

Original Research Article

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## Evaluation of MAK All Season Horticultural Mineral Oil (HMO) Against Major Insect Pests of Apple in Kashmir

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### ABSTRACT

Field evaluation of MAK all season Horticultural Mineral Oil (HMO) was done against San Jose scale *Quadraspidiotus perniciosus* Comstock and European red mite *Panonychus ulmi* Koch in apple orchards at two locations in Kashmir under field conditions during year 2014-2015. Phytotoxicity and effect on natural enemies were also recorded. HP (HMO) was used as standard check for conducting the experiment. Both the oils were sprayed during dormant and summer season to suppress different stages of the insect pests. Different concentrations of oil were sprayed viz., 2.5, 2.0 and 1.5% during dormant season and 1.0, 0.75 and 0.50% in summer season. All the concentrations significantly reduced the pest population over the standard check. Highest mortality of 76.66% and 81.22% were recorded against San Jose scale and 78.19% and 82.35 % against European red mite at 2.5% at Wakura during dormant and summer season respectively. None of the phytotoxicity effects were seen on the apple plant. *Stethorus punctum* and Coccinellids were the key predators found feeding on scale insect and European red mite. Maximum cumulative mean mortality of natural enemies was recorded as 36.73 at 1.0 % spray of MAK. The findings of the study exerted that by spraying these oils considerable reduction in the rate of infestation was observed in apple trees at both the locations.

#### Keywords

Apple, San Jose scale, European red mite, Bio efficacy

#### Article Info

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### Introduction

In Jammu and Kashmir, apple *Malus domestica* (Borkh) is the most important fruit crop among all the cultivated fruits. However, the production and quality of apple is affected because of several factors including insect pests. The major insect pests attacking this crop are San Jose scale and European red mite and are the most destructive and widely distributed all over the world (Bhalla and Gupta 1993). These pests have been

accidentally introduced to many countries and are considered major pests in most regions of the world where deciduous fruits are grown (Madson and Morgan, 1970). The damage by San Jose scale *Quadraspidiotus perniciosus* (Comstock) is caused by nymphs and female scales, which suck the sap from branches, twigs and fruits, weakens the plant and leaves, render the fruit unacceptable and unmarketable. European Red Mite *Panonychus ulmi* (Koch) is another serious pest feeding on foliage and thereby reducing

the yield of the plant. Different HMO's have been tested for the control of San Jose scale (Badenes *et al.*, 2010), while as insecticides have also been used for the management of San Jose scale (Singh *et al.*, 2001). Taking a note of the severity of the pests the experiment was undertaken to test the efficacy of the product, its phytotoxicity, and impact on quality apple yield and effect on natural enemies in the apple ecosystem of Kashmir Valley.

### **Materials and Methods**

To evaluate the effectiveness of MAK Horticultural mineral oil against San Jose scale and European red mite on apple, field trial was carried out in an apple orchard in Wakura and Zaznah of Ganderbal district during 2014-15 and 2015-16 in Kashmir in a randomized block design (RBD). The orchard had apple trees of Red Delicious cultivar having uniform size and age of 20 years. The orchard was selected taking into account the outbreak and damage caused by the pest. There were seven treatments and each treatment was replicated thrice. Three treatments of MAK all season HMO @ 1.5, 2.0 and 2.5% were compared with that of Standard Check (HP HMO) @ 1.5, 2.0 and 2.5% in dormant and three treatments of MAK all season HMO @ 0.5, 0.75 and 1.0% were compared with three treatments of Standard Check (HP HMO) @ 0.5, 0.75 and 1.0 % in summer. Water Sprayed Trees were kept as untreated control. Spraying was done by high volume power sprayer @10 liter / tree in Dormant and @ 15 liter/tree in summer. Pre-treatment observations were recorded before the spray and post treatment observations were recorded after 1, 3, 7, 15 and 30 days after spray for the population of San Jose scale and European red mite.

