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MALINIAS, DEVERLYN DAGANOS. MAY 2011. Effect of Cooking Oils-Eggyolk Formulation Against Powdery Mildew (*Erysiphe polygoni* Dc.) of Garden Pea (*Pisum sativum* L.). Benguet State University, La Trinidad Benguet.

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ABSTACT

Application of different cooking oils, Dishwashing Liquid (Joy) and Topsin-M, at their different rates of 37.50ml + 4 liters water, 7.5 ml + 4 liter water, 0.25g + 4 liter water were evaluated to determine their effects against powdery mildew, and their effects on the yield.

Based on the result, powdery mildew infection appeared in all the sample plants 20 days after germination and before the first spray application.

Plants sprayed with Topsin-M (Fungicide) were the earliest plants to form flowers and pods 45 and 49 days after planting, while the untreated plants flowered and formed pods after 48 and 54 days.

At seven days interval, garden pea sprayed with Canola Oil mixture at a rate of 37.50 ml + 4 liters water gave the lowest powdery mildew of 3.65% equivalent to 50%

infection. This was comparable with the 3.53% powdery mildew infection from plants sprayed with 0.25 g Topsin-M + 4 liters water.

In terms of yield, plants sprayed with Canola Oil mixture gave a total yield of 0.75 tons/ha which is also comparable to the 0.81 tons/ha yield obtained from plants sprayed with Topsin-M.

Comparing the oil mixtures that was evaluated against powdery mildew Canola Oil mixture gave the lowest infection with the highest yield.

INTRODUCTION

Most cooking oils proved highly effective in controlling powdery mildew of cucumber when emulsified with yolk. Northover and Schneider (1996) reported that canola and soybean oil were effective in controlling powdery mildew of grapes. Ohtsuka and Nakazawa (1991) reported that mineral oil and canola oil could satisfactorily control resistant strains of powdery mildew pathogen of cucumber because of their physical mode of action.

Egg yolk and cooking oil (Eyco) mixture develop by Shim et al (2006) is widely adopted by Korean farmers for the control of powdery mildew of cucumber. Among various cooking oil, sunflower and rape seed oil (canola) at 0.3% – 0.5% emulsified with 0.1% egg yolk was the most effective showing over 98.5% control value of powdery mildew on cucumber. Fungal mycelia and conidia were severely distorted or shrunken when sprayed with EYCO. Microbial population on the treated cucumber leaf decreased significantly over a period of seven (7) days. Consequently it was assumed that EYCO acts directly against fungal pathogen rather than inducing plant resistant on the plants.

Another study on powdery mildew of tomatoes caused by (*Oidium neolycopersici*) using cooking oils showed similar results. When tomato leaves were sprayed with 0.1% eggyolk emulsified canola oil, peanut oil, safflower oil, soybean oil, and sunflower oil, the severity of tomato powdery mildew caused by (*Oidium neolycopersici*) was greatly reduced to 98.0%. Among these edible oil tested, sunflower oil was the most effective in the control of powdery mildew of tomato. When sprayed with 0.5% sunflower oil, powdery mildew on tomato leaves was reduced to a negligible level of 95% (Ko *et al*., 2003).

The prospect of using cooking oils as fungicide is highly appealing because of its effectiveness, availability, low cost, and simple preparation (Homma et al. 1997; Levene and Rolf, 1921).

The advantage of using oil to manage disease is that it is attributed to its mode of action which is the direct killing of the pathogen or coating of the leaf surface of the crop to prevent germination and penetration of the pathogen resulting in the control of disease, and also destruction and distortion of mycelia and conidia (Grossman, 1990).

Powdery mildew of garden pea (*Erysiphe polygoni* Dc.) is one of the most common, widespread and easily recognizable plant diseases. Powdery mildew appears first as faint, slightly discolored tiny specks from which powdery spots spread to form variously sized areas when it infects the stems, leaves, and pods. Underneath the leaf area, brown or purplish color is apparent, and in severe cases, the leaves are killed and the infected plants weakens, become stunted with pods that appear sunburned (Singh 1980).

The beneficial effect of oil if used to manage powdery mildew disease is that it exhibit direct and systemic effect on the mycelia and conidia of the pathogen that results to distortion or destruction.

Oils are ideal substitute for chemical fungicides in controlling powdery mildew because it does not cause health problems or harm the environment hence the oil emulsified with yolk dispersed smoothly in spray solution owing to its hydrophilic and lipophilic properties and dispersitivity of lecithin.

The study was conducted to:

1. Determine the effect of cooking oils-egg yolk formulation against powdery mildew of garden pea;

2. Determine the effect of cooking oils on the yield

The study was conducted at the STVRDC (Semi Temperate Vegetable Research Center) green house from January 2011 to April 2011.

REVIEW OF LITERATURE

Description of Garden Pea

Garden pea (*Pisum sativum* L.) belongs to the Leguminacae family with the characteristics of butterfly-like papilionacae blossoms. It is believe that it originated from Europe and Asia and it was commonly grown in the garden of Romans and Greeks. (PCARRD, 1982).

It is a tendril and climbing plants that grows well in cool, moist weather and low temperature. This crop is one of the common fruit vegetable in the cool areas of Benguet and Mountain Province (PCARRD, 1982). Garden pea produce well in humus-rich or volcanic soil and thrives best in areas at least 1000 meters above sea level. It favors a cool climate with a range of 10-18ºC.The major producer is the Cordillera Administrative Region (CAR) with an average of 94.5%. In 2005, production was 5.8 tons/ha showing a 1.5% reduction from the output of 5.7 tons/ha or 1.4% in 2006. The area harvested in 2005 was 1.69 ha and went down to 1.67 ha in 2006.

