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Maximizing Productivity of some Faba Bean Varieties by Foliar of Wood Vinegar and Algae under Sandy Soil Conditions

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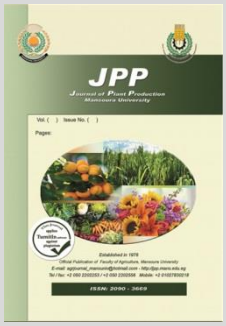

ABSTRACT

Increasing food productivity is one of the most important requirements to meet the growing demand for it. Therefore, this study aimed to study the improvement pf the productivity and quality of some varieties of faba bean grown in sandy soil by foliar spraying with algae and wood vinegar during the two winter seasons (2021–22 and 2022–23). The results showed that the Nubaria-2 variety was superior to the Giza-716 variety in all characters except harvest index in both seasons. The results showed that the foliar spraying with wood vinegar and algae had a substantial impact on yield, its components, and the quality indices of faba bean varieties. Also, the results showed that foliar spraying with high rates of wood vinegar enhanced the seed yield and quality of faba bean varieties. Foliar spraying at a rate of 4 ml/l wood vinegar was superior to all other rates in yield, yield components, P%, K %, protein and total carbohydrates in the two seasons. The results of the study had important effects on the cultivation of faba bean in modern sandy soil. Foliar spray treatments with wood vinegar and algae can be a successful technique for increasing crop productivity and nutritional content, contributing to food security. The results obtained revealed the superiority of the Nubaria-2 variety over the Giza-716 in terms of yield and its components, and foliar spraying at a rate 4 ml/l of wood vinegar gave better results than other rates.

Keywords: Faba bean, Nubaria-2, Giza-716, Wood vinegar, Algae, Sandy soil.

INTRODUCTION

In the Egyptian diet, faba bean (*Vicia faba* L) is an essential source of protein. Now, all efforts are aimed at increasing agricultural productivity to fulfill the growing demand for food. As a result, a large amount of fertilizer has been used to improve agricultural productivity, which is both costly and detrimental to the environment (Foda *et al*., 2021). As a result, several researchers enhanced their efforts to produce a high quantity and quality of output by discovering alternative mineral fertilizers, such as algae extract and wood vinegar.

Foliar feeding is one of the most important fertilizer delivery tactics because it promotes nutrient absorption by breaking the leaf cuticle and entering the cells, resulting in increased crop yield (Mady 2009 and Grewal and Abbey 2018). As a result, foliar application of bio-fertilizers is one of the most significant and effective sources of plant nutrients, emerging as a viable alternative to chemical fertilizers, offering improved nutrient absorption to boost crop output. As a result, foliar spraying is regarded as one of the most environmentally benign farming practices, as well as being more effective than chemical fertilizers applied to the soil (Youssef *et al*., 2023).

Wood vinegar (WV) is a fluid collected from pyrolysis flue gas produced during the high-temperature production of biochar from agricultural waste. It includes between 10% and 20% organic compounds and around 200 distinct types of chemical molecules. Organic acids, benzene, ketones, aldehydes, alcohols and their derivatives, heterocyclic compounds, phenols, and their derivatives, alkyl phenyl ether derivatives, carbohydrates, and nitrogen compounds are among these organic compounds (Ma *et al*., 2013).

Wood vinegar is the gaseous byproducts, water vapor, tar, and volatiles formed by the slow pyrolysis of biomass into charcoal, also known as pyroligneous acid (Lashari *et al*., 2013). Its composition is complicated, consisting mostly of water (80–90%) and more than 200 chemical molecules, including acid, alcohol, phenol, aldehyde, and ester (10–20%), with acetic acid serving as the primary organic acid component (Feng *et al*., 2020).

Wood vinegar is becoming more popular as a natural plant material since it is non-polluting and environmentally benign. It may be utilized in agricultural production as a plant growth booster (Luo *et al.*, 2019), an antibacterial agent, and a soil amendment (Lashari *et al*., 2015). Furthermore, because of its acidic nature, wood vinegar has been proposed to be utilized to increase nutrient availability and minimize N_2O and CH_4 emissions (Zhang *et al*., 2020). In principle, wood vinegar treatment is expected to improve phytoextraction by improving soil metal bioavailability and, as a result, plant absorption and accumulation. Furthermore, wood vinegar may provide a variety of essential components for plant development.