The observations on San Jose scale were recorded from 12 twigs /tree from different

directions. 1cm<sup>2</sup> area (bottom, middle and top) was marked on each twig. The number of crawlers of San Jose scale in dormant, females and nymphs in summer were recorded from each twig. In case of European Red Mite 12 twigs/ tree, each twig 10 cm long were marked for recording the eggs of ERM in dormant season, while as in summer 20 leaves/ tree were taken for observation, both adult and immature stages of ERM were recorded. Bio efficacy and phytotoxicity observations were also recorded after spray in summer at both the locations. Phytotoxicity data as leaf injury on tips/surface, yellowing, wilting, necrosis, hyponasty and epinasty were recorded after 3,7,15 and 30 days after spray using(1-10) scale. Yield was calculated on the basis of A grade apple boxes / tree treatment wise at harvesting time. Similarly the observations on natural enemies were also recorded one day before treatment and 1, 5, 7 and 10 days after treatment for each replication. Mortality of all the insect pests was subjected to corrected per cent mortality as per Abbott 1925. The findings of the study are depicted in Table 1-5 in results.

### **Results and Discussion**

#### **Bio efficacy**

#### **San Jose scale (Dormant season 2014 and 2015)**

The results presented in table 1 indicated that all the oil treatments were better than the untreated control. Observed data revealed that at Wakura pooled mean mortality of 73.30 per cent was recorded in MAK all season HMO @ 2.5 per cent, followed by 68.83 per cent @ 2.0 per cent and 62.03 per cent @ 1.5 per cent. Standard Check (HP HMO) recorded highest mean mortality of 76.66 per cent @ 2.5 per cent, followed by 68.65 per cent @ 2 per cent and 60.04 per cent @ 1.5 per cent, respectively. Water sprayed plants (untreated

control) recorded the lowest pooled mean mortality of 11.89 per cent. In Zaznah pooled mean mortality of 75.11 per cent was recorded in MAK all season HMO @ 2.5 per cent, followed by 71.01 per cent @ 2 per cent and 62.48 per cent @ 1.5 per cent, respectively. Standard Check (HP HMO) recorded highest cumulative mean mortality of 75.93 per cent @ 2.5 per cent, followed by 69.01 per cent @ 2 per cent and 59.32 per cent @ 1.5 per cent, respectively. Water sprayed plants (untreated control) recorded the lowest pooled mean mortality of 9.75 per cent. All the treatments were significantly different from untreated control, whereas the treatments of MAK all season HMO @ 1.5, 2.0 and 2.5 per cent were statistically *at par* with Standard Check (HP HMO) @ 1.5, 2.0 and 2.5 per cent when tested at  $P=0.05$  at 30 days after application of treatment. Among the treatments of MAK all season HMO and Standard Check (HP HMO) @ 2.0 and 2.5 per cent were *at par* with each other when tested at  $P=0.05$  at 30 days after application of treatment.

#### **San Jose scale (Summer 2014 and 2015)**

Perusal of the data in Table 2 revealed that at Wakura highest pooled mean mortality of 78.95 per cent was recorded in MAK all season HMO @ 1.0 per cent, followed by 72.71 per cent @ 0.75 per cent and 62.90 per cent @ 0.50 per cent. Standard Check (HP HMO) recorded highest cumulative mean mortality of 81.22 per cent @ 1.0 per cent, followed by 74.99 per cent @ 0.75 per cent and 66.49 per cent @ 0.50 per cent, respectively. Water sprayed plants (untreated control) recorded the lowest cumulative mean mortality of 12.93 per cent. In Zaznah pooled mean mortality of 80.94 per cent was recorded in MAK all season HMO @ 1.0 per cent, followed by 72.69 per cent @ 0.75 per cent and 59.48 per cent @ 0.5 per cent, respectively. Standard Check (HP HMO) recorded highest cumulative mean mortality of

77.74 per cent @ 1.0 per cent, followed by 75.86 per cent @ 0.75 per cent and 65.77 per cent @ 0.5 per cent, respectively. Water sprayed plants (untreated control) recorded the lowest pooled mean mortality of 14.16 per cent. All the treatments were significantly different from untreated control, whereas the treatments of MAK all season HMO @ 0.50, 0.75 and 1.0 per cent were statistically at par with Standard Check (HP HMO) @ 0.50, 0.75 and 1.0 per cent when tested at  $P=0.05$  at 30 days after application of treatment.

