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Novel herbal extract-Samved Fitocheck growth retardant for fruitfulness and yield of grapes

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Abstract
Chemicals that slow cell division and cell elongation in shoot tissues and regulate plant height physiologically without formative effects. So far only chemical growth retardants are available in market which have residue problem. So, to overcome residue issue Vasumitra Life Energies Pvt. Ltd has developed a formulation of herbal extract having role in induction of fruitfulness as well as retardation of unwanted shoot growth. The extract was applied to vineyard at Pandharpur, during the year 2018-19 at different concentrations keeping Chlormequat Chloride (CCC) as check and one control treatment replicated five times at 5, 7 and 15 leaf stages after foundation pruning as well as 3 leaf stage after fruit pruning. The results revealed that significantly reduced shoot length, internodal length and increases the cane thickness of grape vine. The SPAD values, number of bunches per vine, weight of bunch were found significantly higher in treatments with herbal extract as compared to CCC and control. Fitochek @ 2 ml/lit showed highest fruitfulness percentage 65%, and yield 16.46 t/acre. It had no significant influence on berry length, berry diameter, TSS and acidity. Fitochek and control had no residues at harvest while CCC have residue above EU MRLs. Furthermore, no phytotoxic effects on grape vine were observed in any of treatments under investigations. From the above result and literature surveyed this is first report to demonstrate this novel organic compound (Fitochek) can be used effectively @ 2 ml/lit at different stages (After Foundation and fruit pruning) to retard unwanted shoot growth as well as overcome the residue problem.

Keywords: Growth retardants, fitocheck, chlormequat chloride, residue, herbal extract

Introduction
Grape (*Vitis vinifera* L.) belonging to family *Vitaceae* is a commercially important delicious subtropical fruit crop of India. It is a temperate crop which has got acclimatized to sub-tropical and tropical agro climatic conditions prevailing in the Indian sub-continent. In India, grapes are grown under different soil with cultural operations. Favorable condition induces the excess shoot vigour which leads to be detrimental because most of the metabolites are utilized for continuous vegetative growth. Therefore, it is necessary to reduce the excess vigour of vegetative growth without reducing the shoot number of the vine, which can be achieved with the application of growth retardants (Ramteke and Somkumar, 2005) [14]. Plant growth retardants are synthetic compounds, which are used to reduce the shoot length of plants in a desired way without changing developmental patterns or being phytotoxic (Davis and Curry, 1991) [4]. This is achieved primarily by not only reducing cell elongation, but also by lowering the rate of cell division. Plant growth retardants generally have great effects on elongation of cells, where inhibition of GA synthesis rapidly causes reduction in shoot elongation and thereby increase in fruit quality attributes (Tanimoto, 1983) [17]. There are different growth retardants used in grapes like CCC or Cycocel, Phosfon-D (tributyl-2,4-dichlorobenzylphosphonium chloride), Alar or B 995 (N, N-dimethylaminosuccinamic acid) and CO 11 (N, N-dimethylaminomaleamic acid) as described by Coombe (1967) [3]. Phosphon-D (tributyl-2, 4-dichlorobenzylphosphonium chloride), known as an inhibitor of gibberellin biosynthesis, enhances photosynthetic electron transport by up to 200%, with Fe(CN) 3-6and NADP+ being the electron acceptors (Lendzian *et al*. 1978) [11]. Three different growth retardant as fruit-setting agents were tested for stenospermocarpic cultivar of *Vitis vinifera* grape during girdling like 2-naphthoxyacetic acid (NOA), succinic acid 2-2-dimethyl hydrazide (Alar), and Gibberellic acid (GA_3) in 1975 (Tafazoli, 1977) [15].
Among all used growth retardants CCC is one of the main plant growth regulators which is highly stable gibberellins biosynthesis inhibitor used to inhibit vegetative growth and cell elongation (Kulkarni *et al*. 2018) [8].