Like most legumes, garden pea has a high nutritional value. Aside from being a source of protein and vitamins, it is also good source of income to farmers. The fresh green pods contain about 57 calories, 3.3g protein, 6.3g fat, 13.0 g carbohydrate and 35.0 g minerals (Purseglove, 1972).

Because of its excellent symbiotic relationship with the nitrogen fixing bacteria (*Rhizobium spp*.), soil fertility is improved. The ability to fix nitrogen in the air through the root nodule bacteria provides nitrogen supplement to the soil and therefore lessen the amount of nitrogen fertilizer application (Purseglove, 1972).

Management Measures of Powdery Mildew

Cultural Management

Resistant varieties if available such as 'Almoto', 'Aspen', 'Concord', 'Freezer 604', 'Knight', 'Sentry', 'Sounder', 'Super Sugar Melt' (snap pea), and others should be grown.

Garden pea should be grown in sunny areas as much as possible to provide good air circulation, and avoid applying excess nitrogenous fertilizer. A good alternative is to use a slow-release fertilizer. Overhead sprinkling may help reduce powdery mildew because spores are washed off the plant. However, overhead sprinklers are not usually recommended as a control method in vegetables because their use may contribute to other pest problems. Clean up plant debris in the garden. Destroy or discard (do not compost) diseased materials.

Removal of volunteer field peas, which can harbour disease must be practiced. Avoid sowing field pea crops adjacent to last season's stubble and incorporate or burn infected pea stubble soon after harvest.

Use of Cooking Oils

The banana industry of the French West Indies threatened by leaf spot (*Mycosphaerella musicola*) in the early 1950's was controlled by using mineral oil. The mineral oil has largely replaced conventional fungicides as it is capable of controlling banana leaf spot at very low dosages. It has excellent spreading and sticking properties on leaf surfaces. It has low cost and little or no toxicity to humans and animals (Calpouzos, 1996).

Canola oil. Canola oil is pressed from tiny canola seeds produced by yellow flowering plants of the Brassica Family. Canola was bred naturally from its parent rapeseed in the early 1970's. Consumers recognize canola oil for its nutritional attributes as it contains the lowest level of saturated fatty acids. It is high in monounsaturated fatty acids which have been shown to reduce blood cholesterol levels and has moderate levels of essential poly unsaturated fatty acids. It is also rich source of vitamin E (Barthet, 2008).

Sunflower oil. Sunflower oil has the highest source of polyunsaturated fats that is found in any type of vegetable oil. It also contains 13% of monounsaturated fatty acids and only 8% of saturated fatty acids and vitamin E. Due to the presence of these ingredients in sunflower oil, this oil is said to have various benefits to health of individuals (McGraw, 2007).

Olive oil. Olive oil is a natural juice which preserve the taste, aroma, vitamins and properties of the olive fruit. Olive oil is the only vegetable oil that can be consumed as it is freshly pressed from the fruit. The beneficial health effects of olive oil are due to both high content of monounsaturated fatty acids and its high content of anti-oxidative substances. Studies have shown that olive oil offers protection against heart disease by controlling LDL (bad) cholesterol levels while raising HDL (good) cholesterol levels (McGee, 2008).

Use of Foliar Fungicides

Crops from flowering onwards should be checked for disease occurrence. Early detection and early spraying of protectant fungicides will protect the uninfected foliage. In New York State, some products that can be used to treat powdery mildew are: *Bacillus*

subtilis, neem oil, potassium bicarbonate, sulfur or lime sulphur (Gubler and Hirschfelt, 1986).

Another fungicides that are locally used to control the disease are: Elosal, Dithane M-45,Benlate, Zineb and Phaltan (Marthur *et al.*, 1973) as cited by Singh (1973).

Topsin-M has a 70% wettable powdery fungicide, for the control of diseases of Rice, Tobbaco, Vegetables, Ornamentals and other crops. It also control mites and nematodes on vegetables, fruits and ornamentals. It has a unique combination of preventive, curative and systemic fungicidal properties. It improves leaf color and growth, it can be used as soil drench to systematically control plant diseases, and it is stable in sunlight and gives longer residual crop protection (Edward *et al*., 1991).

MATERIALS AND METHODS

One hundred forty four pots with a surface diameter of 6 inches were filled with 10 kg of soil. The pots were laid out on Complete Randomized Design (CRD) with four replications. The cooking oil used were: canola, sunflower and olive oil.

The treatments were:

Treatments	Replication
T_0 = control	No application

T_1 = Topsin-M (Fungicide)	0.25g + 4 liters water
T_2 = Dishwashing Liquid (Joy)	7.5ml + 4 liters water
T_3 = Canola oil	37.50ml + 4 liters water
T_4 = Sunflower	37.50ml + 4 liters water
T_5 = Olive oil	37.50 ml + 4 liters water

Figure 1 shows the overview of the experiment while Figure 2 shows the experiment set-up.

Cooking Oil Spray Preparation

The mixture of cooking oil and yolk (COY) was prepared using, 1 egg yolk which was added in 100 ml water and vigorously blended for 3-4 minutes. Each amount of cooking oil (37.50 ml) was supplemented into the yolk solution and homogenized for over 5 minutes using the vortex mixer. The COY mixture was added in distilled water to bring 20L spray solution. The cooking oil and yolk (COY) mixture was sprayed on the leaves of garden pea plants when first signs of powdery mildew was observed following a 7-day interval. The control plants were not treated with any.

Figure 1. Overview of experimental area at the Semi-Temperate Vegetable Research Greenhouse at Balili, La Trinidad, Benguet

Figure 2. Experiment set-up at the Semi-Temperate Vegetable Research (STVRDC) Green House at Balili, La Trinidad Benguet 50 Days after planting

Data Gathered

1. Number of days from planting to first appearance of powdery mildew symptoms.

2. Number of days from sowing to appearance of flowers and pods. This was taken by counting the number of days from sowing until the plants started to develop flowers and pods.

