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Melaleuca cajuputi leaf and branch extracts decreased weeds growth and weeds density in corn field

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Abstract— Products from organic agriculture were accepted for food safety, less environmental impact, enrich nutrition and probably more tasty than products from chemical agriculture. Plant natural products which are numerous sources for allelopathy effect were interested to discovery new herbicides for organic agriculture. Plant which mostly found in fresh water mangrove forest, *Melaleuca cajuputi*, was used to determine the reduction of weeds. The result indicated that these extracts inhibited all tested weed species. Thus, this experiment was focused on the effect of *Melaleuca cajuputi* leaf and branch extracts on the reduction of weeds growth and weeds density in corn field. Eight weed species; *Vernonia cinerea*, *Merremia hederacea*, *Cyperus rotundus*, *Ipomcea aquatic*, *Dactyloctenium aegyptium*, *Rottboellia cochinchinensis*, *Amaranthus viridis* and *Commelina diffusa* in corn field experiment were evaluated. *Melaleuca cajuputi* leaf and branch extracts of 10 and 15% were applied in field soil for 7 days before corn seeds growing and were sprayed every 7 days on soil surface until 60 days. Weeds dry weight and weeds density were evaluated at 30, 60, 90 and 120 days. The result showed that *Melaleuca cajuputi* leaf and branch extracts decreased weeds growth and weeds density. The highest growth and density reductions were found at 15% of *Melaleuca cajuputi* leaf extract. The mixture of *Melaleuca cajuputi* leaf and branch grind at the concentration of 4 kg/9 m^2 showed less reduction on weeds growth and weeds density than 15% of *Melaleuca cajuputi* leaf extract. However, *Melaleuca cajuputi* leaf and branch extracts and grind not affected to corn growth and productivity.

Keywords—***Melaleuca cajuputi*; weed reduction; corn field; allelopathy**

INTRODUCTION

Zea mays variety Suwan 5 was introduced to grow since 1993 for corn animal feed due to high productivity, rich nutrition and tolerant (KURDI, 2014). *Z. mays* for animal feed is one of fifty important economic crop in Thailand for consume in the country and for export. Corn grains were export about 40 million tons per years mainly to Malaysia, Indonesia and Taiwan (OAE, 2014). Top five provinces which produced corn animal feed are Lop Buri, Nakorn Ratchasima, Nakorn Sawan, Tak and Phetchaburi. Agricultural products contaminated chemical herbicide and pesticide were limited exporting. Thus, natural products could be an option to protect *Z. mays* crop from weeds and insects due to short half-life and environmental safely (Duck, 2002). Reference (Rice, 1995) discussed the effect of allelopathy in natural weed management. For example, the row of cover crops and crop residues in natural weed management, allelochemicals as natural herbicides and the use of allelopathic crop cultivars in natural weed control. Allelopathy can play an important role in various crop systems such as cover crops, mixed crops and multiple crops (Leather, 1983; Leather, 1987).

Melaleuca cajuputi tree is a local plant in Thailand especially at the south and east part of Thailand. It is mostly found in fresh water mangrove forest. Leaf of *M. cajuputi* has been reported for anti-inflammatory (Liu, 1995) antimicrobial activities (Doran, 1999; Dubey, 1983) and anti-termite properties (Sakasegawa, 2003). The extract from *M. cajuputi* leaf mainly contained terpenoids such as cajuput oil, eugenol and 1,8-cineole (Khare, 2007; Susanto, 2003; Schimleck, 2003). Therefore, *M. cajuputi* extract might be an interesting source for development of natural herbicide and pesticide in crop production. This experiment mainly focuses on the reduction of weeds found in corn field during *Z. mays* growth by *M. cajuputi* leaf and branch extracts.

MATERIALS AND METHODS

The experiment was done in corn field at Corn and Sorghum Research Center of Kasetsart University, Pakchong Nakorn Ratchasima province, Thailand. Soil physical properties are sandy clay with medium to low pH, red brown colour and good water distribution. *Z. mays* variety Suwan 5 was used in this experiment. Soil was prepared by two times plowing. Chemical fertilizer, N-P-K, at the ratio of 15-15-15 with the concentration of 50 kg/rai was mixed into soil. Land

was devised to 3 x 3 m^2 in each block for 24 blocks. Four rows of corn with 25 x 75 cm distance were grown in each block.

Melaleuca cajuputi leaf and branch were grinded in small pieces and extracted with water at the ratio of 1:1 by maceration for 3 days at room temperature. Crude extracts were separated from plant samples and mixed with water to get 10 and 15% of crude extract in water. These extracts were used to apply in corn field. *Melaleuca cajuputi* leaf and branch grinded without extracted were mixed together at the ratio of 1:1 and applied to soil at 7 days before started growing corn.