However, as an environmentally beneficial product, extensive studies on the effects of wood vinegar on the efficiency of phytoextraction have never been done. Pyroligneous acid (PA) or Wood vinegar is an acidic reddish-brown aqueous liquid. It is obtained by clarifying the liquid output of the combustion process of woods or wood remnants from the wood processing industry, tree branches,

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bamboo, agricultural straw, fruit shell, and other biomaterials. (Yang *et al*., 2016).

Wood vinegar is frequently utilized in the manufacturing of NR sheets as an insect repellent, odor eliminator, wood preserving, plant growth booster and soil and/or foliar fertilizer, animal feed additive, and coagulant. Until recently, many of the goods have been used in a wide range of markets. Wood vinegar has lately been shown to be good to crops. Wood vinegar, on the other hand, contains a variety of functional substances in appropriate proportions that not only benefit crop growth, but also yield good interactions, that can promote stress and disease resistance, crop growth, and thus such an effect can eventually boost crop yield and quality (Gu *et al*., 2020).

According to previous studies, diluting wood vinegar 300 times can boost, yield as well as protein content, enhance rice quality, and significantly increase panicle number, photosynthesis, and efficient tillers number. (Jeong *et al*., 2015). In low soil quality or dry conditions, adding wood vinegar to beans can increase their nutritional content while reducing infection with dangerous bacteria (Mao *et al*., 2019).

Algae, whether linked in a small zone or not, enhance soil structure and increase production. The use of algae in plants has resulted in an increase in root, shoot length, and the number of leaves, and hence the plant's overall improvement. (Vyomendra and Kumar 2016).

Moreover, Clear types of blue-green algae can carry out both photosynthesis and nitrogen fixation, which provides them with biological and agrarian inclinations for a different type of bio-fertilizer that may enhance the structure of mainly saline-alkaline soil, and boost crop yielding and quality. To some extent, they are useful in water refining. (Gupta, *et al*., 2015; Nabti *et al*., 2017).

Meanwhile, the applied study of foliar wood vinegar and algae on field crops is still in the exploratory stage, some concentrations of wood vinegar and algae were selected to study the effect of foliar spraying addition on yield and quality of faba bean for two years under sandy soil conditions.

MATERIALS AND METHODS

Experimental Site

The sets were tested at a private farm in the El-Wadi El-Gaded Governorate for two seasons (2021/22) and 2022/23). The soil type is sandy and had previously been grown at the test site as described in the Carter and Gregorich, (2008).

Soil samples were gathered from the 30 cm soil layer depth for lab analysis before the trail was started and irrigation water was collected for analysis, as shown in Table 1, while the analysis of the algae and wood vinegar used is shown in Table 2.

Table 1. Physical and chemical properties of the experimental site before sowing and irrigation water.

Soil of experience			Irrigation water		
Determination		**Percentage**	**Determination**		**Percentage**
Mechanical analysis	Sand	85.80	Chemical analysis	pH	7.70
	Silt	6.55		EC ($ds.m^{-1}$)	0.80
	Clay	7.65	Soluble cations (mg/l)	K^+	3.18
	Textural class	Sandy		Na^+	3.12
Chemical analysis	pH	7.90		Mg^{++}	6.22
	EC ($ds.m^{-1}$)	0.55		Ca^{++}	7.02
	O.M. %	0.35	Soluble anions (mg/l)	$CO_3^=$	0.00
	$CaCO_3$	3.12		HCO_3^-	3.87
Available Nutrients	Nitrogen	0.85		Cl^-	0.57
	Phosphorus	0.13		$SO_4^=$	15.10
	Potassium	0.65			

Table 2. Chemical analysis of the algae and wood vinegar

Algae			Wood vinegar	
Determination		**Percentage**	**Determination**	**Percentage**
Chemical analysis	pH	7.50	Organic acids	25.92
	Carbon/Nitrogen	18.30	Ketenes	9.77
	Organic matter	57.30	Esters	4.10
	Organic carbon	25.00	Furan derivatives	1.59
Available Nutrients	Nitrogen	3.30	Alkenes	3.52
	Phosphorus	2.50	Baldheads	1.80
	Potassium	0.63	phenols	40.15
	Iron	0.15		
	Zinc	0.05		
	Magnesium	0.02		
	Copper	0.005		

Experimental design

The experimental design of the study was a split plot design with three replicates in a randomized complete block configuration. The main plots were allocated faba bean cultivars, whereas the subplots received foliar spraying rates.

