on the plants and the study carried out by (8) had reported that Spirotetramat has systemic translocational activity in the plant and its effect is gradual as it is a vital process inhibitor for the insect. From the results of (17) it is concluded that cytokinins are plant resistance inducers and activate the plant defense system which affects the efficiency of the plant feeding the insect, thereby limiting their growth and establishment, the response will vary according to plant type, insect type and type of the inducer used.

The findings are similar to those of (18) who showed that the use of Sivanto Prime alone or in combination with plant resistance inducers was more effective than using the products alone in controlling the green peach aphid. The above suggests that the relative efficacy of the integrative treatments in the current study may be due to interactions between the biological and chemical treatments and the effect of kinetin on the plant's defense status, creating an improved integrated pest management program.

The effects of integration of Kinetin with some biological and chemical agents on polyphenol oxidase

ISSN 2072-3857

(PPO) enzyme activity in cauliflower leaves.

Effect of integration of Kinetin with some biological and chemical agents on polyphenol oxidase (PPO) enzyme activity in cauliflower leaves.

Based on the results of statistical analysis, it was found that the treatments of kinetin, biological and chemical treatments had a significant effect on the polyphenol oxidase (PPO) enzyme activities in the leaves of cauliflower. Kinetin alone at 0.5 and 1 g/L resulted in higher enzyme activities than the control treatment, 1.35 and 1.39 U/g FW, respectively, compared to 0.52 U/g FW in the control.

The results also indicated that the PPO enzyme activity rates of the treatments Kinetin (1 g/L) + P. fluorescens and Kinetin (1 g/L) + P. syringae was 3.03 and 3.06 U/g FW respectively, which was higher compared with control treatment with 0.52 U/g FW.

The interaction results between treatments and the varieties used in the study (Steady and Nahar) highlighted the superiority of the treatments Kinetin (1 g/L) + P. fluorescens + Sivanto Prime and Kinetin (1 g/L) + P. syringae + Sivanto Prime on the Steady variety, significantly outperforming most treatments, with enzyme activity increasing from 0.55 U/g FW in the control to 3.25 and 3.31 U/g FW, respectively. The results also showed significant differences between varieties, with the Steady variety showing a higher PPO enzyme activity than the Nahar variety (1.90 U/g FW, compared to 1.70 U/g FW in Nahar).

Table(2)·The effects of integration of Kinetin with some biological and chemical agents on polyphenol oxidase (PPO) enzyme activity in cauliflower leaves

PPO activity (U/g FW)			
Treatment	**Varieties**		
	Nahar	**Steady**	**MeanTreatment Effect**
Kinetine 5.0	**1.19**	**1.5**	**1.35**
kinetine 1	**1.24**	**1.53**	**1.39**
P· fluorescens	**0.57**	**0.88**	**0.73**
P· syringae	**0.58**	**0.87**	**0.74**
Sivanto Prime	**0.65**	**1.11**	**0.88**
Movento	**0.61**	**1.1**	**0.85**
Kinetine 5.0 + P· fluorescens	**1.31**	**1.62**	**1.47**
Kinetine 5.0+ P· syringae	**1.35**	**1.66**	**1.51**
kinetine 1+ P· fluorescens	**1.67**	**1.98**	**1.83**
kinetine 1 + P· syringae	**1.68**	**1.99**	**1.84**
Kinetine 5.0+ Sivanto Prime	**1.6**	**1.85**	**1.73**
Kinetine 5.0+Movento	**1.56**	**1.78**	**1.67**
kinetine 1 + Sivanto Prime	**1.9**	**2.2**	**2.05**

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kinetine 1 + Movento	**1.86**	**2.17**	**2.02**
P· fluorescens + Sivanto Prime	**0.99**	**1.12**	**1.06**
P· fluorescens + Movento	**0.94**	**0.98**	**0.96**
P· syringae+ Sivanto Prime	**1**	**1.12**	**1.06**
P· syringae+ Movento	**0.94**	**0.99**	**0.97**
Kinetine 0.5+P· fluorescens+ Sivanto Prime	**2.41**	**2.81**	**2.61**
Kinetine 0.5+ P· fluorescens+ Movento	**2.33**	**2.68**	**2.51**
Kinetine 0.5+ P· syringae+ Sivanto Prime	**2.47**	**2.89**	**2.68**
Kinetine 0.5+ P· syringae+ Movento	**2.33**	**2.68**	**2.51**
Kinetine 1+P· fluorescens+ Sivanto Prime	**2.81**	**3.25**	**3.03**
Kinetine 1+ P· fluorescens+ Movento	**2.76**	**3.13**	**2.95**
Kinetine 1+ P· syringae+ Sivanto Prime	**2.81**	**3.31**	**3.06**
Kinetine 1+ P· syringae+ Movento	**2.77**	**3.13**	**2.95**
control	**0.5**	**0.55**	**0.52**
L.S.D 0.05	**0.052**		**0.035**
Mean Variteties Effect	**1.7**	**1.9**	
L.S.D 0.05 for Variteties	**0.096**		