Randomized Complete Block Design (RCBD) with 6 treatments and 4 replications was used. Treatments were *M. cajuputi* leaf and branch extracts at the percentage of 10 and 15 and dry powder of leaf and branch. Control was neither *M. cajuputi* nor dry powder. *M. cajuputi* extracts were applied to soil at 7 days before seed growing with the ratio of 1 L per block (3 x 3 m^2) and continuously sprayed every 7 days in the corn field. *M. cajuputi* dry powder (4 kg dry weight per block) was mixed with soil and water at 7 days before seed growing.

Density and biomass of eight weed species; *Vernonia cinerea*, *Merremia hederacea*, *Cyperus rotundus*, *Ipomcea aquatic*, *Dactyloctenium aegyptium*, *Amaranthus viridis*, *Rottboellia cochinchinensis* and *Commelina diffusa*, were evaluated at 30, 60, 90 and 120 days after seed growing. Corn growth, corn flowering, silk production and yields were investigated at harvesting stage.

RESULTS AND DISCUSSIONS

Weeds found in corn field at 30 days after seed growing were *V. cinerea*, *M. hederacea*, *C. rotundus*, *I. aquatic* and *D. aegyptium*. The lowest weeds density presented in the treatment of 15% *M. cajuputi* leaf extract followed by 15% branch extract, 10% branch extract, dry powder of leaf and branch and control at the numbers of 11.75, 15.75, 16.50, 16.50, 17.75 and 21.25 plants m^{-2}, respectively. Percentage of weed reduction of 10% leaf extract, 10% branch extract, dry powder of leaf and branch, 15% branch extract and 15% leaf extract treatments were 16.47, 22.35, 22.35, 25.88 and 44.71%, respectively (Fig.1).

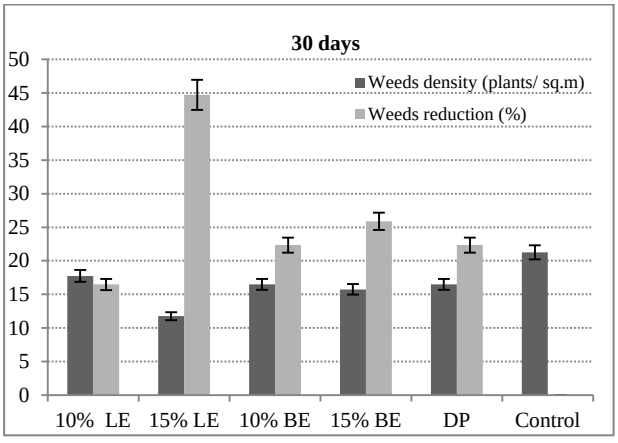

Fig. 1 The effect of *Melaleuca cajuputi* extracts and powder on weeds density and percentage of weeds reduction in corn field at 30 days after growing. LE; leaf extract, BE; branch extract and DP; dry powder.

Vernonia cinerea, *M. hederacea*, *I. Aquatic*, *D. Aegyptium* and *R. cochinchinensis* were found in corn field at 60 days after seed growing. The lowest weed density was found in the treatment of 15% *M. cajuputi* leaf extract followed by 15% branch extract, dry powder of leaf and branch, 10% leaf extract, 10% branch extract and control at the numbers of 25.25, 25.75, 28.00, 29.25, 35.25 and 46.25 plants m^{-2}, respectively. The highest percentage of weed reduction was found in the treatment of 15% leaf extract followed by 15% branch extract, dry powder of leaf and branch, 10% branch extract and 10% leaf extract at the value of 45.41, 44.32, 39.46, 36.76 and 23.78%, respectively (Fig.2).

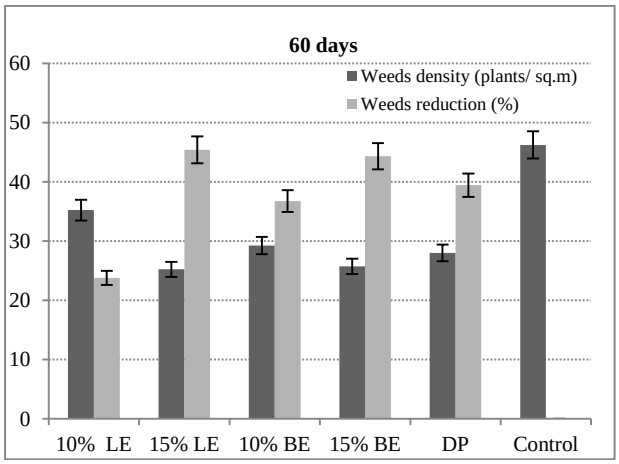

Fig. 2 The effect of *Melaleuca cajuputi* extracts and powder on weeds density and percentage of weeds reduction in corn field at 60 days after growing. LE; leaf extract, BE; branch extract and DP; dry powder.