CCC is commercially available under the trade name Cycocel. It also known as Chlorocholine chloride contains a quaternary ammonium group (Gent and McAvoy, 2000) [5]. It inhibits the cyclization of geranylgeranyl pyrophosphate to copallyl pyrophosphate in the gibberellin biosynthesis pathway (Rademacher, 2000) [13]. It is highly mobile in both xylem and phloem tissue and rapidly absorbed and translocated. (Lord and Wheeler, 1981; Kust, 1986) [12, 10]. Application of CCC to crops results in plants with shorter internodes and thicker, darker green leaves (Tolbert, 1960a, 1960b) [19, 20]. A threshold concentration is required for growth inhibition (Birecka, 1967) [2], with reports of low concentrations actually promoting stem elongation (Tolbert, 1961; Halevy and Wittwer, 1965) [21, 6]. Improper application or excessively high concentrations result in severe marginal leaf chlorosis or chlorotic spotting (Armitage, 1994) [1].

In the recent years, repeated detection of exceeding levels of residues of CCC has been found in grape, particularly which were exported from India to EU countries. To overcome the residue problems of CCC it is urge to replace it with some organic compounds. But from literature survey it was found that there is no any organic compound to replace CCC. So, Vasumitra has developed herbal product which is a blend of potential herbal extract amended with silica and potash in ionic form. Management of internal vital energy is the principle of Sanjeevan System, which is taken from the philosophy and principles of science of Yog, Vedas and Upanishads. According to ancient sciences, internal vital energy is managed by balancing energies of Panch mahabhutas or five basic elements such as Prithvi(Earth)/, Jal(Water), Tej (Fire), Vayu(Gas), Akash(Space) and their role for plant development or life cycle described by Jambhekar,

2017(https://www.slideshare.net/BhushanJambhekar/effect-of-samved-fugall-co2-absorbent-on-bt-cotton).

It balances the C: N ratio and induces root development which in turn helps to increase cytokinin: auxin ratio. Hence, the use of Fitochek during foundation pruning results in enhancement of bud fruitfulness in grapes as well as retard the unwanted shoot growth at the same time this herbal product do not have any residual problem. Hence, the present investigation was carried out to study the influence of herbal extract Fitochek on morphological, yield, quality parameters and residue in the grape berry samples.

Materials and Methods

The experiment was conducted on Manik Chaman variety grafted on Dogridge rootstock at location Kasegaon, Taluka-Pandharpur, District- Solapur, Maharashtra, India with spacing 2.1 m x 1.5m between the vines. The experiment was carried out in randomized block design having six treatments replicated five times. Harbal Extract was obtained from Vasumitra Life Energies Pvt. Ltd., Pune. Battery operated knapsack sprayer fitted with hollow cone nozzle was used for spray. Water volume @ 400 L/ acre used for spray was calculated based on requirement where 1000 L/ha was used at full canopy. The treatments were, T_1: Fitochek @ 2, 2, 2 ml/lit; T_2: Fitochek @ 2, 4, 6 ml/lit; T_3: Fitochek @ 4,6,8 ml/lit; T_4: Fitochek @ 6, 8, 10 ml/lit; T_5: CCC @ 500, 1000, 1500 ppm applied at 5, 7 and 15 leaf stage respectively after foundation pruning and T_6 was control. After fruit pruning at 3 leaf stage T_1: Fitochek @ 2ml/lit; T_2: Fitochek @ 1 ml/lit; T_3: Fitochek @ 2 ml/lit; T_4: Fitochek @ 3 ml/lit; T_5: CCC @ 250 ppm; T_6: control. Standard cultural practices were followed during the experiment. Observations on shoot length, internodal length, cane diameter and SPAD were recorded at 90 days after foundation pruning. The parameter such as fruitfulness (%), number of bunches/vine, bunch weight (g), yield(kg)/ vine, 50 berry weight (g), berry length (mm), berry diameter (mm), TSS (^{o}Brix), acidity (g/100 ml), Phytotoxicity symptoms, residues in berries were recorded.