#### **European red mite (Dormant 2014 and 2015)**

The results presented in table 3 indicated that all the oil treatments were better than the untreated control. Data recorded revealed that at Wakura pooled mean mortality of 75.52 per cent was recorded in MAK all season HMO @ 2.5 per cent, followed by 72.22 per cent @ 2.0 per cent and 64.13 per cent @ 1.5 per cent. Standard Check (HP HMO) recorded highest cumulative mean mortality of 78.19 per cent @ 2.5 per cent, followed by 73.03 per cent @ 2 per cent and 65.56 per cent @ 1.5 per cent, respectively. Water sprayed plants (untreated control) recorded the lowest pooled mean mortality of 8.26 per cent. In Zaznah pooled mean mortality of 75.11 per cent was recorded in MAK all season HMO @ 2.5 per cent, followed by 71.58 per cent @ 2 per cent and 62.77 per cent @ 1.5 per cent, respectively. Standard Check (HP HMO) recorded highest cumulative mean mortality of 76.64 per cent @ 2.5 per cent, followed by 73.70 per cent @ 2 per cent and 65.58 per cent @ 1.5 per cent, respectively. Water sprayed plants (untreated control) recorded the lowest pooled mean mortality of 8.15 per cent. All the treatments were significantly different from untreated control, whereas the treatments of MAK all season HMO @ 1.5, 2.0 and 2.5 per cent were statistically at par with Standard Check (HP HMO) @ 1.5, 2.0 and 2.5 per cent when tested

at  $P=0.05$  at 30 days after application of treatment. Among the treatments of MAK all season HMO and Standard Check (HP HMO) @ 2.0 and 2.5 percent were at par with each other when tested at  $P=0.05$  at 30 days after application of treatment.

### **European red mite (Summer 2014 and 2015)**

Perusal of the data in Table 4 revealed that at Wakura highest pooled mean mortality of 83.19 per cent was recorded in MAK all season HMO @ 1.0 per cent, followed by 77.94 per cent @ 0.75 per cent and 74.99 per cent @ 0.50 per cent. Standard Check (HP HMO) recorded highest cumulative mean mortality of 82.35 per cent @ 1.0 per cent, followed by 77.81 per cent @ 0.75 per cent and 73.73 per cent @ 0.50 per cent, respectively. Water sprayed plants (untreated control) recorded the lowest cumulative mean mortality of 12.19 per cent. In Zaznah pooled mean mortality of 81.52 per cent was recorded in MAK all season HMO @ 1.0 per cent, followed by 73.97 per cent @ 0.75 per cent and 71.42 per cent @ 0.5 per cent, respectively. Standard Check (HP HMO) recorded highest cumulative mean mortality of 79.11 per cent @ 1.0 per cent, followed by 78.28 per cent @ 0.75 per cent and 69.13 per cent @ 0.5 per cent, respectively. Water sprayed plants (untreated control) recorded the lowest pooled mean mortality of 11.92 per cent. All the treatments were significantly different from untreated control, whereas the treatments of MAK all season HMO @ 0.50, 0.75 and 1.0 per cent were statistically at par with Standard Check (HP HMO) @ 0.50, 0.75 and 1.0 per cent when tested at  $P=0.05$  at 30 days after application of treatment.

### **Phytotoxicity on apple plants**

The test dosages of MAK all season HMO were sprayed with three concentrations in

summer as 0.50, 0.75 and 1.0 for phytotoxicity study. The phytotoxicity observations were recorded on 3, 7, 15 and 30 days after spray.