3. Weekly powdery mildew severity rating. This was done through weekly rating of 10 sample plants in each treatment marked with colored threads.

Scale	Description
1	healthy leaves/plant or no infection
2	light infection/only few plant parts infected
3	50% of leaves are infected
4	75% of every plant is affected by powdery mildew
5	100% of every plant is affected

4. Final powdery mildew severity. This was the final rating before the last harvest. The ten sample plants in each treatment was used.

5. Crop yield

a. Marketable pods. Refers to good quality pods in terms of size and free from diseases and insect damage.

b. Non-marketable pods. Pods that are not fitted for market (pods damaged by insects and pathogen.

RESULTS AND DISCUSSION

Number of Days from Planting
to First Appearance of Powdery
Mildew Symptoms

Table 1 shows the number of days from planting to first appearance of powdery mildew symptoms. Results shows that powdery mildew infection appeared in all the sample plants 20 days after germination and before the first spray application.

Number of Days from Planting
to First Appearance of Flowers

Table 2 shows the number of days from planting to flowering. Plants applied with Fungicide (Topsin-M) were the earliest plants to form flowers (45 days) while those Untreated plants flowered longer within 48 days.

Table 1. Number of days from planting to first appearance of powdery mildew symptom

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	19	21	19	22	81	20.25[a]
Topsin-M (Fungicide)	19	19	21	23	82	20.50[a]
Dishwashing Liquid (Joy)	20	22	22	19	83	20.75[a]
Canola Oil	19	20	20	21	80	20.00[a]
Sunflower Oil	22	19	19	19	79	19.75[a]
Olive Oil	19	19	20	20	78	19.50[a]
CV (%)						9.55

Means with the same letter/s are not significantly different at 5% level DMRT

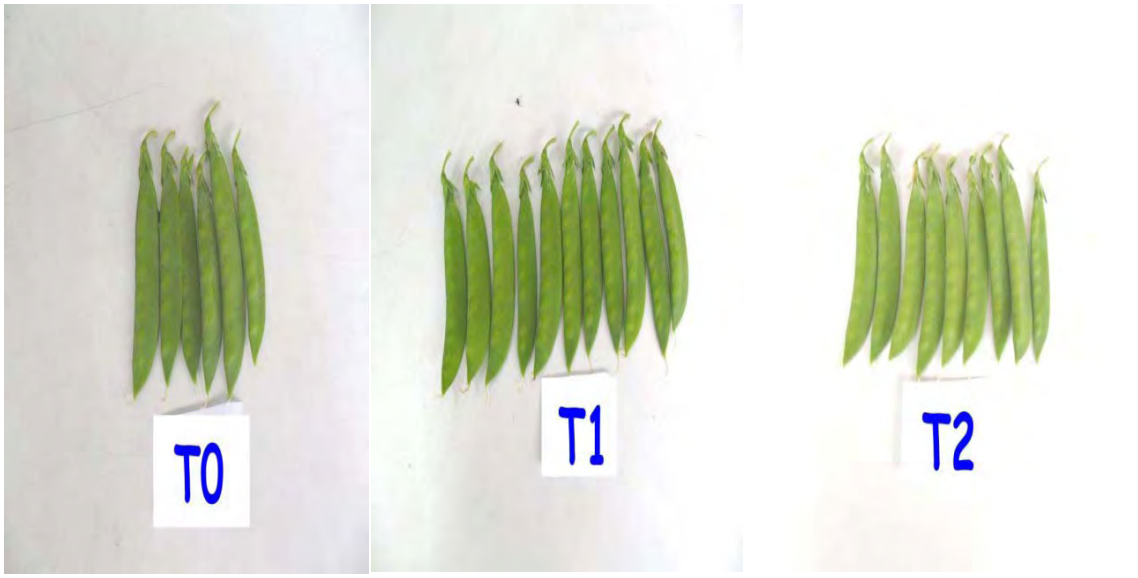
Number of Days from Flowering
to Pod Setting

There was no significant difference obtained on the number of days from flowering to pod formation (Table 2). However, plants applied with Topsin- M after 4 days develop pods followed by plants applied with different oils after 5 days. Untreated plants formed pods seven days after flowering.

Table 2**.** Number of days from sowing to flowering and to pod setting

TREATMENT	DAYS OF PLANTING TO FLOWERING	DAYS FROM FLOWERING TO POD FORMATION
Untreated	48.00[a]	7.00[a]
Topsin-M (Fungicide)	45.00[a]	4.00[a]
Dishwashing Liquid (Joy)	47.00[a]	6.00[a]
Canola	46.00[a]	5.00[a]
Sunflower oil	46.00[a]	5.00[a]
Olive oil	46.00[a]	5.00[a]
CV (%)	9.55%	9.55%

Means with the same letter/s are not significantly different at 5% level DMRT



(a) (b) (c)

(d) (e) (f)

Figure 3. (a) Pods harvested for the untreated garden pea plants; (b) pods sprayed with 0.25ml Topsin-M + 4 L water; (c) Pods harvested from garden pea plants sprayed with 7.5ml Dishwashing Liquid (Joy) + 4L water; (d) Pods from garden pea sprayed with 37.50 ml Canola Oil + 4L water; (e) Pods from garden pea sprayed with 37.50 ml Sunflower Oil + 4 L water ; (f) Pods from garden pea sprayed with 37.50 ml Olive Oil + 4 L wate

Initial Powdery Rating

Powdery mildew infection on the different treatments before the first spray application were the same (Table 3). Plants in the control had the highest rating of 1.30 compared with powdery mildew infection incurred in plants that were sprayed with Canola Oil, Sunflower Oil and Olive Oil with means of 1.25 and 1.28. According to Northover and Scheineder (1993), Oils has its physical mode of action such as direct killing of the pathogen or coating of the leaf surface to prevent germination and penetration of the pathogen resulting in the control of the disease.