Field trials in both seasons were conducted utilizing a drip irrigation system with drippers positioned 30 cm apart. (2 L/hour). The seeds were planted in hills 25 cm apart on plots 15 m^2 (1/280 fed) in area with five ridges (500 cm long and 60 cm width). The irrigation system was irrigated every 5-7 days, and it was added once before sowing at 10 days.

Agricultural practices

In both seasons, faba bean varieties, i.e., Giza-716 and Nubaira-2, were planted on November 10th at a rate of 30 kg/fed (fed =4200 m^2). The Beans Research Institute, Agricultural Research Centre provided the Faba bean seeds. Phosphorus and potassium were applied at rates of 75 kg P_2O_5/fed and 50 kg K_2O/fed, respectively. Before planting, a

mono-calcium super-phosphate treatment of phosphorus (15.5% P_2O_5) was applied. Potassium sulphate (48% K_2O) was applied after 45 days of sowing. Nitrogen was applied twice (after 20 and 30 days after sowing) at a rate of 30 kg N/fed in the form of ammonium nitrate (33.5% N). During both growth seasons, weeds were treated twice, 25 and 50 days after planting, as well as insects and other agricultural practices, as directed by Egypt's Ministry of Agriculture.

Treatments

Algae and wood vinegar were sprayed for faba bean varieties after 30 days, 45 days, and 60 days from sowing with an average of 300 liters of water per feddan at the following rates:

- **F_1**=Control foliar spaying with water
- **F_2**=Foliar spaying with algae (1 ml/l)
- **F_3**=Foliar spaying with algae (2 ml/l)
- **F_4**=Foliar spaying with algae (4 ml/l)
- **F_5**=Foliar spaying with wood vinegar (1 ml/l)
- **F_6**=Foliar spaying with wood vinegar (2 ml/l)
- **F_7**=Foliar spaying with wood vinegar (4 ml/l)

Yield and its components

At harvest time, a random sample of 10 randomly selected plants was placed between the middle ridges of each plot to determine plant height (cm), number of seeds per plant (g), seed weight per plant (g), and 100-seed weight (g). All plants in each plot were harvested to estimate, seed yield (ton/fed), straw yield (ton/fed), biological yield (ton/fed) and harvest index % = (seed yield/biological yield) *100.

Chemical analysis

A.O.A.C. (2000) evaluated the levels of total nitrogen and soluble carbohydrates in seeds. According to A.A.C.C. (2000) the crude protein content was determined by multiplying the N% by 6.25. According to Carter and Gregorich (2008) method for estimating phosphorus levels using a spectrophotometer, according to Motsara and Roy (2008), the K^+ concentrations were measured using an emission flame photometer.

Statistical analyses

The data were statistically evaluated using analysis of variance (ANOVA), mean comparisons with COSTAT, and the least significant differences (LSD) at a level of 5% to determine differences between means. Statistical software for Windows version 6.1 was used for the calculations (Statsoft Inc., 2001).

RESULTS AND DISCUSSION

1. Yield and yield components

Variety differs

The finding in Table 3 shows a significant difference in yield and yield components between the two varieties such as plant height, number of seed per plant, weight of seed per plant, weight of 100 seeds, seed and straw yields per feddan as well as biological yield per feddan and harvest index. Nubaria-2 variety is a significant superior to Giza-716 variety in all characteristics except harvest index in both seasons. However, results reveal the superiority of Giza-716 variety in harvest index in both seasons. Genetic variations may explain the variation in yield characteristics across faba bean varieties.

In this regard, Ahmed and El-Abagy (2007) linked differences in growth characteristics among faba bean cultivars to differences in the number of nodules formed on the roots of the tested cultivars, implying that each cultivar's growth may be primarily dependent on nitrogen fixation, as well as differences in photosynthetic partitioning and migration between cultivars and the endogenous.

Table 3. Effect of faba bean varieties on yield and yield components under sandy soil conditions

Varieties	Plant height(cm)	Number of seeds/plant	Seed weight /plant (g)	Weight of 100 seed(g)	Seed yield (ton/fed)	Straw yield (ton/fed)	Biol. Yield (ton/fed)	Harvest index (%)
				2021/2022				
Giza-716	86.47	30.65	48.42	99.66	1.90	2.05	3.96	48.13
Nubarua-2	102.95	33.80	50.14	105.83	1.92	2.42	4.35	44.52
F-test	**	**	**	**	*	*	*	**
				2022/2023				
Giza-716	91.19	33.38	51.50	105.40	2.04	2.19	4.23	48.29
Nubarua-2	108.23	36.52	53.31	111.93	2.06	2.58	4.65	44.68
F-test	**	**	**	**	*	*	*	**

In this regard, Gerema (2020) demonstrates that varieties differ in their growth and development and that these changes are due to the plant's morphological, physiological, and biochemical processes.