At 90 days after seed growing, *V. cinerea*, *M. hederacea*, *C. rotundus*, *I. Aquatic*, *D. aegyptium*, *R. cochinchinensis* and *C. Diffusa* were found in corn field. The lowest weed density was found in 15% *M. cajuputi* leaf extract, 15% branch extract, 10% leaf extract, 10% branch extract, dry powder of leaf and branch and control at the numbers of 7.25, 8.50, 9.00, 9.00, 9.50 and 12.00 plants m^{-2},respectively. The highest percentage of weed reduction was found in the treatment of 15% leaf extract followed by 15% branch extract, 10% leaf extract, dry powder of leaf and branch and 10% branch extract at the value of 39.96, 29.17, 25.00, 25.00 and 20.83%, respectively (Fig.3).

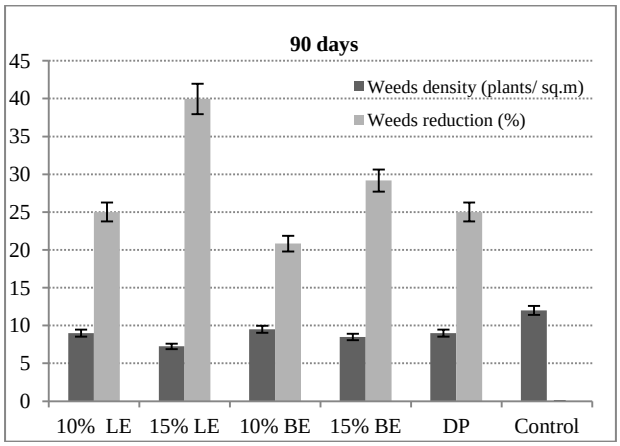

Fig.3 The effect of *Melaleuca cajuputi* extracts and powder on weeds density and percentage of weeds reduction in corn field at 90 days after growing. LE; leaf extract, BE; branch extract and DP; dry powder.

At corn harvesting stage (120 days), weed species found in corn field were *V. cinerea*, *M. hederacea*, *I. Aquatic*, *A. viridis* and *R. cochinchinensis.* The lowest weed density was found in the treatment of 15% leaf extract followed by 10% leaf extract, dry powder of leaf and branch, 15% branch extract, 10% branch extract and control at the numbers of 11.25, 11.50, 11.75, 12.00, 12.25 and 13.50 plants m^{-2}, respectively. The highest percentage of weeds reduction was found in the treatment of 15% leaf extract followed by 10% leaf extract, dry powder of leaf and branch, 15% and 10% branch extract with the value of 16.67, 14.81, 12.96, 11.11 and 9.53%, respectively (Fig.4).

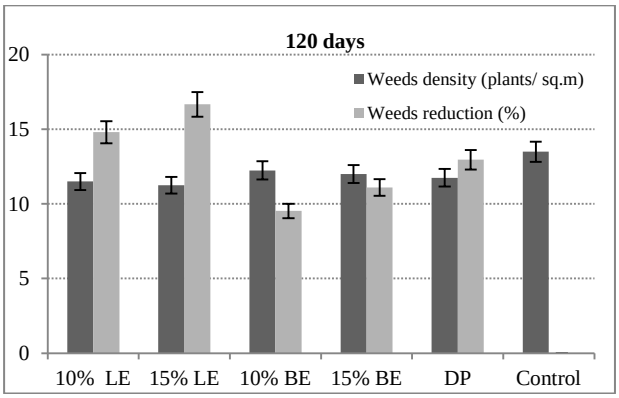

Fig.4 The effect of *Melaleuca cajuputi* extracts and powder on weeds density and percentage of weeds reduction in corn field at 120 days after growing. LE; leaf extract, BE; branch extract and DP; dry powder.