Table 3. Initial rating of powdery mildew of garden pea

TREATMENT	RATE OF APPLICATION	MEAN SEVERITY RATING 29 DAP
Untreated	No amendments	1.30[a]
Topsin- M (Fungicide)	0.25g + 4L water	1.20[a]
Dishwashing Liquid (Joy)	7.5mL + 4L water	1.22[a]
Canola Oil	37.50mL + 4L water	1.25[a]
Sunflower Oil	37.50mL + 4L water	1.28[a]
Olive Oil	37.50mL + 4L water	1.28[a]
CV %		5.0%

Means with the same letter/s are not significantly different at 5% level DMR

Weekly Powdery Mildew Severity Rating

Table 4 shows the weekly mean powdery mildew rating on garden pea from first up to the six week. The rating obtained after the first application of different Oils, on the untreated plants and those sprayed with Olive Oil differed significantly with means of

2.28 and 1.90, compared to plants sprayed with Topsin-M at a rate of (0.25g + 4 L water) and Dishwashing Liquid (Joy)at a rate of (7.5 ml + 4 L water), Canola Oil, and Sunflower Oil at a rate of 37.50 ml+ 4 L water .

On the second week, plants sprayed with Topsin-M had the lowest powdery mean infection of 1.48, while the untreated showed the highest powdery mildew infection with a mean of 2.28.

It was recorded that on the third week, untreated plants had the most severe infection with a severity rating of 2.60 compared to the lowest rating of 2.20 by the garden pea plants sprayed with Topsin-M and Dishwashing Liquid (Joy) followed by Olive Oil, Canola Oil, and Sunflower Oil with severity infection of 2.33, 2.38, and 2.45. The untreated had a rating of 3.58.

On the other hand, it was observed that at fourth rating powdery mildew infection became more severe. Dishwashing Liquid (Joy) exhibited the lowest rating of 2.28 followed by Topsin-M with a mean of 2.55 severity rating.

Finally, during the fifth rating, still the untreated had the highest rating of 3.88 while the Dishwashing Liquid (Joy) has the lowest severity rating of 3.25 followed by those sprayed with Topsin-M with a rating of 3.38. Plants sprayed with Sunflower Oil, Canola Oil, and Olive Oil with a rating of 3.45 and 3.53.

Table 4. Weekly powdery mildew rating

TREATMENT	MEAN SEVERITY RATING				
	36 DAP	43 DAP	50 DAP	57 DAP	63 DAP
Untreated	1.68[a]	2.28[a]	2.60[a]	3.58[a]	3.88[a]

Topsin-M	1.35^{d}	1.48^{d}	2.20^{cd}	2.55^{c}	3.38^{b}
Dishwashing Liquid (Joy)	1.38^{d}	1.63^{cd}	2.20^{cd}	2.28^{c}	3.25^{c}
Canola Oil	1.48^{bc}	2.10^{ab}	2.38^{abc}	3.28^{b}	3.53^{b}
Sunflower Oil	1.48^{b}	1.75^{bcd}	2.45^{ab}	3.25^{b}	3.45^{b}
Olive Oil	1.53^{bc}	1.90^{bc}	2.33^{bcd}	3.15^{b}	3.53^{b}
CV%	50%	11.32%	5.82%	3.32%	3.132%

Means with the different letter/s are significantly different at 5% level DMRT

Statistical analysis showed significant differences of powdery mildew infection in plants sprayed with different Oils, Dishwashing Liquid (Joy) and Topsin-M.

Final Disease Severity Rating Recorded
After Seven Weeks

Final rating of powdery in Table 5 showed that the application of Sunflower Oil, and Olive Oil to control powdery mildew were similar. Plants sprayed with Topsin-M had the lowest powdery mildew rating (3.53) followed by Canola Oil (3.65) and Dishwashing Liquid (Joy) (3.78) compared to untreated which had the highest powdery mildew rating of 4.22.

Table 5.Final rating of powdery mildew

TREATMENT	RATE OF APPLICATION	MEAN SEVERITY RATING 70 DAP
Untreated	No application	4.22^{a}
Topsin-M	0.25 g + 4 liter water	3.53^{d}
Dishwashing Liquid	7.5 ml + 4 liter water	3.78^{b}