Effect foliar spraying of algae and wood vinegar

Data in Table 4 showed that all foliar spraying with algae and wood vinegar improved for all yield and yield components, and the higher spraying rate was better than the lower spraying rate in the two seasons. Spraying at a rate of 4 ml/l algae and wood vinegar is an effective strategy for improving faba bean productivity. The highest values were obtained from spraying at a rate of 4 ml/l (F_7) from wood vinegar treatment all characters except harvest index in both seasons. So, foliar spraying of algae and wood vinegar at all rates promote most yield characters including plant height, number of seed per plant and seed weight per plant as well as seed and straw yield.

Many studies have documented the favorable impact of algae on plant yield, such as Reda *et al*. (2020) on soybean, Ali (2021) on wheat, and Kunmiao *et al*., (2021), who have also found a good influence of wood vinegar on plant production. In this regard, Travero and Mihara (2016) discovered that wood vinegar treatment of soybean plants had no statistically significant influence on plant growth but had a significant effect on yield. However, the Nubaria-2 variety had the greatest yield features when treated with wood vinegar. These findings were corroborated by Foda *et al*., (2021).

Dalal *et al*., (2020) observed this impact of algae application rate and recommended that foliar spraying application of algae extracts at 4 ml/l under water stress is an effective approach for enhancing soybean yield. Where, many substances in wood vinegar promote crop growth, such as acids and phenol, the effect of hormones and all the substances that have a promoting effect in the wood vinegar

or algae can generate a condition of balanced plant interaction that increases crop development from all angles and has a beneficial effect that exceeds the administration of a single plant hormone regulator (Cao *et al*., 2017).

Table 4. Effect of foliar spraying with algae and wood vinegar on yield and yield components of faba bean under sandy soil conditions

Foliar fertilizers		Plant height (cm)	Number of seeds/ plant	Seed weight /plant (g)	Weight of 100 seed (g)	Seed yield (ton/fed)	Straw yield (ton/fed)	Biol. Yield (ton/fed)	Harvest index (%)
2021/2022									
Control	F_1	78.50	25.33	38.66	85.56	1.67	1.66	3.33	50.15
Algae	F_2	85.33	28.33	43.16	95.50	1.90	2.19	4.09	46.54
	F_3	90.83	30.00	45.33	101.92	1.92	2.26	4.18	45.50
	F_4	95.50	32.33	47.83	105.74	1.95	2.31	4.26	45.42
Wood vinegar	F_5	100.33	35.00	53.00	108.03	1.96	2.35	4.31	46.70
	F_6	104.16	36.83	56.00	111.09	1.99	2.42	4.41	45.15
	F_7	108.33	38.50	61.00	111.38	2.02	2.49	4.51	44.83
$LSD_{0.05}$		1.29	0.76	0.89	5.19	0.01	0.06	0.05	0.78
2022/2023									
Control	F_1	83.00	27.33	41.11	90.49	1.78	1.77	3.55	50.23
Algae	F_2	89.83	30.33	45.89	101.01	2.03	2.33	4.36	46.72
	F_3	95.66	32.50	48.19	107.80	2.06	2.41	4.47	45.68
	F_4	101.00	35.16	50.85	111.83	2.09	2.46	4.55	45.57
Wood vinegar	F_5	105.83	38.00	56.35	114.25	2.11	2.50	4.61	46.81
	F_6	109.16	39.83	59.54	117.50	2.13	2.58	4.72	45.34
	F_7	113.50	41.50	64.85	117.81	2.17	2.66	4.83	45.03
$LSD_{0.05}$		0.82	0.83	1.34	5.41	0.01	0.05	0.06	0.75

F_1 =Control foliar with water F_2 =Foliar with algae (1 ml/l) F_3=Foliar with algae (2 ml/l)
F_4=Foliar with algae (4 ml/l) F_5= Foliar with wood vinegar (1 ml/l) F_6=Foliar with wood vinegar (2 ml/l) F_7=Foliar with wood vinegar (4 ml/l)

According to Chalermsan and Peerapan (2009), wood vinegar contains various functional substances in an appropriate proportion that are not only beneficial to crop growth but also produce good interactions that can promote robust crop growth, and this effect can ultimately increase crop yield and quality. Ali (2021) observed that spraying with biofertilizer (3 ml/l) and adding algae fertilizer (5 ml/l) separately resulted in a significant increase in all vegetative growth and yield components of wheat grain.

