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Application of wood vinegar to fermented liquid bio-fertilizer for organic agriculture on soybean

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Abstract

The efficiency of wood vinegar added to fermented liquid organic fertilizer to increase yields and reduce pest infestations was evaluated on a new variety of soybean (Srisamrong1). The experimental plots were located at the experiment station of the Faculty of Agriculture Natural Resources and Environment, Naresuan University, Phitsanulok. This study was undertaken during the rainy season (May to September 2008). The experiment was a split plot in RCBD (randomized complete block design) with 6 treatments and 3 replications per treatment. The fermented liquid organic fertilizer from herbs and wood vinegar was evaluated in 6 treatments: 1) water as control; 2) wood vinegar; 3) derris + neem seed + turmeric + molasses; 4) turmeric + tobacco + turmeric + molasses; 5) citronella grass + neem seed + turmeric + molasses; 6) citronella grass + tobacco + turmeric + molasses. A ratio of 5:3:1:5 (kg: kg: kg: mL) was applied on the 3rd to 6th treatments and were fermented in wood vinegar at 50 mL/25 liters of water included with 12 gm of a microbial activator (LDD7). All of the treatments were diluted with water in a 1:200 ratio prior to spraying. Beginning at 15 days after planting the 6 treatments were applied as foliage sprays at 7 day intervals for a total of 8 times. The results showed that yields and the yield components response to the application of wood vinegar and fermented liquid organic fertilizer was not significantly different among treatments. However, treatment 2 (wood vinegar) showed a trend towards a higher efficiency of yield components such as average height, node length, seed number and weight /100 seeds, which were 65.45 cm, 10.46 cm, 39.99 and 18.57 gm, for treatments 2-5 respectively. The average yields were

2,512.5 kg/ha (402 kg/rai). The levels of soybean pest infestations were estimated. The 2nd treatment (wood vinegar) showed the highest significant pest control efficacy compared to the other treatments. The wood vinegar treatment showed a mean insect damage score of 1.75 compared to 3.29 for the other treatments.

Keywords : wood vinegar, fermented liquid organic fertilizer, organic agriculture, soybean

Introduction

Soybean (*Glycine max (L.) merrill*) is an important economic crop of Thailand. The Office of Agricultural Economics, Ministry of Agriculture and Cooperatives (2006) reported that Thailand has an annual soybean production of 0.21 million tons, representing 12 percent of the local demand. These are not enough soybeans available locally to meet domestic needs, thus it must be imported from overseas. A limiting factor to increased soybean production in Thailand is low productivity per rai. One main cause of the low productivity is the outbreaks of insect pests which lead to a greater application of chemical pesticides. The misuse of pesticides affect the farmers' health, economic returns, and the environment. Therefore, using fermented liquid organic fertilizer from herbs such as derris, neem, turmeric, citronella grass, tobacco etc. and wood vinegar to substitute for the use of chemical insecticides are a possible alternative for farmers. The use of alternative organic pesticides would provide an environmentally friendly method for soybean production.

Liquid organic fertilizer is a product from the bio-fermentation of vegetables, fruits, and animal wastes fermented with sugar and useful microbes. These microbes help to break down nutrients in plants making them a potentially valuable nutrient-rich organic fertilizer source. When the raw products are processed by bacteria or microorganisms, substances are liberated, such as proteins, amino acids, organic acids, major nutrients, minor nutrients, accelerating growth hormones, vitamins, and enzymes, all of which are potentially useful for the efficient growth of plants (Apai and Thongdeethae, 2001).

Wood vinegar is an organic compound which is suitable for use by organic farmers. Wood vinegar is a byproduct of charcoal production. It is a liquid generated from the gas and combustion of fresh wood burning in an airless condition namely, Iwate kiln. When the gas from the combustion is cooled, it condenses into a liquid. Raw wood vinegar has more than 200 chemicals, such as acetic acid, formaldehyde, ethyl-valerate, methanol, tar, etc. Wood vinegar has been used in a variety of processes, such as industrial, livestock, household and agricultural products. Wood vinegar reportedly improves soil quality, eliminates pests, accelerates plant growth, and acts as a plant growth regulator or growth inhibitor (Apai and Thongdeethae, 2001).