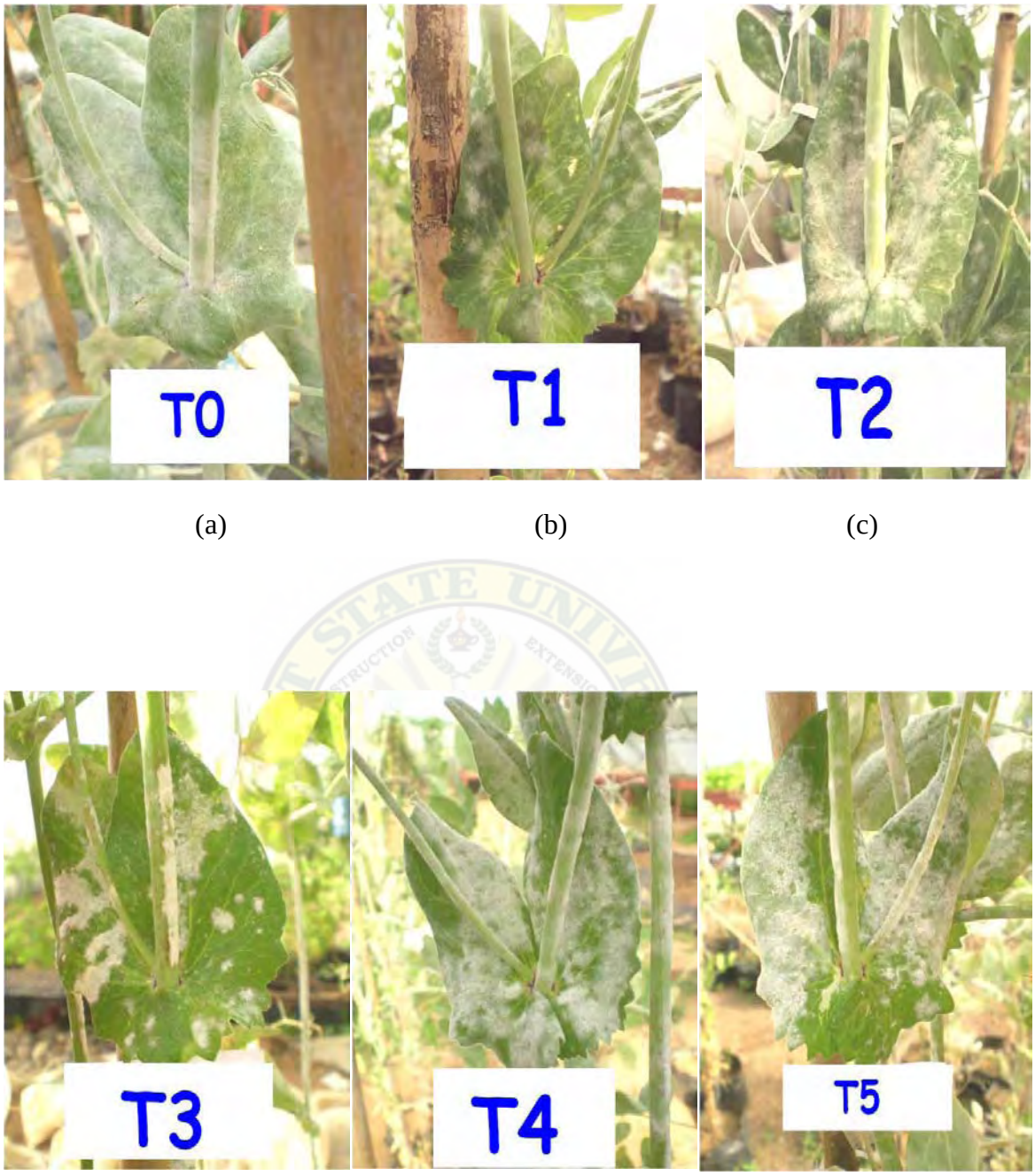
(Joy)		
Canola Oil	37.50 ml +4 liters water	3.65[c]
Sunflower Oil	37.50 ml + 4 liter water	3.85[b]
Olive Oil	37.50 ml +4 liter water	3.85[b]
CV%		2.40

Means with different letter/s are significantly different at 5% level DMRT

This result implies that the different Cooking Oils influenced the marketable yield of garden pea.

Homas and Garthwaite (1993) stated that Topsin-M is a systemic fungicide which is absorbed by plants through the roots or the above ground tissues and accumulates in the veins and at the leaf margins. This will explain why plants applied with Topsin-M gave the lowest infection and high yield.

Figure 4 shows the powdery mildew infection 63 days after planting while Figure 5 shows the conidia of powdery mildew.



(a) (b) (c)

(d) (e) (f)

Figure 4. Powdery mildew infection 63 days after planting; (a) untreated garden pea plants; (b) plants sprayed with 0.25g Topsin-M + 4 L water; (c) plants sprayed with 7.5ml Dishwashing Liquid + 4 L water; (d) plants sprayed with 37.50ml Canola oil + 4 L water; (e) plants sprayed with 37.50ml Sunflower Oil + 4 L water; (f) plants sprayed with 37.50ml Olive Oil + 4 L water.