The current study clearly showed that foliar spraying with wood vinegar and algae boosted faba bean plant growth, nutrient absorption, quality, and yield where wood vinegar is a natural extension of cytokinin, proteins, nucleic acids, and chlorophyll (Kunmiao *et al*., 2021). The findings revealed that yield and yield components reacted to all interventions. When compared to the other treatments, the wood vinegar treatment produced the highest yield component values, such as average plant height, seed number, and weight of 100 seeds. Thus, Pangnakorn *et al*., (2009) observed that foliar wood vinegar improved soybean yield in comparison to either the positive control or the negative control.

Effect of the interaction

The effect of the interaction between faba bean varieties and foliar spraying algae and wood vinegar on yield and yield components are imported in Table 5 the data revealed that, the interaction was significant in seed yield per feddan, straw yield per feddan, biological yield per feddan, and harvest index in two seasons except plant height, number of seed per plant, weight of seed per plant and weight of 100 seeds.

The best treatment for seed yield per feddan, straw yield per feddan and biological yield per feddan was Nubaria-2 variety with foliar spraying by wood vinegar (4 ml/l) (F_7) in both seasons, while Giza-716 variety with control treatment gave the highest value of harvest index in both seasons.

The results presented in the table show that the foliar spraying faba bean varieties with algae or wood vinegar significantly increased yield components and thus seed and straw yield, while untreated faba bean plants had the lowest values. In this regard, Ahmed and El-Abagy (2007) linked differences in growth characteristics among faba bean cultivars to differences in the number of nodules formed on the roots of the tested cultivars, implying that each cultivar's growth may be primarily dependent on nitrogen fixation as well as differences in photosynthetic partitioning and migration between cultivars and the endogenous.

Therefore, it is important to undertake field and research experiments under local conditions in different place to understand how faba bean plant respond to foliar spraying with algae, wood vinegar, in order to provide useful recommendations and insight to farmers and researchers to obtain to best results with local environmental conditions and sustainable agricultural.

2. Quality characteristics

Variety differs

Data in Table 6 show a significant difference in chemical content between the two varieties such as phosphorus %, potassium %, protein % and total carbohydrates in two seasons. However, the extent of the effect may differ among varieties. The findings demonstrate that the Nubaria-2 cultivar outperformed the other cultivar in all quality characteristics in two seasons. The disparities in performance for growth qualities between the two cultivars may be linked to their genetic background, which had a significant effect in this respect. Some Faba bean varieties differ in their growth features, such as phosphorus, potassium, as well as protein percentages and total carbohydrates %.

Table 5. Effect of the interaction between varieties and foliar spraying with algae and wood vinegar on yield and yield components of faba bean under sandy soil.