Results

The present study revealed that the influence of Samved Fitochek on the morphological parameters like fruitfulness, yield and residues in grape berries. The application of Samved Fitochek significantly reduces the shoot length, internodal length, and increases the cane thickness of grape vine (Table 1). The minimum shoot length was recorded in T1 (107.20 cm) followed by recorded in T5 (110.20 cm) while treatment T6 (66.91 cm) recorded longest shoot length which was high among all six treatments. Shortest internodal length recorded in T5 (5.00 cm) which found at par with the treatment T1 (5.15 cm) while control T6 (6.00 cm) was showed highest. The maximum cane thickness was in T5 (8.24 mm) treatment which was at par with treatment T1 (8.11 mm) and T2 (8.06 mm) while minimum cane thickness was recorded in treatment T6 (7.43 mm). The maximum SPAD values recorded in T_2 (33.60) followed by T_5 (33.20) while the minimum in control T_6 (30.40) as shown in table 1. The SPAD value is an indirect index of chlorophyll content and CO_2 absorption was useful for efficient photosynthesis.

The herbal extract has positive influence on yield parameters (table 2). The highest fruitfulness percentage 72% was recorded in T5 which was at par with 65% in T1 followed by 60% fruitfulness in treatment T2 and T3 and the lowest fruitfulness 50% was recorded in T6 (Table 2). The maximum number of bunches per vine (46.47) were recorded in T1 followed by T5 (43.33) which was at par with T2 (42.00) while the minimum number of bunches per vine (38.67) recorded in control treatment T6. The highest weight of bunch (601.50 g) was recorded in the treatment T1 which was significantly superior over other treatments followed by 524.25 g in T5. The lowest bunch weight (327.25 g) recorded in control. The highest yield (28.20 kg/vine and 20.47t/acre) was recorded in the T1 followed by T5 treatment (22.68 kg/vine and 16.46 t/acre) while the lowest yield (12.64 kg/vine and 9.17t/acre) was recorded in control treatment T6. The highest brix yield 4.65 kg/vine recorded in the treatment T_1 followed by treatment T5 (3.60 kg/vine) and minimum brix yield was recorded in control T6 (2.49 kg/vine).

Fitochek had no significant influence on berry length, berry diameter, TSS and acidity (Table 3). No phytotoxic effects such as chlorosis, tip burning, necrosis on leaves and berries, epinasty and russeting on leaves/ berries of grape vine up to ten days after each spray of Fitochek were observed in any of treatments under investigations. With respect to residues analysis, Fitochek treatments (T1- T4) and control had no residues found in berries at harvest.

Discussion

Samved Fitochek was formulated using botanical extracts which store the energies of Vayu/Gas, Tej/Fire, and Prithvi/Earth. Hence these energies activate CO_2 absorption, photosynthesis and absorption of P and K. Efficient CO_2 absorption was effective to balance C:N ratio of plant whereas active uptake of P and K along with CO_2 absorption not only was useful for efficient photosynthesis but at the same time was helpful to suppress excess N uptake and balance C:N, N:P and N:K ratio of plant. In turn biosynthesis of

Gibberellins was blocked and cytokinin synthesis was stimulated and excess vegetative growth was stopped resulted in reduction of shoot length, internodal length and increase in fruitfulness of buds. In present investigation application of growth retardant extract results in reduction of shoots and internodal length. In the same way application of growth retardants CCC results in plants with shorter internodes and thicker, darker green leaves (Tolbert, 1960) [18]. Present results showed that Fitocheck @ 2 ml/lit is most appropriate concentration for optimum results regarding growth regulation and fruitfulness of grapes. Because, a threshold concentration is required for growth inhibition (Birecka, 1967) [2], with reports of low concentrations actually promoting stem elongation (Tolbert, 1961; Halevy and Wittwer, 1965) [21, 6]. Furthermore, fruit number and yield increased by application of cycocel @ 1500 ppm on peach but had no significant effect on fruit weight, TSS and acidity (Kumar *et al*. 2005) [9]. According to Kulkarni *et al*. (2018) [8] three different concentrations (1000, 1500, 2000 mg/l) of CCC at three different stages (5, 7, 12 leaf stage) were superior in respect to reducing total shoot length, internodal distance, leaf area, cane weight and increased cane thickness, petiole diameter and well developed cluster primordial (Percent fruitfulness). Also CCC significantly inhibited the growth rate of new shoots at 3rd week after treatment (TaiLi *et al*. 2011) [16]. It also demonstrated that chlorophyll a and chlorophyll b content of leaves was increased after application of growth retardants. In present study number of bunches are increased and according to Ramteke and Somkuwar (2005) [14] number of bunches is an indirect indication of fruitfulness of the bud in a vine after pruning.