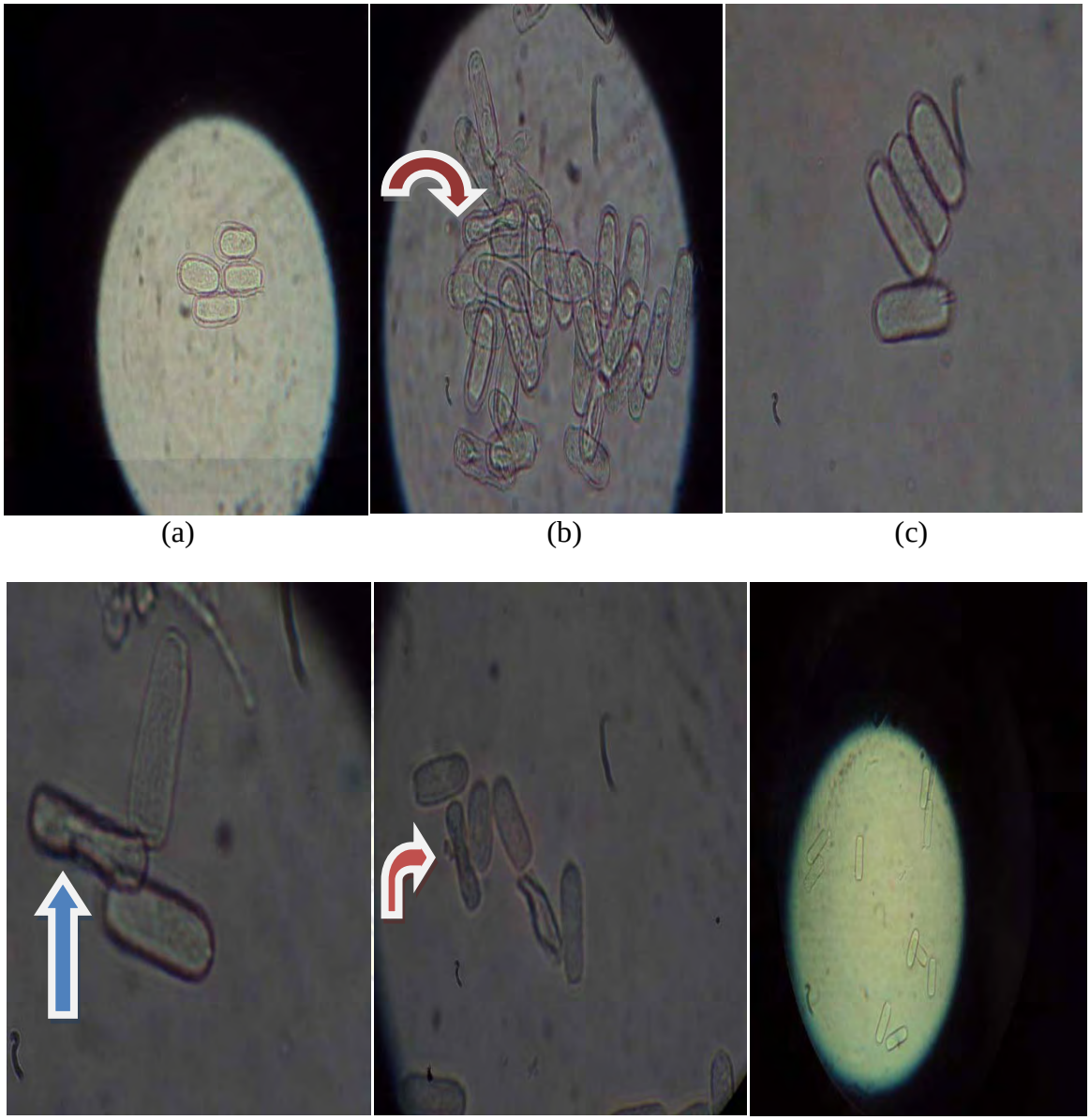


Figure 5. Conidia of powdery mildew from (a) untreated garden pea plants(100x); (b) conidia sprayed with 0.25g Topsin-M + 4L water (note the distorted conidia pointed by arrow 400x); (c) conidia sprayed with 7.5ml Dishwashing Liquid (joy) + 4L water (400x); (d) conidia sprayed with 37.50 ml Canola Oil + 4L water (note the distorted conidia pointed by arrow (400x); (e) conidia sprayed with 37.50 ml Sunflower Oil + 4L water (note the distorted conidia pointed by arrow (400x); (f) conidia sprayed with 37.50 ml Olive Oil (400x).

Total Yield (tons/ha)

Table 6 shows a significant difference on the harvested marketable pods. The highest mean weight of marketable pods was obtained from plants applied with Topsin-M which was attributed to lower powdery mildew infection than plants applied with different oils and dishwashing liquid (Joy). The lowest marketable pods were obtained from untreated plants which could also be attributed to severe powdery mildew infection.

Table 6. Total yield (tons/ha)

TREATMENT	REPLICATION					
	I	II	III	IV	TOTAL	MEAN
Untreated	0.48	0.48	0.60	0.54	2.10	0.53[d]
Topsin-M (Fungicide)	0.78	0.84	0.78	0.84	3.24	0.81[a]
Dishwashing Liquid (Joy)	0.60	0.66	0.72	0.60	2.58	0.65[bc]
Canola Oil	0.78	0.78	0.78	0.66	3.00	0.75[ab]
Sunflower Oil	0.78	0.78	0.66	0.66	2.88	0.72[abc]
Olive Oil	0.72	0.78	0.66	0.60	2.76	0.69[bc]
CV%						9.17%

Means with the same letter/s are significantly different at 5% level DM

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

Field experiment was conducted at Balili, La Trinidad, Benguet from January to April 2011 to determine the effect of cooking oils combined with eggyolk in controlling powdery mildew (*Erysiphe polygoni* Dc.) of garden pea and compare the effect of cooking oils with that of Topsin-M.

In terms of flower and pod formation, plants applied with Thopsin-M were the first plants to form flowers and pods.

On the appearance of symptom, plants applied with Olive Oil showed the earliest plants to develop powdery mildew after 19-20 days.

On the disease severity powdery mildew on garden pea showed that the untreated plants had the highest mean disease severity compared to plants applied with different cooking oils, Topsin-M, and Dishwashing Liquid (Joy).

Among the treatments used, application of Topsin-M gave the highest weight of marketable pods. However, yields that are comparable to those applied with Topsin-M were obtained from plants applied with different oils and Dishwashing Liquid (Joy). The untreated plants registered the lowest yield.

Conclusion

Based from the result, cooking oils – egg yolk formulation can provide protection against powdery mildew, although Topsin-M gave better results.

Recommendation

Cooking oil and yolk mixture can be used as alternative to fungicide, this is because of its effectiveness, availability, simple preparation, edible and environment friendly. Its effectiveness as fungicide can help promote organic production not only in small scale gardening but also for large scale production.

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APPENDICES

Appendix Table 1. Number of days from planting to first appearance of powdery mildew symptom

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	1V		
Untreated	19	21	19	22	81	20.25[a]
Topsin-M	19	19	21	23	82	20.50[a]
Dishwashing Liquid (Joy)	20	22	22	19	83	20.75[a]
Canola Oil	19	20	20	21	80	20.00[a]
Sunflower Oil	22	19	19	19	79	19.75[a]
Olive Oil	19	19	20	20	78	19.50[a]

TOTAL	118	120	121	124	483	120.75

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F COMPUTED	TABULATED F	
					0.05%	0.1%
TREATMENT	5	4.38	0.875	0.459854[ns]	2.77	4.25
Expt. Error	18	34.25	1.902778			
TOTAL	23	38.63				