Variety	Foliar Fertilizers		Plant Height (cm)	No. of seeds /plant	Seed weight /plant (g)	Weight of 100 seed (g)	Seed yield (ton/fed)	Straw yield (ton/fed)	Biological yield (ton/fed)	Harvest index (%)
2021/2022										
Giza-716	Control	F_1	71.00	25.33	38.66	85.56	1.67	1.60	3.27	51.07
	Algae	F_2	76.67	27.33	42.00	93.00	1.80	1.95	3.75	49.04
		F_3	83.00	28.67	44.33	99.30	1.91	2.14	4.05	47.13
		F_4	87.67	30.67	47.33	103.20	1.94	2.18	4.11	47.09
	Wood vinegar	F_5	92.00	33.33	52.00	105.60	1.96	1.96	3.92	50.00
		F_6	95.33	35.33	55.00	108.30	1.98	2.22	4.21	47.04
		F_7	99.67	36.67	61.00	115.00	2.04	2.27	4.31	46.71
Nubaria-2	Control	F_1	86.00	26.67	40.00	88.16	1.68	1.66	3.34	50.32
	Algae	F_2	94.00	29.33	44.30	98.01	1.91	2.43	4.34	44.05
		F_3	98.67	31.33	46.33	104.55	1.93	2.48	4.40	43.88
		F_4	103.33	34.00	48.33	108.28	1.95	2.52	4.47	43.76
	Wood vinegar	F_5	108.67	36.67	54.00	110.46	1.97	2.57	4.55	43.40
		F_6	113.00	38.33	57.00	113.88	2.00	2.62	4.62	43.26
		F_7	117.00	40.33	61.00	120.00	2.07	2.70	4.77	42.97
$LSD_{0.05}$			ns	ns	ns	ns	0.01	0.08	0.08	0.01
2022/2023										
Giza-716	Control	F_1	75.00	27.33	41.11	90.49	1.78	1.71	3.49	50.91
	Algae	F_2	80.67	29.33	44.65	98.36	1.98	2.08	4.06	49.23
		F_3	87.67	30.67	47.13	105.02	2.05	2.28	4.33	47.31
		F_4	92.67	33.33	50.32	109.15	2.08	2.32	4.40	47.25
	Wood vinegar	F_5	97.00	36.33	55.29	111.69	2.10	2.09	4.19	50.12
		F_6	100.33	38.33	58.48	114.55	2.13	2.38	4.51	47.19
		F_7	105.00	39.67	64.86	119.31	2.16	2.44	4.60	46.92
Nubaria-2	Control	F_1	91.00	28.67	42.53	93.24	1.80	1.71	3.51	50.39
	Algae	F_2	99.00	31.33	47.13	103.66	2.05	2.59	4.64	44.22
		F_3	103.67	34.33	49.26	110.57	2.08	2.64	4.71	44.06
		F_4	109.33	37.00	51.39	114.52	2.10	2.69	4.79	43.91
	Wood vinegar	F_5	114.67	39.67	57.41	116.83	2.11	2.74	4.86	43.51
		F_6	118.00	41.33	60.60	120.45	2.15	2.79	4.94	43.49
		F_7	122.00	43.33	64.86	125.37	2.19	2.88	5.07	43.16
$LSD_{0.05}$			ns	ns	ns	ns	0.01	0.09	0.09	0.01

Table 6. Effect of varieties on quality of faba bean seeds under sandy soil conditions

Varieties	2021/2022				2022/2023			
	P	K	Protein	T. Carb	P	K	Protein	T. Carb
	(%)							
Giza-716	0.14	2.18	13.25	29.00	0..17	2.25	13.68	30.59
Nubarua-2	0.16	2.51	14.16	33.09	0.19	2.58	14.58	34.90
F-test	*	*	*	**	*	*	*	**

P=Phosphorus **K=Potassium** **T.Carb=Total Carbohydrates**

Abd El-Gawad, *et al*., (2015) and Simma *et al*., (2017) had comparable results. The same data shows that there were significant changes in macroelement (N, P, and K) content, total carbohydrate percentage, and crude protein content amongst cultivars. Furthermore, the Nobaria-2 cultivar had the highest values for these chemical contents of the seeds. Hassanein *et al*., (2020) also observed differences in the chemical composition of different faba bean seed.

Effect foliar spraying of algae and wood vinegar

Data in Table 7 show that the foliar spraying of algae and wood vinegar treatments enhanced from phosphorus %, potassium %, protein % and total carbohydrates % in seeds of faba bean However, the extent of the effect may differ among varieties, and application by algae and wood vinegar, for that it is significant with the increase of the fertilizers rate in both seasons. The findings revealed that foliar spraying rates had a considerable impact on the quality of faba bean seed. Where, the greatest rate provided P%, K%, protein%, and total carbohydrates% with a 4 ml/l (F_7) from wood vinegar.

The same data demonstrates that vinegar treatment greatly increased faba bean production more than algae treatment, as seen by a considerable rise in most of the yield quality characteristics. Many researchers (Mao *et al*., 2019) have found that vinegar treatment increases the concentration of macro elements (NPK), protein, and carbohydrates in seeds. The good effect of wood vinegar may be explained by the fact that it contains various beneficial components in suitable quantities that can boost crop development (Gu *et al*., 2020).

Effect of the interaction

The data in Table 8 reveal that the interaction between varieties and foliar spraying by algae and wood vinegar has a positive effect on the quality characteristics. The data in the same table reveal that the maximum chemical contents of the seeds were obtained by the Nubaria-2 variety under high levels of foliar spraying.

Regarding the interaction between varieties and rate of application, it is clear from the data presented in Table 8 that most quality characteristics are positively affected by either algae or wood vinegar treatment of application is

gradually increased. It is interesting to see the advantage of vinegar treatment over algae treatment at all concentrations.