Observations were recorded as leaf injury, yellowing, wilting, necrosis, hyponasty and epinasty. No adverse effect on apple trees after spray was recorded and there were no phytotoxicity symptoms recorded during the evaluation programme in both the years 2014 and 2015 at both the locations Wakura and Zaznah District Ganderbal Kashmir (J&K).

### **Toxicity to Natural Enemies**

#### **Wakura**

Toxicity of MAK all season HMO was evaluated against two important natural enemies *Stethorus punctum* and *Coccinellids* associated with San Jose scale and European red mite in the Kashmir Valley as presented in table 5. Highest cumulative mean mortality of natural enemies was recorded as 36.73 % in case of MAK all season HMO @ 1% followed by 31.15 % @ 0.75% and 21.42 % @ 0.50 % respectively. While as Standard Check (HP HMO) recorded highest cumulative mean mortality of 27.05% @ 1 % followed by 24.61 % @ 0.75 % and 18.12% @ 0.50%. Highest pooled mean mortality of 36.46 % of *Stethorus punctum* was recorded in MAK all season HMO @ 1% followed by 32.29 % @ 0.75 % and 18.44 % @ 0.5 %. The pooled mean mortality of 27.07 % of *Stethorus punctum* was recorded in Standard Check (HP HMO) @ 1% followed by 23.69 % @ 0.75 % and 18.05 % @ 0.5 % respectively. Perusal of data in table 5 revealed that Highest pooled mean mortality of 37.00 % of *Coccinellids* was recorded in MAK all season HMO @ 1% followed by 30.00 % @ 0.75 % and 24.41 % @ 0.5 %. The pooled mean mortality of 27.04 % of *Coccinellids* was recorded in Standard Check (HP HMO) @ 1% followed by 23.87 % @ 0.75 % and 18.20 % @ 0.5 % respectively.

**Table.1** Bioefficacy of MAK all season HMO as dormant spray against San Jose Scale *Quadraspidotus perniciosus* on apple cv. Red Delicious at Wakura and Zaznah (District Ganderbal) Kashmir (J&K) during 2014 and 2015

Wakura									
Treatment	Conc. %	Pre-treatment count/cm <sup>2</sup>	Per cent corrected mortality of San Jose Scale/cm <sup>2</sup> (DAT)					Pooled Mean	*Yield (A grade apple)
			1	3	7	15	30		
HMO (MAK)	1.5	34.00	27.33	49.96	64.32	81.04	87.50	62.03	4.20
	2.0	33.83	47.67	54.46	65.40	84.77	91.87	68.83	4.89
	2.5	31.15	48.53	60.31	73.35	89.20	95.14	73.30	5.52
HMO (HP) Check	1.5	31.00	28.67	39.42	60.26	82.92	88.94	60.04	4.29
	2.0	30.00	38.36	54.76	71.13	85.45	93.55	68.65	4.65
	2.5	30.62	51.22	65.24	80.05	90.39	96.38	76.66	5.10
Control	-	31.09	3.59	8.62	13.23	15.75	18.27	11.89	3.18
C.D (0.05)			1.11	1.58	1.17	1.04	0.99		
Zaznah									
HMO (MAK)	1.5	38.53	27.71	47.11	65.17	83.20	89.20	62.48	4.25
	2.0	39.54	47.01	58.29	69.03	87.35	93.37	71.01	4.30
	2.5	37.39	48.67	63.24	76.68	91.11	95.83	75.11	5.30
HMO (HP) Check	1.5	37.39	28.23	37.10	59.79	82.74	88.74	59.32	4.38
	2.0	38.09	40.73	56.05	69.31	85.48	93.47	69.01	4.80
	2.5	38.29	49.12	64.55	78.97	90.86	96.14	75.93	5.85
Control	-	37.84	4.00	7.61	10.22	11.54	15.39	9.75	3.17
C.D (0.05)			1.02	1.00	0.89	0.75	1.05		

DAT= Days after treatment

\*= Boxes/tree

**Table.2** Bioefficacy of MAK all season HMO as summer spray against San Jose Scale *Quadraspidotus perniciosus* on apple cv. Red Delicious at Wakura and Zaznah (District Ganderbal) Kashmir (J&K) during 2014 and 2015