Therefore, application of wood vinegar to fermented herb-based bio-fertilizers for soybean production is one organic agriculture method that may help to reduce the use of both pesticides and fertilizers. The aim of this study was thus to evaluate the efficiency of liquid fermented bio-fertilizers using several formulas containing both herbs and wood vinegar on a new variety of Soybean, Srisamrong1.

Materials and Methods

The experiments were conducted in the rainy season between May-September at the Faculty of Agriculture Natural Resources and Environment, Naresuan University, Phitsanulok Province. The individual experimental plots size was 2x5 meters, the data were collected from a harvested area of 1 x 4 meters from a total of 36 plots in the planted area. Soybeans (Srisamrong1) were sown in rows spaced 50 cm apart. Beginning at 15 days after planting, the 6 treatments of fermented liquid organic fertilizer were applied as foliage application at 7 days intervals a total of 8 times (60 days old). All of the treatments were diluted with water in a ratio of 1:200 before spraying. The experiment had a split plot RCBD (randomized complete block design) with 6 treatments and 3 replications per treatment as follows:

1. water (control)
2. wood vinegar
3. FLB* formula 1 (derris + neem seed + turmeric + molasses)
4. FLB* formula 2 (turmeric + tobacco + turmeric + molasses)
5. FLB* formula 3 (citronella grass + neem seed + turmeric + molasses)
6. FLB* formula 4 (citronella grass + tobacco + turmeric + molasses)

*FLB= Fermented Liquid Bio-fertilizer

A ratio of 5:3:1:5 (kg:kg:kg:mL) was applied on the above 3rd to 6th treatments and were fermented in wood vinegar 50 mL/25 litres of water and included 12 gm of microbial activator (LDD7). All of the treatments were diluted with water at a 1:200 ratio prior to spraying.

Data Recording

The values of nutrient content in soils before planting and after harvesting were analyzed. The yield components of soybean in terms of height, limb number, node length, seed number, pod number, weight /100 seeds and yield (kg/rai) were recorded. The data were measured in 1x4 m² of the planted area and 13% of moisture randomly from 10 plants. The rating scores of insect pest infestation on soybean were measured based on the criteria shown in table 3.

Data Analysis

The data were analyzed with ANOVA and significant differences determined by Duncan's new multiple range test (DMRT) using Sirichai's statistics program.

Results

Table 1 shows the response of a variety of soybean (Srisamrong1) to the application of wood vinegar and fermented liquid organic fertilizer. Although there were no significant differences among all of the treatments, the 2nd treatment (wood vinegar) trended to affect the yield components more than the control (water) and the other treatments. The average of height, node number, limb number and pod/plant of treatments sprayed with wood vinegar were 67.87 cm; 10.93 node; 0.67 limb, and 25.77 pod respectively. Similarly, all treatments showed no significant differences, but the 2nd treatment (wood vinegar) trended towards the highest number of seeds; weight of 100 seeds and the average yield/rai, with mean values of 47.33 seeds, 19.24 gm and 426 kg/rai, respectively (Table 2). The results of the damage index values from disease and insect pest infestations are shown in Table 3. The 2nd treatment (wood

vinegar) showed the lowest damage values with respect to insect pest control. The wood vinegar treatment showed a highly significant difference on insect damage, with a score of 1.75 compared to an average damage score of 3.29-4 for the other treatments (Table 3).

Table 1: Effects of wood vinegar and fermented liquid bio-fertilizer on height, limb, node and pod on soybean (Srisamrong1) in Phitsanulok (May - September 2551).