In this regard, Nurhayati *et al*., (2005) showed that a 3-5% concentration of wood vinegar considerably enhanced quality characteristics. Kunmiao *et al*., (2021) recently stated that wood vinegar may be viewed as a compound plant growth regulator analog and that wood vinegar has a good effect on crops when used at the recommended dosage. The encouraging impact of algae rate was reported by Reda *et al*., (2020), who showed that foliar spraying with algae at 8 g/l generated good yields and high NPK, crude protein, and total carbohydrate content in seed.

Table 7. Effect of foliar spraying with algae and wood vinegar on quality of faba bean seeds under sandy soil conditions.

Foliar fertilizers		2021/2022				2022/2023			
		P	K	Protein	T. Carb	P	K	Protein	T. Carb
		(%)							
Control	F_1	0.12	1.95	11.73	25.16	0.15	2.01	12.10	26.55
Algae	F_2	0.14	2.30	12.90	27.00	0.17	2.38	13.32	28.48
	F_3	0.15	2.34	13.36	28.50	0.18	2.40	13.80	30.06
	F_4	0.16	2.35	13.83	30.50	0.19	2.41	14.29	32.17
Wood vinegar	F_5	0.16	2.40	14.27	33.66	0.19	2.47	14.73	35.51
	F_6	0.17	2.53	14.65	35,16	0.20	2.60	15.12	37.09
	F_7	0.19	2.58	15.20	37.33	0.22	2.65	15.83	39.38
$LSD_{0.05}$		0.01	0.03	0.15	0.94	0.01	0.02	0.21	1.56

Table 8. Effect of the interaction between varieties and foliar spraying with algae and wood vinegar on quality of faba bean seeds under sandy soil conditions.

Variety	Foliar Fertilizers		20212022				2022/2023			
			P	K	Protein	T. Carb	P	K	Protein	T. Carb
			(%)							
Giza-716	Control	F_1	0.12	1.95	11.73	25.16	0.14	1.94	11.96	25.32
	Algae	F_2	0.14	2.13	12.48	26.33	0.17	2.18	12.88	27.78
		F_3	0.15	2.16	12.94	27.33	0.18	2.21	13.38	28.83
		F_4	0.15	2.21	13.25	28.33	0.18	2.27	13.69	29.88
	Wood vinegar	F_5	0.16	2.26	13.75	30.67	0.19	2.32	14.19	32.34
		F_6	0.15	2.31	14.13	32.00	0.18	2.37	14.56	33.75
		F_7	0.17	2.37	14.67	34.33	0.21	2.43	15.17	36.22
Nubaria-2	Control	F_1	0.13	2.01	11.88	26.33	0.15	2.06	12.25	27.78
	Algae	F_2	0.14	2.51	13.33	27.67	0.17	2.57	13.77	29.18
		F_3	0.17	2.54	13.79	29.67	0.20	2.60	14.23	31.29
		F_4	0.16	2.60	14.42	32.67	0.19	2.66	14.90	34.46
	Wood vinegar	F_5	0.18	2.43	14.79	36.67	0.21	2.49	15.29	38.68
		F_6	0.17	2.75	15.19	38.33	0.20	2.82	15.69	40.43
		F_7	0.20	2.79	15.73	40.33	0.23	2.86	16.00	42.55
$LSD_{0.05}$			ns	0.06	0.23	1.37	ns	0.04	0.75	1.45

ns=non significant

Economic Feasibility

The effects of foliar spraying wood vinegar and algae on the net return, gross income, and total cost of two faba bean varieties are shown in Table 9. The faba bean cultivars with the highest net return values were found to be those treated with a 4 ml/L spray of wood vinegar and algae. Plants in the control group that were not treated with wood vinegar or algae yielded the least significant outcomes.

Foliar spraying faba bean plants at a rate of 4 ml/l with algae or wood vinegar enhanced net yield by 16%, 19%, and 20%, respectively, compared to the control without spraying algae or wood vinegar for both cultivars Giza -716 and Nubaria-2. The net return ranged between (44840, 46120 L.E.) and (47040, 48480 L.E./fed) in varieties Giza -716 and Nubaria-2, with the highest significant values recorded in the case of 4 ml/l with plants foliar sprayed with algae and wood vinegar and the lowest in the case of control without foliar spraying wood vinegar.

Table 9. Economic feasibility of foliar spraying with algae and wood vinegar fertilizers on seed and straw yield of faba bean varieties under sandy soil average of two years.