Wakura									
Treatment	Conc. %	Pre-treatment count/cm <sup>2</sup>	Per cent corrected mortality of San Jose Scale/cm <sup>2</sup> (DAT)					Pooled Mean	*Yield (A grade apple)
			1	3	7	15	30		
HMO (MAK)	0.50	8.65	22.87	49.54	71.39	84.29	86.43	62.90	4.20
	0.75	9.04	47.42	63.95	78.55	86.31	88.35	72.71	4.89
	1.0	8.89	60.22	73.16	84.18	86.79	90.39	78.95	5.52
HMO (HP) Check	0.50	9.07	33.28	47.59	73.14	81.42	87.42	66.49	4.29
	0.75	9.52	50.01	59.01	79.82	84.90	89.12	74.99	4.65
	1.0	9.34	66.34	69.72	83.83	87.62	91.42	81.22	5.10
Control	-	9.62	7.38	9.12	12.24	16.04	19.88	12.93	3.18
C.D (0.05)			1.24	1.57	1.16	1.12	1.03		
Zaznah									
HMO (MAK)	0.50	7.42	13.54	46.82	70.20	81.70	85.15	59.48	4.25
	0.75	8.77	49.34	62.70	77.17	86.05	88.17	72.69	4.30
	1.0	9.85	66.28	73.94	84.43	88.66	91.37	80.94	5.30
HMO (HP) Check	0.50	8.80	27.27	55.52	74.38	84.32	87.35	65.77	4.38
	0.75	9.40	55.82	66.54	80.09	87.56	89.32	75.86	4.80
	1.0	8.54	62.12	67.62	81.74	87.12	90.09	77.74	5.85
Control	-	9.75	8.70	10.40	13.47	17.24	20.99	14.16	3.17
C.D (0.05)			1.03	1.05	1.41	1.07	1.12		

DAT= Days after treatment

\*= Boxes/tree

**Table.3** Bio efficacy of MAK all season HMO as dormant spray against European red mite *Panonychus ulmi* (Koch) on apple cv. Red Delicious at Wakura and Zaznah (District Ganderbal) Kashmir (J&K) during 2014 and 2015

Wakura									
Treatment	Conc. %	Pre-treatment count per twig	Percent mortality of European Red Mite/twig (DAT)					Pooled Mean	*Yield (A grade apple)
			1	3	7	15	30		
HMO (MAK)	1.5	44.24	29.62	45.90	67.97	85.76	91.38	64.13	4.20
	2.0	43.25	43.89	60.57	72.60	89.40	94.67	72.22	4.89
	2.5	41.62	45.28	64.11	79.61	91.93	96.67	75.52	5.52
HMO (HP) Check	1.5	38.20	32.63	48.68	68.82	86.22	91.46	65.56	4.29
	2.0	36.27	42.31	61.24	77.33	89.45	94.81	73.03	4.65
	2.5	36.00	52.00	66.87	83.19	91.76	97.12	78.19	5.10
Control	-	40.67	3.19	5.64	8.11	10.00	14.34	8.26	3.18
C.D (0.05)			1.05	1.11	1.06	1.45	1.19		
Zaznah									
HMO (MAK)	1.5	38.70	27.84	54.67	65.76	83.46	89.50	62.77	4.25
	2.0	39.92	47.96	64.24	69.97	87.51	93.53	71.58	4.30
	2.5	37.87	49.22	69.88	77.38	90.43	96.01	75.11	5.30
HMO (HP) Check	1.5	45.37	32.57	48.83	68.93	86.23	91.34	65.58	4.38
	2.0	44.50	45.63	62.27	75.71	90.10	94.79	73.70	4.80
	2.5	37.58	51.57	65.15	79.83	90.28	96.35	76.64	5.85
Control	-	44.67	4.36	6.33	8.11	8.53	13.41	8.15	3.17
C.D (0.05)			0.88	1.32	1.14	0.97	0.89		

DAT=Days after treatment

\*= Boxes/tree.