Here, it is proved that Fitochek retarded the shoot growth but enhanced bunch weight and fruit yield. Similarly, experimentally proved that CCC influences the formation and development of cells in plant stalk. Treatment with CCC reduced shoot and stolon growth and dry weight but promoted tuberisation. In field trial on a variety of rye and other plants elongation of four internodes was found to be reduced which was due to decreased cell extension and cell division. It was reported that the walls of parenchyma cells of CCC treated plants were thinner and those sclerenchyma cells were thicker compared to the cell walls of the control (Kosher *et al*. 1982). Coombe (1967) [3] evaluated four growth retarding chemicals CCC or Cycocel, Phosfon-D (tributyl-2,4-dichlorobenzylphosphonium chloride), Alar or B 995 (N, N-dimethylaminosuccinamic acid) and CO 11 (N, N-dimethylaminomaleamic acid) and found that leaves were darker green, shoots were shortened, tendrils retarded, laterals differentiated more inflorescences, more berries set and berry size was decreased. None of them represent abnormal growth. In present study, residue was not found at harvest when Fitochek was applied but application of CCC showed residue above MRLs. Kulkarni *et al*. (2018) [8] reported that the berries samples showed the presence of CCC residues above European Union MRLs. High concentration of CCC treated vines reported more residues in berry as compare to low concentration of CCC treated vines.

Table 1: Effect of Fitochek on morphologi1cal parameters of grapes at 90 days of April pruning

Treatment	Shoot length (cm)	Internodal length (cm)	Cane diameter (mm)	SPAD
T1	107.20	5.15	8.11	32.80
T2	122.80	5.52	8.06	33.60
T3	124.80	5.41	7.68	32.00
T4	120.60	5.40	7.45	31.40
T5	110.20	5.00	8.24	33.20
T6	127.20	6.00	7.43	30.40
S.Em (±)	3.83	0.19\	0.21	1.16
C.D. @ 5%	11.38	0.55	0.61	NS

Table 2: Effect of Fitochek on yield parameters of grapes

Treatment	Fruitfulness (%)	No of Bunches/vine	Bunch weight (g)	Yield (kg)/ vine	Yield (t)/ Acre	Yield (t)/ ha	Brix yield (kg/vine)
T1	65	46.67	601.50	28.20	20.47	50.58	4.65
T2	60	42.00	444.75	18.64	13.53	33.44	3.07
T3	60	41.00	417.75	17.03	12.37	30.56	2.59
T4	55	41.00	478.50	19.70	14.30	35.34	3.27
T5	72	43.33	524.25	22.68	16.46	40.68	3.60
T6	50	38.67	327.25	12.64	9.17	22.67	2.49
S.Em (±)	-	0.72	15.78	1.10	0.80	1.97	0.42
C.D. @ 5%	-	2.27	47.99	3.45	2.51	6.20	1.34

Table 3: Effect of Fitochek on quality parameters of grapes

Treatment	No of berry/ Bunch	50 Berry Weight (g)	Berry length (mm)	Berry Diameter (mm)	Skin thickness (µm)	TSS (ºBrix)	Acidity (g/100 ml)	TSS: Acidity ratio
T1	125.00	183.63	23.53	14.88	20.50	16.48	0.97	16.99
T2	116.25	205.88	24.03	15.60	22.25	16.45	0.92	17.88
T3	110.25	181.75	25.30	15.50	19.25	15.23	1.04	14.64
T4	123.25	199.00	26.45	15.80	21.25	16.60	0.90	18.44
T5	111.75	169.25	24.93	14.73	22.50	15.88	0.97	16.37
T6	108.00	151.88	23.65	14.60	22.25	19.73	0.88	22.42
S.Em (±)	4.29	10.75	0.41	1.20	1.81	1.35	0.04	-
C.D. @ 5%	NS	32.71	NS	NS	NS	NS	NS	-