Treatments	yield components			
	height (cm.)*	node /plant**	limb/plant***	pod/plant****
1. Control (water)	66.60	10.37	0.37	22.7
2 wood vinegar	67.87	10.93	0.67	25.77
3 FLB (formula 1)	66.03	10.47	0.53	21.10
4 FLB (formula 2)	63.13	10.83	0.67	22.50
5 FLB (formula 3)	63.73	10.37	0.50	21.93
6 FLB (formula 4)	65.33	9.77	0.30	22.00
Average	65.45	10.46	0.51	22.56
F-test	ns	ns	ns	ns

ns = non significant difference

*C.V. = 10.47%; **C.V. = 4.15%; ***C.V. = 57.33 % ; ****C.V. = 12.58%

FLB= Fermented Liquid Bio-fertilizer

Table 2: Effects of wood vinegar and fermented liquid bio-fertilizer on number of seed, weight of 100 seeds and yield (kg/rai) of soybean (Srisamrong1) in Phitsanulok (May - September 2551).

Treatments	yield components		
	number of seed /plant*	weight of 100 seeds**	yield (kg/rai)***
1. Control (water)	36.60	18.08	389
2. wood vinegar	47.33	19.24	426
3. FLB (formula 1)	34.27	18.69	337
4 FLB (formula 2)	41.33	18.50	418
5 FLB (formula 3)	40.40	18.36	417
6 FLB (formula 4)	40.0	18.5	422
Average	39.99	18.57	402
F-test	ns	ns	ns

ns = non significant difference

*C.V. = 15.43 % **C.V. = 3.68% ***C.V. = 15.02 %

FLB= Fermented Liquid Bio-fertilizer

Table 3: Effects of wood vinegar and fermented liquid bio-fertilizer on insects pest infestation of soybean

Treatments	Scores of insects pest infestation on soybean
1. Control (water)	3.75 ^a
2. wood vinegar	1.75 ^b
3. FLB (formula 1)	3.50 ^a
4. FLB (formula 2)	4.00 ^a
5. FLB (formula 3)	3.50 ^a
6. FLB (formula 4)	3.25 ^a
Average	3.29 ^a
F-test	*

ns = non significant difference

* = highly significant difference at level of confidence 99 % and 95 % by DMRT method

Note: Criteria for the ratings to insect pest infestation on soybean leaves

Score 1 = leaves area were infested <25%

2 = leaves area were infested between 26 to 50%

3 = leaves area were infested between 51 to 75%

4 = leaves area were infested between 76 -100%

With respect to the soil nutrient analysis taken after experiment completion the highest organic matter (% OM) levels were found in the plots sprayed with FLB formula 3; (citronella grass + neem seed + turmeric + molasses) at 1.67%. The lowest % OM occurred in the plot spray with FLB formula 2 (turmeric + tobacco + turmeric + molasses) and on the 2nd treatment (wood vinegar). In addition, the plots sprayed with FLB formula 4 (citronella grass + tobacco + turmeric + molasses) showed the highest P and K values, but no significant difference between treatments were found with respect to micronutrient levels. (Table 4)

The nutrient analysis values from the wood vinegar and fermented liquid bio-fertilizer treatments is shown in Table 5. The result show that the lowest pH (2.74) and EC (Electrical Conductivity) (17.19) values were found in the 2nd treatment (wood vinegar). The major nutrients (NPK) and minor nutrients (Ca and Mg) in wood vinegar treatment were much lower when compared with controls and with all the other treatments.

Table 4: Analysis of nutrient content in soil samples prior to planting and after experiment completion in trials run during the rainy season (May - September 2551).