**Table.4** Bioefficacy of MAK all season HMO as summer spray against European red mite *Panonychus ulmi* (Koch) on apple cv. Red Delicious at Wakura and Zaznah (District Ganderbal) Kashmir (J&K) during 2014 and 2015

Wakura									
Treatment	Conc. %	Pre-treatment count per leaf	Per cent corrected mortality of European red mite per leaf (DAT)					Pooled Mean	*Yield (A grade apple)
			1	3	7	15	30		
HMO (MAK)	0.50	6.40	48.19	74.16	79.59	85.68	87.34	74.99	4.20
	0.75	6.46	53.04	77.02	82.39	87.94	89.31	77.94	4.89
	1.0	6.42	66.63	83.06	86.56	88.81	90.90	83.19	5.52
HMO (HP) Check	0.50	9.97	48.68	71.02	78.01	83.14	87.79	73.73	4.29
	0.75	9.90	54.70	77.35	81.48	85.69	89.80	77.81	4.65
	1.0	9.22	66.53	80.32	84.94	88.46	91.50	82.35	5.10
Control	-	9.48	5.78	8.95	12.49	15.99	17.74	12.19	3.18
C.D (0.05)			1.02	1.11	1.45	1.0	1.12		
Zaznah									
HMO (MAK)	0.50	8.89	48.56	64.26	74.31	82.58	87.39	71.42	4.25
	0.75	10.05	51.19	72.50	75.81	82.22	88.13	73.97	4.30
	1.0	9.42	66.48	80.50	84.02	86.71	89.89	81.52	5.30
HMO (HP) Check	0.50	9.03	43.08	64.44	73.78	77.45	86.89	69.13	4.38
	0.75	10.70	57.16	78.39	80.92	84.65	90.28	78.28	4.80
	1.0	8.13	61.85	76.40	80.70	85.62	90.98	79.11	5.85
Control	-	9.57	6.57	9.16	11.41	14.92	17.54	11.92	3.17
C.D (0.05)			0.99	0.85	0.57	1.17	1.02		

DAT= Days after treatment

\*= Boxes/tree.

**Table.5** Toxicity of MAK all season HMO as summer spray against natural enemies of San Jose scale and European red mite on apple cv. Red Delicious at Wakura and Zaznah, (District Ganderbal) Kashmir (J&K) during 2014 & 2015