[ns] = Not significant CV = 9.55%

Appendix Table 2. Number of days from planting to flowering

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	48	48	48	48	192	48[a]
Topsin-M	45	45	45	45	180	45[a]
Dishwashing Liquid (Joy)	47	47	47	47	188	47[a]
Canola Oil	46	46	46	46	184	46[a]
Sunflower Oil	46	46	46	46	184	46[a]
Olive Oil	46	46	46	46	184	46[a]
TOTAL	278	278	278	278	1112	278

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F COMPUTED	TABULATED F 0.05%	TABULATED F 0.1%
TREATMENT	5	21.33	4.266	0	2.77	4.25
Expt. Error	18	0.00	0			
TOTAL	23	21.33				

^{ns} = Not significant CV = 9.55%

Appendix Table 3. Number of days from flowering to pod setting

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	7	7	7	7	28	7[a]
Topsin-M	4	4	4	4	16	4[a]
Dishwashing Liquid (Joy)	6	6	6	6	24	6[a]
Canola Oil	5	5	5	5	20	5[a]
Sunflower Oil	5	5	5	5	20	5[a]
Olive Oil	5	5	5	5	20	5[a]
TOTAL	32	32	32	32	128	32

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F COMPUTED	TABULATED F 0.05%	TABULATED F 0.1%

TREATMENT	5	21.33	4.266	0	2.77	4.25
Expt. Error	18	0.00				
TOTAL	23	21.33				

[ns]= Not significant CV = 9.55%

Appendix Table 4. Disease severity initial rating

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	1.3	1.3	1.4	1.2	5.2	1.3[a]
Topsin-M	1.1	1.2	1.3	1.2	4.8	1.2[a]
Dishwashing Liquid (Joy)	1.2	1.3	1.2	1.2	4.9	1.22[a]
Canola Oil	1.2	1.3	1.3	1.2	5	1.25[a]
Sunflower Oil	1.2	1.3	1.3	1.3	5.1	1.28[a]
Olive Oil	1.2	1.3	1.3	1.3	5.1	1.28[a]
TOTAL	7.2	7.7	7.8	7.4	30.1	1.25

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%

Treatment	5	0.03	0.006	1.54ns	2.77	4.25
Error	18	0.07	0.003889			
TOTAL	23	0.10				

ns = Not significant Coefficient of Variation = 5.0%

Appendix Table 5. Disease severity second rating

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	1.6	1.7	1.6	1.8	6.7	1.68[a]
Topsin-M	1.3	1.4	1.3	1.4	5.4	1.35[d]
Dishwashing Liquid (Joy)	1.4	1.4	1.4	1.3	5.5	1.38[d]
Canola Oil	1.4	1.4	1.6	1.5	5.9	1.48[bc]
Sunflower Oil	1.4	1.4	1.6	1.5	5.9	1.48[b]
Olive Oil	1.6	1.5	1.5	1.5	6.1	1.53[bc]
TOTAL	8.7	8.8	9	9	35.5	1.48

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	0.27	0.054	8.84	2.77	4.25

Error	18	0.11	0.006111
TOTAL	23	0.38	

** - Highly significant Coefficient of Variation = 5.0%

Appendix Table 6. Disease severity third rating

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	2.3	2.4	2.2	2.2	9.1	2.275[a]
Topsin-M	1.4	1.5	1.5	1.5	5.9	1.475[d]
Dishwashing Liquid (Joy)	1.5	1.6	1.7	1.7	6.5	1.625[cd]
Canola Oil	1.8	2.8	1.9	1.9	8.4	2.1[ab]
Sunflower Oil	1.8	1.6	1.9	1.7	7.0	1.75[bcd]
Olive Oil	1.9	2	1.9	1.8	7.6	1.9[bc]
TOTAL	10.7	11.9	11.1	10.8	44.5	1.85

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	1.79	0.358	8.16**	2.77	4.25
Error	18	0.79	0.043889			

TOTAL	23	2.58

** - Highly significant Coefficient of Variation = 11.32%

Appendix Table 7. Disease severity fourth rating

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	2.8	2.8	2.6	2.2	10.4	2.6[a]
Topsin-M	2.1	2.2	2.2	2.3	8.8	2.2[cd]
Dishwashing Liquid (Joy)	2.1	2.2	2.2	2.3	8.8	2.2[cd]
Canola Oil	2.4	2.4	2.3	2.4	9.5	2.375[abc]
Sunflower Oil	2.4	2.3	2.5	2.6	9.8	245[ab]
Olive Oil	2.4	2.3	2.3	2.3	9.3	2.325[bcd]
TOTAL	14.2	14.2	14.1	14.1	56.6	2.36

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5	0.1
Treatment	5	0.48	0.096	5.08**	2.77	4.25
Error	18	0.34	0.018889			
TOTAL	23	0.84				

** - Highly significant Coefficient of Variation = 5.82

Appendix Table 8. Disease severity fifth rating

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	3.7	2.6	3.4	3.6	14.3	3.575[a]
Topsin-M	2.3	2.6	2.6	2.7	10.2	2.55[c]
Dishwashing Liquid (Joy)	2.2	2.3	2.3	2.3	9.1	2.275[c]
Canola Oil	3.2	3.3	3.3	3.3	13.1	3.275[b]
Sunflower Oil	3.1	3.3	3.3	3.3	13.0	3.25[b]
Olive Oil	3.2	3.1	3.1	3.2	12.6	3.15[b]
TOTAL	17.7	18.2	18	18.4	72.3	3.01

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	4.88	0.98	98**	2.77	4.25
Error	18	0.19	0.01			
TOTAL	23	5.07				