Varieties	Fertilizers Type	Feddan costs(L.E)	Foliar Fert. Price(L.E)	Seed yield	Price (L.E)	Straw yield	Price (L.E)	Total income	Net return
Giza -716	No fertilizers	2500	0.0	1.72	34400	1.72	6880	41280	38780
	Algae	2500	900	1.98	39600	2.16	8640	48240	44840
	Wood vinegar	2500	1500	2.06	41200	2.23	8920	50120	46120
Nubaria-2	No fertilizers	2500	0.0	1.74	34800	1.72	6880	41680	39180
	Algae	2500	900	2.01	40200	2.56	10240	50440	47040
	Wood vinegar	2500	1500	2.08	41600	2.72	10880	52480	48480

Algae= 300 L.E/liter Wood vinegar= 500L.E/liter Seed yield = 20 L.E/Kg Straw yield =4.00 L.E/Kg

CONCLUSION

Based on the findings, it can be concluded that foliar spraying treatment of either algae or wood vinegar has a mimicking impact on faba bean production, with the effect being more obvious at higher levels of application. Finally, the use of algae or wood vinegar not only increases faba bean output, but also quality, as seen by high macro element, protein, and carbohydrate content. As a result, it can aid in the attainment of sustainability goals in newly sandy soils. Overall, these studies suggest that the dose of algae or wood vinegar applied beneath sandy soil is crucial for obtaining

the advantages. These data indicate that foliar spraying with a rate 4 ml/l wood vinegar produced the highest yield, yield components and seeds quality.

List of abbreviations

N	Nitrogen	pH	hydrogen ion buffer
P	Phosphorus	Na	Sodium
K	Potassium	Mg	Magnesium
Ca	Calcium	CO_3	Carbon trioxide or Carbonate
T. Cab.	Total carbohydrates	HCO_3	Bicarbonate Calcium
O.M	Organic matter	Cl	Chloride
Fed	feddan	SO_4	Sulphate
L.E.	Egyptian pound	O.C	Organic Carbon
E.C	Electrical conductivity	WV	Wood Vinegar

Consent for publication

The authors declare that the work has consent for publication.

Competing interests

The authors have no competing interests to declare relevant to this article's content.

Author contributions

Authors R.E and A.A: Data analysis, results interpretation, final editing and proofreading of the paper, checking for consistency, and citation guidelines. Authors A.T and S.E: literature review, and methodology, initial data analysis. All authors read and approved the final manuscript.

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تعظيم إنتاجية بعض أصناف الفول البلدي بالرش بخل الخشب والطحالب تحت ظروف الأراضي الرملية

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الملخص

زيادة إنتاجية الغذاء أحد أهم المتطلبات لتلبية الطلب المتزايد عليه. لذلك، كان الهدف من هذه الدراسة هو دراسة تحسين إنتاجية وجودة بعض أصناف الفول البلدي المزروع في الأرض الرملية بالرش الورقي بالطحالب وخل الخشب خلال موسمي الشتاء (22/2021، 23/2022). أوضحت النتائج أن صنف نوبارية-2 تفوق علي صنف جيزة-716 في معظم الصفات المدروسة.كما أظهرت النتائج أن الرش بخل الخشب والطحالب كان لهما تأثير ايجابي على مؤشرات المحصول والجودة لأصناف الفول البلدي، أيضا، الرش الورقي بمعدل 4 مل/لتر بخل الخشب والطحالب كان له تأثير ايجابي عن المعدلات الأخرى في المحصول ومكوناته، الفوسفور، البوتاسيوم، والبروتين والكربوهيدرات الكلية لكلا من صنفي الفول البلدي في الموسمين. كذلك جميع معاملات الرش الورقي بخل الخشب والطحالب كان لها تأثيرات ايجابية علي محصول البذور لأصناف الفول البلدي وجودتها الغذائية. وكان لنتائج الدراسة آثار مهمة على زراعة الفول البلدي في الأراضي الرملية الحديثة، مما يوفر رؤى جديدة حول التقنيات الحديثة للزراعة المستدامة والصديقة للبيئة. مما يساهم في الأمن الغذائي.كشفت النتائج التي تم الحصول عليها تفوق صنف نوبارية-2 علي صنف جيزة- 716 في المحصول ومكوناته، الرش الورقي بمعدل 4 مل/لتر بخل الخشب أعطي أفضل النتائج عن المعدلات الأخرى.