Weeds biomass (dry weight) at 120 days after seed growing was investigated. The result showed that lowest weeds biomass was found in the treatment of 15% *M. cajuputi* leaf extract followed by 10% leaf extract, dry powder of leaf and branch, 10% branch extract, 15% branch extract and control with the value of 16.59, 18.95, 20.41, 21.35, 21.85 and 26.65 g/m^2, respectively. The highest percentage of weed reduction was found in the treatment of 15% leaf extract followed by 10% leaf extract, dry powder of leaf and branch, 10% branch extract and 15% branch extract with the value of 37.75, 28.89, 23.41, 19.88 and 18.01%, respectively (Fig. 5).

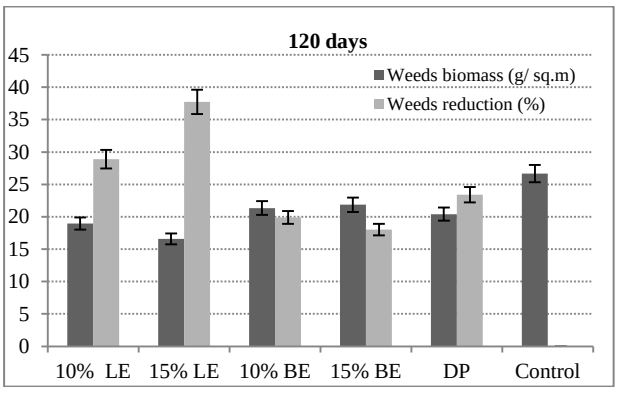

Fig.5 The effect of *Melaleuca cajuputi* extracts and powder on weeds biomass and percentage of weeds reduction in corn field at 120 days after growing. LE; leaf extract, BE; branch extract and DP; dry powder.

However, corn growth and productivity were investigated after treatments of *M. cajuputi* leaf and branch extract and dry powder of leaf and branch. The result presented that corn height, stem diameter, leaf numbers and biomass were no significant difference between each treatments. The average height, stem diameter, leaf numbers and biomass was 155.79 cm, 1.68 cm, 13.30 g/plant and 246.04 kg/rai. Which mean *M. cajuputi* leaf and branch 10 and 15% extract and dry powder of leaf and branch had no effected to growth of corn in the field (Table I).

TABLE I
CORN GROWTH AT HARVESTING STAGE AFTER APPLIED *MELALEUCA CAJUPUTI* EXTRACTS AND POWDER FOR WEED CONTROL IN CORN FIELD.

Treatments	Corn at harvesting stage (120 days) /1			
	Height (cm)	Stem diameter (cm)	Leaf num. (g/plant)	Biomass (kg/rai)
10% LE	150.38a/2	1.63a/2	13.40a/2	240.75a/2
15% LE	151.88a	1.70a	13.15a	244.00a
10% BE	156.50a	1.60a	13.00a	241.00a
15% BE	156.50a	1.78a	13.15a	250.25a
Dry powder	162.25a	1.75a	13.53a	256.50a
Control	157.25a	1.65a	13.58a	243.75a
Average	155.79a	1.68a	13.30a	246.04a
LSD 95%	15.63	0.21	0.71	61.22
%CV	6.7	8.5	3.6	16.5
F-test	ns	ns	ns	ns

Remarks: LE was leaf extract, BE was branch extract
/1 Average from 4 replications
/2 Different characters in the same row indicated statistically different ($p<0.05$) by DMRT
ns no statistically different

Corn flowering and corn silk production were evaluated. The result indicated that day started flowering, day 50% flower, day started corn silk and day 50% corn silk were no significantly different in each treatments with the average of 51.71, 55.50, 53.04 and 58.54 days, respectively (Table II). Day started flowering, day 50% flower, day started corn silk and day 50% corn silk in treatment sprayed with 15% leaf extract were 51.52, 55.25, 52.75 and 58.00 days while in control treatment were 51.50, 55.50, 53.75 and 58.50 days, respectively.

TABLE II
CORN FLOWERING AND CORN SILK PRODUCTION AFTER APPLIED *MELALEUCA CAJUPUTI* EXTRACTS AND POWDER FOR WEED CONTROL IN CORN FIELD.

Treatments	Day started flowering (days) /1	Day 50% flowers (days) /1	Day started corn silk (days) /1	Day 50% corn silk (days) /1
10% LE	51.00a/2	55.00a/2	52.50a/2	58.25a/2
15% LE	51.25a	55.25a	52.75a	58.00a
10% BE	51.75a	55.50a	53.25a	58.50a
15% BE	52.75a	56.00a	53.00a	59.50a
Dry powder	52.00a	55.75a	53.00a	58.50a
Control	51.50a	55.50a	53.75a	58.50a
Average	51.71a	55.50a	53.04a	58.54a
LSD 95%	1.95	2.15	1.24	1.86
%CV	2.5	2.6	1.5	2.1
F-test	ns	ns	ns	ns