** - Highly significant

Coefficient of Variation = 3.32%

Appendix Table 9. Disease severity sixth rating

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	3.9	3.8	3.9	3.9	15.5	3.875[a]
Topsin-M	3.5	3.2	3.4	3.4	13.5	3.375[b]
Dishwashing Liquid (Joy)	3.4	3.4	3.1	3.1	13.0	3.25[c]
Canola Oil	3.6	3.4	3.6	3.5	14.1	3.525[d]
Sunflower Oil	3.5	3.4	3.4	3.5	13.1	3.45[d]
Olive Oil	3.6	3.4	3.6	3.5	14.1	3.525[d]
TOTAL	21.5	20.6	21	20.9	84	3.5

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	0.89	0.178	14.83**	2.77	4.25
Error	18	0.021	0.012			
TOTAL	23	1.10				

** - Highly significant

Coefficient of Variation = 3.32%

Appendix Table 10. Disease severity final rating

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	4.3	4.1	4.2	4.3	16.9	4.225[a]
Topsin-M	3.3	3.6	3.6	3.6	14.1	3.525[d]
Dishwashing Liquid (Joy)	3.7	3.8	3.9	3.7	15.1	3.775[b]
Canola Oil	3.6	3.6	3.7	3.7	14.6	3.65[c]
Sunflower Oil	3.9	3.9	3.8	3.8	15.4	3.85[b]
Olive Oil	3.9	3.9	3.8	3.8	15.4	3.85[b]
TOTAL	22.7	22.9	23	22.9	22.5	3.8125

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	1.14	0.228	27.36**	2.77	4.25
Error	18	0.15	0.008333			
TOTAL	23	1.29				

** - Highly significant Coefficient of Variation = 2.40%

Appendix Table 11. Marketable pods first harvest

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	24.69	28.21	29.44	29.55	111.89	27.9725[c]
Topsin-M	28.20	45.96	40.05	36.55	150.76	37.69[a]
Dishwashing Liquid (Joy)	26.99	38.16	35.74	29.11	130.00	32.5[b]
Canola Oil	42.42	45.75	48.81	36.05	173.02	43.255[a]
Sunflower Oil	40.18	38.18	34.10	35.96	148.42	37.105[a]
Olive Oil	40.35	41.43	42.01	35.96	160.05	40.0125[a]
TOTAL	202.83	237.98	230.15	203.18	874.14	36.42

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	593.73	118.746	5.35**	2.77	4.25
Error	18	399.25	22.18			
TOTAL	23	992.98				

** - Highly significant Coefficient of Variation = 12.93%

Appendix Table 12. Marketable pods second harvest

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	30.87	32.69	34.94	30.01	128.51	32.1275[b]
Topsin-M	46.72	52.77	53.63	53.63	205.17	51.2925[a]
Dishwashing Liquid (Joy)	42.58	44.42	42.50	42.50	174.13	43.5325[a]
Canola Oil	57.35	54.82	41.44	41.44	197.14	49.285[a]
Sunflower Oil	52.33	57.40	38.68	38.68	186.42	46.605[a]
Olive Oil	48.55	52.89	40.63	40.63	181.77	45.4425[a]
TOTAL	278.40	294.99	246.89	246.89	1073.14	44.71

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	912.37	182.474	5.09**	2.77	4.25
Error	18	644.98	35.83			
TOTAL	23	1557.35				

** - Highly significant Coefficient of Variation = 13.39%

Appendix Table 13. Marketable Pods third harvest

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	24.27	23.63	31.06	28.25	107.21	26.8[b]
Topsin-M	33.02	34.77	35.72	35.34	138.85	34.71[a]
Dishwashing Liquid (Joy)	27.56	26.87	38.96	30.47	123.86	30.97[a]
Canola Oil	27.28	34.30	33.10	30.44	125.12	31.28[a]
Sunflower Oil	34.03	34.08	34.16	34.21	136.48	34.12[a]
Olive Oil	28.47	30.74	29.05	27.70	115.96	28.99[b]
TOTAL	174.63	184.39	202.05	186.41	747.48	31.145

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	180.52	36.104	3.88*	2.77	4.25
Error	18	167.67	9.315			
TOTAL	23	348.19				

* - Significant Coefficient of Variation = 9.70

Appendix Table 14. Total yield (g)

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		

Untreated	79.83	84.53	95.44	87.81	347.61	86.9025[d]
Topsin-M	132.45	136.35	127.83	135.48	532.10	133.025[a]
Dishwashing Liquid (Joy)	97.13	109.45	119.33	102.08	427.99	106.9975[c]
Canola Oil	127.05	134.86	125.44	107.92	495.27	123.8175[ab]
Sunflower Oil	126.54	129.66	106.27	108.85	471.32	117.83[abc]
Olive Oil	117.37	125.36	110.76	104.29	457.78	114.445[bc]
TOTAL	680.37	720.21	685.06	646.43	2732.07	113.84

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	5025.40	1005.08	11.94**	2.77	4.25
Error	18	1515.76	84.21			
TOTAL	23	6541.16				

** - Highly significant Coefficient of Variation = 8.06%

Appendix Table 15. Total yield (tons/ha)

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Untreated	0.48	0.48	0.60	0.54	2.10	0.54[d]

Topsin-M	0.78	0.84	0.78	0.84	3.24	0.81[a]
Dishwashing Liquid (Joy)	0.60	0.66	0.72	0.60	2.58	0.645[bc]
Canola Oil	0.78	0.78	0.78	0.66	3.00	0.75[ab]
Sunflower Oil	0.78	0.78	0.66	0.66	2.88	0.72[abc]
Olive Oil	0.72	0.78	0.66	0.60	2.76	0.69[bc]
TOTAL	4.14	4.32	4.20	3.90	16.56	0.69

ANALYSIS OF VARIANCE

SOURCE OF FREEDOM	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.5%	0.1%
Treatment	5	0.19	0.038	9.5**	2.77	4.25
Error	18	0.07	0.004			
TOTAL	23	0.26				

** - Highly significant

Coefficient of Variation = 9.17%

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