The research assumes that the strong phenolic oxidase (PPO) enzyme activity after ternary interaction treatments, (kinetin + bacteria + insecticide), may be attributed to synergy in the induction of internal response mechanisms of the plant. All of these factors resulted in the activation of biochemical defense signaling pathway(s). this may refer to the activity of such oxidative enzyme that could increase due to the compensation of biological which lead to enhance the activity to against different biotic stress .(19)

who observed that the activity of the oxidative enzymes such as PPO gets increased in the biological combinations which will improve the defense system of the plant against attack. The differences in stimulation between single agents are thought to be due to their different physiological effects. It has been suggested to be a cytokinin which affects metabolic pathways involved in the synthesis of phenolic compounds and their conversion to quinones, which are anti-nutritional for insects, and plant defense barriers, tissue thickening and hardness (20), (21).

Excessive enzyme activity in plants triggered by P. syringae over that of the P. fluorescens is not attributed to specific growth promotion mechanisms. The researcher thinks that P. syringae strains are weak pathogens which act as biotic elicitors, triggering the immune system and inducing systemic acquired resistance and hormonal signaling pathways that induce the production of defensive enzymes. This is fairly similar to the findings of (22) and (23) on the activation of the pathway of phenolic compounds by microorganisms. In terms of the chemical insecticides (Sivanto Prime and Movento), the elevated PPO

ISSN 2072-3857

activity is the result of the plant's response to stress caused by chemical and biotic stress generated by the penetration of the cells, resulting in the production of reactive oxygen species (ROS) which stimulates the expression of the genes encoding oxidative enzymes. Sun and (24) showed a correlation between the activity of PPO and the immediate reaction to biotic and abiotic stress (17). The researcher is convinced that combining these factors provides a full activation of the plant's defense system and a decrease in the M. persicae green peach aphid population density.

Influence of Kinetin in Combination with some Biological and Chemical Agents on Cauliflower head weight.

The results of the present investigation revealed that all the treatments under investigation significantly increased the head weight (g) of cauliflower plants of both varieties Nahar and Steady over the control treatment indicating improvement in the physiological state, growth and productivity of the plants. This improvement is logical, because the activation of the internal vital processes was correlated with the decrease of the effects by biotic stress, resulting in better metabolic efficiency and translocation of photosynthates towards the economic parts (heads).

The application of kinetin alone at 0.5 and 1 g/L significantly increased the head weight up to 1082 and 1168 g per head as compared to 524 g in the control. This could be explained by the fact that cytokinins stimulate cell division and control the activity of the apical meristems, hence head size and the build-up of organics in head.

The highest cauliflower head weights of 1344 g and 1351 g were obtained with the ternary interaction treatments involving the use of the biological agents, P. fluorescens and P. syringae, combined with Sivanto Prime, respectively. This shows the synergistic effect of these three treatments on growth, greater efficiency in the uptake of nutrients, less biotic stress which in turn leads to more dry matter in the growing head. The control treatment had the lowest weight of 524 g, in contrast.

Result of two cultivars showed differences Stady and Nahar, which showed slightly differences of head weight (1160 g and 1140 g) respectively. this might due to the genetic differences between these variety.

with Steady variety being superior to Nahar variety in average head weight (1160 g for Steady and 1140 g for Nahar), suggesting that there was a genetic difference in their responses to the applied treatments.