Table 4: Comparison of residues in different treatment of Samved Fitochek, CCC and control

Treatment	Residue (mg/kg)
T1	BLQ < 0.00
T2	BLQ
T3	BLQ
T4	BLQ
T5	0.152
T6	BLQ

Table 5: Show the Shoot length and Inter nodal

	Shoot length	Inter nodal length (cm)	Cane diameter	SPAD	No. of Bunches/ vine	Bunch weight	Yield (kg)/ vine	Yield (t)/ Acre	Yield (t)/ ha	Brix yield (kg/ vine)	No of berry/ bunch	50 Berry Weight	Berry average length	Berry Diameter	Skin thickness	TSS	Acidity
Shoot length	1																
Inter nodal length	0.844	1															
Cane diameter	-0.746	-0.733	1														
SPAD	-0.564	-0.706	0.918	1													
No. Bunches/ vine	-0.917	-0.796	0.776	0.683	1												
Bunch weight	-0.937	-0.886	0.693	0.637	0.953	1											
Yield (kg)/ vine	-0.945	-0.847	0.705	0.625	0.978	0.993	1										
Yield (t)/ Acre	-0.945	-0.848	0.705	0.625	0.978	0.993	1.000	1									
Yield (t)/ ha	-0.945	-0.848	0.705	0.625	0.978	0.993	1.000	1.000	1								
Brix yield (kg/ vine)	-0.937	-0.716	0.636	0.508	0.950	0.949	0.971	0.971	0.971	1							
No of berry/ bunch	-0.540	-0.440	0.172	0.267	0.647	0.740	0.729	0.729	0.729	0.759	1						
50 Berry Weight	-0.047	-0.310	0.182	0.527	0.279	0.366	0.316	0.317	0.317	0.218	0.636	1					
Berry length	0.148	-0.256	-0.362	-0.152	-0.260	0.014	-0.091	-0.090	-0.090	-0.222	0.148	0.364	1				
Berry Diameter	0.346	-0.045	-0.248	0.144	-0.147	-0.013	-0.082	-0.081	-0.082	-0.205	0.370	0.865	0.646	1			
Skin thickness	-0.032	0.174	0.193	0.102	-0.188	-0.155	-0.164	-0.165	-0.164	-0.049	-0.183	-0.183	-0.241	-0.353	1		
TSS	0.393	0.801	-0.511	-0.682	-0.506	-0.579	-0.524	-0.525	-0.525	-0.307	-0.274	-0.578	-0.454	-0.495	0.489	1	
Acidity	0.363	0.322	-0.314	-0.322	-0.131	-0.309	-0.250	-0.249	-0.250	-0.286	-0.279	-0.220	-0.227	-0.005	-0.781	-0.012	1

Conclusion

It appears from the results that spraying of CCC @ 500, 1000, 1500 ppm and Fitochek @ 2ml/lit of water at different stages (after eoundation pruning- 5 leaf stage, 7 leaf stage, 15 leaf stage) and after fruit pruning CCC @ 250 ppm and Fitochek @ 2ml/lit of water - 3 leaf stage) recorded significantly increase in fruitfulness as well as retard the unwanted shoot growth, highest bunch weight, yield and no residues of Samved Fitochek in Manik Chaman grapes. In view of this study it indicates that Samved Fitochek also equivalent/ or on par to CCC with respect to reduction of the unwanted shoot growth, as well as increase in fruitfulness, highest bunch weight and yield. Hence from present investigation and literature surveyed the Samved Fitochek is novel and first organic growth retardant beneficial to overcome residue problems and increase the fruitfulness and yield in grapes.

Conflict of interest

The authors declare that there are no conflicts of interest associated with this publication.

Ethical approval

This research did not involve any studies with human participants or animals (vertebrates) performed by any of the authors.

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