Soil Samples	Values of analysis of nutrient content in soil samples treated with treatments (ppm)							
	pH	%OM	P	K	Ca	Mg	Zn	Fe
Pre harvesting soils	7.02	0.93	8.60	42	1496.20	421.80	1.28	42.16
Post harvesting soils								
1. control (water)	7.08	1.06	12.20	48	1798.8	326.80	6.38	25.12
2. wood vinegar	7.51	1.0	12.225	48	1862.5	361.10	6.70	23.56
3. FLB (formula 1)	6.77	1.19	5.825	42	1603.8	473.10	9.12	76.87
4. FLB (formula 2)	6.91	0.93	9.28	42	1596.9	379.50	9.25	18.99
5. FLB (formula 3)	6.98	1.67	12.975	60	2098.0	388.20	9.81	36.15
6. FLB (formula 4)	7.00	1.54	31.625	66	1680.7	305.60	8.39	38.70

Table 5: Analysis of nutrients in wood vinegar and fermented liquid bio-fertilizer

Treatments	Values of analysis of nutrient content in the treatments (%)						
	pH	EC (ms/cm)	N	P	K	Ca	Mg
2. wood vinegar	2.74	17.19	0.03	0	0	0	0.003
3. FLB (formula 1)	4.28	26.70	0.14	0.010	0.97	0.25	0.13
4. FLB (formula 2)	4.99	28.30	0.16	0.014	0.75	0.30	0.05
5. FLB (formula 3)	4.20	23.30	0.14	0.089	0.79	0.11	0.09
6. FLB (formula 4)	4.24	25.30	0.16	0.027	0.85	0.14	0.10

Table 6: Weather data include temperature, rainfall and humidity during the rainy season (May- September 2551).

Whether data	Monthly data (year 2008)					
	May	June	July	August	September	Average
Rain (ml.)	125.3	119.8	211.3	227.2	670.8	270.9
Temperature(°C)						
(max.)	36.9	35.8	35.1	33.9	33.4	35.09
(min.)	18.7	18.6	19.9	17.7	17.1	18.4
Relative Humidity (%)	77.6	82.8	87.9	87.3	87	84.5

cited : Rice Research Center, Phitsanulok

Rainfall during the duration of the experiment was 270.9 mm. Meantime, the average maximum and minimum average temperatures were 35.0 °C and 18.4 °C, respectively while the relative humidity was 84.5% as shown in Table 6.

Discussion

The wood vinegar and fermented liquid bio-fertilizer, combined in different formulations, were applied on soybean (Srisamrong1). Although the results showed that yield and yield components responded to all of the treatments, the treatment responses were not significantly different compared to the control (water). However, the 2nd treatment (wood vinegar) tended to have the highest yield component values such as average height, node number, seed number and weight of 100 seeds when compared with the other treatments, which were fermented from various kinds of herbs. In addition, the wood vinegar showed better suppression of pest infestations. Similarly, Chotitayangkul et al., (2004) reported that the application of wood vinegar on soybean (KKU 5E) did not increase significantly the height, dry weight and yield components. But they found high efficiency of germination on soybean seed treated with wood vinegar at a ratio of 1:300. Pagnakorn et al., (2008) reported that the application of wood vinegar at 0.1% and 0.2% concentrations showed a high efficiency for controlling insect pests in Chinese kale. In addition, the application of only extracted substances had lower effect on yield components than mixing bio-fertilizer with yeast (Mekki and Ahmed, 2005). Moreover, in an evaluation of several herb extracts to control the Kiefer lime leaf miner, they showed that derris resulted in better leaf miner control than the other treatments, including Ocimum (Uraisakul and Piadang, 2008). In contrast, the present study was conducted on experimental plots where soybean had never been previously planted. Therefore, the major insect pests of soybean in our research were soybean pod bug (*Riptortus linearis* Fabricius), soybean looper (*Pseudoplusia includens*), and the pod sucking bug (*Nezara viridula*).

Conclusions

The yields and yield components response to the application of wood vinegar and fermented bio fertilizer as foliage sprays on soybean leaves was not significantly different among treatments. However, the wood vinegar spray treatment did show a trend towards greater values with respect to several yield components and showed the best pests suppression levels on soybean, compared to the other treatments.

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