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Table (3)·Influence of Kinetin in Combination with some Biological and Chemical Agents on Cauliflower head weight

head weight(g)			
Treatment	Varieties		
	Nahar	Steady	MeanTreatment Effect
Kinetine 5.0	1079	1085	1082
kinetine 1	1168	1167	1168
P· fluorescens	1055	1036	1046
P· syringae	1045	1065	1055
Sivanto Prime	890	877	884
Movento	883	850	867
Kinetine 5.0 + P· fluorescens	1132	1142	1137
Kinetine 5.0+ P· syringae	1160	1164	1162
kinetine 1+ P· fluorescens	1241	1250	1246
kinetine 1 + P· syringae	1275	1295	1285
Kinetine 5.0+ Sivanto Prime	1089	1124	1107
Kinetine 5.0+Movento	1085	1110	1098
kinetine 1 + Sivanto Prime	1140	1192	1166
kinetine 1 + Movento	1180	1124	1152
P· fluorescens + Sivanto Prime	1148	1151	1150
P· fluorescens + Movento	1140	1125	1133
P· syringae+ Sivanto Prime	1158	1164	1161
P· syringae+ Movento	1151	1150	1151
Kinetine 0.5+P· fluorescens+ Sivanto Prime	1230	1234	1232
Kinetine 0.5+ P· fluorescens+ Movento	1212	1212	1212
Kinetine 0.5+ P· syringae+ Sivanto Prime	1249	1250	1250
Kinetine 0.5+ P· syringae+ Movento	1239	1245	1242
Kinetine 1+P· fluorescens+ Sivanto Prime	1342	1346	1344
Kinetine 1+ P· fluorescens+ Movento	1320	1321	1321
Kinetine 1+ P· syringae+ Sivanto Prime	1350	1351	1351
Kinetine 1+ P· syringae+ Movento	1337	1334	1336
control	480	567	524
L.S.D 0.05	62.56		44.23
Mean Varieties Effect	1140	1160	
L.S.D 0.05 for Varieties	12.04		

ISSN 2072-3857

The higher cauliflower weight observed after the use of kinetin may be explained by its function as a plant cytokinin which plays a role in meristematic cell division and development of tissue growth resulting in increased synthesis of photosynthetic products and organic matter in the developing head and its productive properties. The result is in some degree consistent with the indication given in (25) that changes in endogenous level of cytokinins cause changes in the morphology of cauliflower heads through regulating meristem growth and cell division.

In addition to the stimulation of the physiological processes associated with growth and accumulation of organic matter, the increase in head weight of cauliflower plants inoculated with P. fluorescens and P. syringae is believed to be due to their plant growth promotion activity which leads to better growth of root system and a greater efficiency of nutrient uptake from the soil. According to (26) plant growth-promoting bacteria (PGPB) had been observed to generate growth promoters and enhance the bioavailability of nutrients, which resulted in better plant growth. The results of (27) also established that the use of PGPR bacteria in cauliflower crops resulted in weight and yield increase which was attributed to the better nutrient uptake efficiency.

In terms of Sivanto Prime and Movento, the greater the increase in the head weight, the less severe the green peach aphid infestation. Such reduction in sap loss and maintenance of photosynthetic efficiency resulted in photosynthates being diverted to the economic parts of the plant. From the results of (28) it was concluded that Spirotetramat is systemic in the plant and affects sucking insects including the green peach aphid. Meanwhile, (9) has shown the effectiveness of Flupyradifurone in the protection of plants from sucking pests because of its activity on the insect nervous system which causes a state of paralysis, a stop in feeding and death.

The results of the current study on cauliflower **Brassica oleracea** var. The infection of plants resulting in the formation of fruiting bodies, known as botrytis, is similar to that reported by study (18) on broccoli, Brassica oleracea. In *italica*, the application of Sivanto Prime resulted in a greater head weight than the control treatment because the green peach aphid was reduced and plant growth efficiency maintained. They also find the results of study (29) partially in agreement with the results of this study in that the use of systemic insecticides to control the green peach aphid in tobacco plants resulted in lower level of infestation, better plant growth and higher yields.

Conclusions

The data presented in the study indicated that the combination of the biological and biological and chemical agents with the kinetin had better insecticidal effects on the green peach aphid, Myzus persicae than the single and binary applications. The treatments of kinetin with either Pseudomonas fluorescens or Pseudomonas syringae and Sivanto Prime gave the highest levels of control as this combination of treatments proved to be effective. The ability of different bacterial strains to enhance the efficacy of the green peach aphid control was seen, as Pseudomonas

ISSN 2072-3857

syringae was more effective than Pseudomonas fluorescens. The integrative treatments also had an effect in raising the polyphenol oxidase (PPO) enzyme activity which is indicative of the activation of internal plant defense mechanisms as a result of the insect attack. The results of this study indicated that the superior pest control achieved and induction of plant defense responses had beneficial effects on productive traits, with the integrative treatments yielding greater weights of cauliflower heads than the control treatment. Overall, the study results confirm that integrating kinetin with biological agents and insecticides represents a promising approach to enhance the efficacy of controlling the green peach aphid and improve the productivity of cauliflower plants.

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