Treatments	Conc. %	Pre-treatment count		Post treatment count* (Mean population of Natural Enemies (DAT))								Pooled mean % mortality of NE		Cumulative Mean % mortality of NE
				S				C				S	C	
				1	5	7	10	1	5	7	10			
<b>Wakura</b>														
(MAK HMO)	0.50	1.76	1.85	1.61 (7.99)	1.52 (13.35)	1.40 (15.49)	1.24 (31.92)	1.63 (7.05)	1.50 (19.10)	1.31 (29.33)	1.18 (22.17)	1.44 (18.44)	1.40 (24.41)	21.42
	0.75	1.76	1.79	1.45 (17.38)	1.26 (28.21)	1.13 (21.75)	0.89 (46.83)	1.56 (12.53)	1.31 (26.64)	1.61 (35.33)	0.99 (30.50)	1.18 (32.29)	1.25 (30.00)	31.15
	1.0	1.84	1.78	1.52 (17.68)	1.23 (33.43)	1.09 (26.56)	0.79 (53.17)	1.48 (12.64)	1.22 (32.07)	1.03 (42.71)	0.80 (55.60)	1.16 (36.46)	1.13 (37.00)	36.73
HP HMO (Standard Check)	0.50	1.70	1.67	1.57 (7.25)	1.46 (14.04)	1.29 (22.98)	1.18 (27.92)	1.57 (5.97)	1.44 (13.75)	1.26 (23.10)	1.17 (29.96)	1.38 (18.05)	1.36 (18.20)	18.12
	0.75	1.88	1.83	1.69 (10.11)	1.53 (18.90)	1.34 (29.02)	1.15 (36.75)	1.64 (10.41)	1.49 (18.69)	1.32 (18.59)	1.14 (37.78)	1.43 (23.69)	1.39 (23.87)	24.61
	1.0	1.79	1.76	1.57 (7.07)	1.38 (22.89)	1.20 (32.76)	1.01 (40.39)	1.57 (10.80)	1.38 (21.64)	1.18 (32.79)	1.00 (42.97)	1.29 (27.07)	1.29 (27.04)	27.05
Water (Control)	-	1.72	1.73	1.68 (2.34)	1.65 (4.37)	1.60 (7.00)	1.55 (10.43)	1.68 (0.09)	1.64 (5.21)	1.58 (8.39)	1.53 (11.29)	1.62 (6.04)	1.61 (6.95)	6.49
C.D. (P≤0.05)				1.01	1.32	1.04	1.11	0.99	1.11	1.21	1.02			
<b>Zaznah</b>														
(MAK HMO)	0.50	1.75	1.64	1.54 (11.93)	1.45 (17.03)	1.32 (24.47)	1.18 (34.74)	1.56 (10.18)	1.47 (15.35)	1.35 (22.32)	1.18 (34.36)	1.37 (22.04)	1.44 (20.55)	20.63
	0.75	1.77	1.73	1.53 (13.86)	1.28 (27.69)	1.11 (37.28)	0.89 (46.54)	1.53 (10.04)	1.26 (24.68)	1.11 (33.63)	0.89 (47.40)	1.20 (31.34)	1.31 (32.41)	31.87
	1.0	1.79	1.77	1.44 (19.52)	1.20 (32.88)	1.08 (39.91)	0.76 (53.45)	1.52 (16.29)	1.23 (32.29)	1.08 (40.53)	0.76 (52.89)	1.21 (36.44)	1.15 (35.50)	35.97
HP HMO (Standard Check)	0.50	1.84	1.86	1.58 (10.65)	1.44 (18.12)	1.31 (25.59)	1.16 (34.93)	1.64 (8.13)	1.54 (13.36)	1.41 (20.92)	1.24 (32.67)	1.46 (25.59)	1.46 (18.99)	22.29
	0.75	1.85	1.76	1.64 (13.74)	1.39 (23.11)	1.26 (32.21)	0.98 (43.61)	1.56 (17.05)	1.31 (26.84)	1.17 (34.94)	1.02 (39.91)	1.34 (28.63)	1.25 (29.18)	28.90
	1.0	1.79	1.74	1.48 (19.97)	1.22 (32.07)	1.05 (42.71)	0.80 (55.60)	1.40 (21.85)	1.20 (32.88)	1.05 (41.36)	0.73 (53.45)	1.12 (36.64)	1.11 (35.85)	36.24
Water (Control)	-		1.76	1.57 (4.59)	1.51 (8.59)	1.48 (10.41)	1.44 (12.56)	1.64 (3.00)	1.60 (5.42)	1.55 (8.38)	1.51 (10.77)	1.50 (9.04)	1.58 (7.00)	8.01
C.D. (P≤0.05)				0.98	0.47	1.16	0.87	1.03	0.89	1.02	1.06			

\*Mean of 3 replicates, Figures in Parenthesis are % Mortality of Natural enemies

S=*Stethorus punctum*, C=*Coccinellids*, N.E= Natural enemies

The population of A and S recorded on the basis of per 6 leaves and C on the basis of 4 branches.

## **Zaznah**

Perusal of the data in table 5, highest cumulative mean mortality of natural enemies was recorded as 35.97 % in MAK all season HMO @ 1.0% followed by 31.87 % @ 0.75% and 20.63 % @ 0.50 % respectively. While as Standard Check (HP HMO) recorded highest cumulative mean mortality of natural enemies 36.24 % @ 1.0% followed by 28.90 % @ 0.75% and 22.29 @ 0.50 %. Highest pooled mean mortality of 36.44 % of *Stethorus punctum* was recorded in MAK all season HMO @ 1.0% followed by 31.34 % @ 0.75 % and 22.04 % @ 0.5 %.