Remarks: LE was leaf extract, BE was branch extract
/1 Average from 4 replications
/2 Different characters in the same row indicated statistically different ($p<0.05$) by DMRT
ns no statistically different

Corn yield was evaluated after harvesting from the experiment field at 120 days of growing. The result showed that corn ear length, corn ear circumference, kernels weight and corn yield of each treatments were no statistically different. Treatment which sprayed 15% leaf extract showed corn ear length, corn ear circumference, kernels weight and corn yield of 19.02 cm, 4.71 cm, 131.09 g/plant and 663.31 kg/rai while the control treatment presented corn ear length, corn ear circumference, kernels weight and corn yield of 19.26 cm, 4.47 cm, 127.08 g/plant and 661.27 kg/rai, respectively. The average of corn ear length, corn ear circumference, kernels weight and corn yield for all treatments were 18.85 cm, 4.55 cm, 129.56 g/plant and 660.71 kg/rai (Table II).

TABLE III
CORN YIELD AT HARVESTING STAGE AFTER APPLIED *MELALEUCA CAJUPUTI* EXTRACTS AND POWDER FOR WEED CONTROL IN CORN FIELD.

Treatments	Corn at harvesting stage (120 days) /1			
	Corn ear length (cm)	Corn ear circumference (cm)	Kernels weight (g/plant)	Corn yield (kg/rai)
10% LE	18.60a/2	4.55a/2	134.53a/2	659.05a/2
15% LE	19.02a	4.71a	131.09a	663.31a
10% BE	19.02a	4.65a	131.01a	657.56a
15% BE	19.00a	4.59a	128.04a	663.09a
Dry powder	18.59a	4.34a	125.62a	659.99a
Control	19.26a	4.47a	127.08a	661.27a
Average	18.85a	4.55a	129.56a	660.71a
LSD 95%	18.85	4.55	129.56	660.71
%CV	6.3	6.3	8.5	9.4
F-test	ns	ns	ns	ns

Remarks: LE was leaf extract, BE was branch extract
/1 Average from 4 replications
/2 Different characters in the same row indicated statistically different ($p<0.05$) by DMRT
ns no statistically different ns no statistically different

These results indicated that *M. Cajuputi* leaf and branch extracts including dry powder of leaf and branch reduced weed density during corn growing until harvesting stage. Thus, it is interesting to find the natural compounds from this plant which might be developed to a novel herbicide. References (Duck, 2003; Duck 2003) discussed that natural compounds have several benefits over synthetic compounds. Natural compounds are mostly water-soluble and non-halogenated molecules. Natural products have short half-life and considered safe of environmental toxicology standpoint. There is a need to discover new herbicides since the number of herbicide-resistance weeds is increasing and synthetic herbicide are less effective against the resistance weed biotype Some of natural products exploited as commercial herbicides are triketone (Heap, 1997; Itoh,, 1999; Fischer 2000), cinmethylin, bialaphos, glufocinate, dicamba, pelargonic and tentoxin (Bhowmik, 1992)

Mesotrione, a HPPD inhibitor, has been developed as herbicide for weed control in corn (Bhowmik, 2003). This herbicide discovered from a natural compound in lemon bottlebrush (*Callistemon citrinus*) which is in the family Myrtaceae same as *Melaleuca cajuputi*. Reference (Heisey, 1999) developed an allelopathic compound from b arh and foliage of tree-of-heaven (*Ailanthus altissima*) as a natural product herbicide. Ailanthone exhibited a strong herbicide activity when sprayed on soil before seed germination. Reference (Xuan, 2003; Hong, 2004)found that the allelopathic plants did not cause any injury to rice and improved rice yield up to 20%.

CONCLUSIONS

Melaleuca cajuputi leaf and branch extracts at the concentration of 10 and 15% with ratio of 1 L per 9 m^2 and dry powder of leaf and branch at the concentration of 4 kg/rai inhibited weeds growth and propagation in corn filed during growth period until harvesting period. Furthermore, *Melaleuca cajuputi* leaf and branch extracts and dry powder had no effect to growth and yield of corn during experiment. This result indicated that *Melaleuca cajuputi* either leaf and branch extracts or leaf and branch grinded as dry powder were possible to use as herbicide in corn field or in other crops. However, the used of *Melaleuca cajuputi* leaf extract at the concentration of 15% showed better result than branch extract and dry powder of leaf and branch. Thus, the active compounds from *Melaleuca cajuputi* leaf extract are interesting to investigate and give conclusion for allelopathy effect.

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