The pooled mean mortality of 36.64 % of *Stethorus punctum* was recorded in Standard Check (HP HMO) @ 1.0% followed by 28.63 % @ 0.75 % and 25.59 % @ 0.5 % respectively (Table 5).

Highest pooled mean mortality of 35.50 % of *Coccinellids* was recorded in MAK all season HMO @ 1.0% followed by 32.41 % @ 0.75 % and 20.55 % @ 0.5%. The pooled mean mortality of 35.85 % of *Coccinellids* was recorded in Standard Check (HP HMO) @ 1.0% followed by 29.18 % @ 0.75 % and 18.99 % @ 0.5% respectively.

## **Impact on yield**

### **Wakura**

The yield in MAK all season HMO treated trees was recorded as 5.52, 4.89 and 4.20 boxes of A grade apple/tree for the three different concentrations which was statistically at par with that of Standard Check (HP HMO) treated trees 5.10, 4.65 and 4.29 boxes of A grade apple/tree. However, water spray (control) trees recorded the lowest yield of 3.18 boxes of A grade apple/tree (Table 1 and 2).

### **Zaznah**

The yield in MAK all season HMO treated trees was recorded as 5.30, 4.30 and 4.25 boxes of A

grade apple/tree for the three concentrations which was statistically at par with that of Standard Check (HP HMO) treated trees 5.85, 4.80 and 4.38 boxes of A grade apple/tree.

However, Water spray (control) trees recorded the lowest yield of 3.17 boxes of A grade apple/tree (Table 1 and 2).

The results revealed (pool data across the locations and years) significant differences in mean per cent mortality of the target pests of Apple in Kashmir due to MAK all season HMO and Standard Check (HP HMO) under trial at different concentrations as compared to the untreated control. The pooled data (2014 and 2015) indicated significant reduction in SJS and ERM populations at 2.5% and 2.0% in dormant and 1.0% and 0.75% in summer.

It is concluded from the present investigation that HMO (Check) @ 2.5% recorded highest 76.66 % and 78.19 % pooled mean mortality of SJS and ERM as dormant spray at Wakura and that of 81.22% and 82.35% pooled mean mortality @ 1% of SJS and ERM as Summer Spray at Wakura.

The maximum yield of (5.83 boxes/tree) of A grade apple was found in HMO's sprayed@ 2.5% at Zaznah. None of the phytotoxicity effects were recorded on apple leaves during 2014 and 2015.

Maximum pooled mortality of natural enemies was recorded as 36.73 % @ 1.0 % against the MAK all season HMO at Wakura. The studies are more or less in conformity with the studies of Lal (1952), and Hix *et al.*, (1999) who reported the similar results. Khajuria and Sharma (1999) reported that San Jose scale infestation was significantly reduced by the application of 2% miscible oil. These results are also in agreement with that of Mir *et al.*, (2015) who reported that the efficacy of all the treatments in respect of exhibiting pest mortalities followed the order of DOE @ 1:7 ratio > DOE @ 1:10 ratio > MAK spray oil @ 3.0 % > DOE @ 1:12 ratio >Arbofine spray oil



@ 3.0 % > MAK spray oil @ 2.5 % >Arbofine spray oil @ 2.5 % > MAK spray oil @ 2.0 % > HP spray oil @ 3.0 % >Arbofine spray oil @ 2.0 % >HP spray oil @ 2.5 % > HP spray oil @ 2.0 %.(Mir et;al 2015).

The overall efficacy of different horticultural mineral oils revealed that spraying of these oils at 2% concentration was very effective in reducing San Jose scale and European red mite population in apple orchards. These findings are in agreement with Sherwani *et al.*, 2017 that have reported 2 % as effective concentration of Petro Star HMO for the control of San Jose scale and European red mite.

Therefore, these horticultural mineral oils (HMOs) should be selected for sound management of these devastating insect pests.

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