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Effect of Tillage and Irrigation Method to Sesame *(Sesamum Indicum L.)* Production in Dryland and Wetland

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Abstract*— The productivity of an agricultural commodity is influenced by culture technology such as tillage and water supply. This research aimed to determine the influence of tillage and water supply on the growth and yield of sesame. This experiment used the factorial randomized block design, with three replications. The First factor was the tillage method which consists of three levels, i.e.; no-tillage, minimum tillage, and full tillage. The second factor was irrigation method, i.e., provision of flush water, provision of water through the ditch and the provision of surface waterways. The result showed that the combination of tillage treatment and the provision of water and a variable number of pods on a trial production on dry land, while on trial in wetland areas only the variable weight of 1000 seeds. As there is a difference in the growth of real variables only on trial in wetland areas due to tillage treatments at all ages observation and the results analysis of the experimental on dryland and wetland that water is the determinant of production.*

I. INTRODUCTION

Sesame (*Sesamum indicum* L.) is the commodity from people plantation supporting various industries that produce edible oil with low saturated fat [1][2]. Its oil contents reach 47-52%. Sesame and its derivative product have high nutrient, for example, sesame oil which is well known as the king of vegetable oil with anti-oxidant that other vegetable oils didn't have [3] [4].

Sesame cultivation in Indonesia is mostly cultivated in a limited range and is still a low domestic production[5], but it has a very important role in the development of agro-industries and value-added products [6], on the contrary, United Statescan produce between 900 – 2240 kg/ha that classified as high productivity. The poor mastery of cultivation technology causes low production per unit area. It is also stated that less proper technical culture procedure willobviously lower production and conversely with technology appliance able to increase productivity up to 34% [7]. Until now, most of our farmer still made mistake in applying sesame cultivation technical culture, including tillage, irrigation, fertilization, planting method and obscure variety usage, these causes mall production per unit area [8] and loos of harvest [9]. Indonesia has land potential that suitable for developing this commodity, registered approximately 70.41 million hectares (58%) of 122.05 million hectares sub-optimal land is suitable for farm development and more than 49.3 million ha and still not being used optimally [10].

Related to that matter, the most important thing is how to apply technical culture correctly, especially tillage and irrigation in dryland/moor development and wetland. Dryland situated in higher area that is cultivated without water inundation as usually does in common land[11].On the other hand, wetland is a field with rain as its primary

water source, so that it will produce in rainy season, while in dry season most of that area will be neglected and left drained because inaccessible water source, and lots of other limitations [12].

Tillage in plant cultivation has a purpose of preparing good plant growth media for the sake of plant growth continuance. There are three tillage models; they are without tillage, minimum tillage and full tillage (reversal and levelling). Whereas procedure of irrigation divided into three methods, they are; surface irrigation, beneath surface irrigation, gush and drops [13]. Furthermore, the purpose of irrigation is to fulfil water need of plant growth in adequate quantity and need period. If the quantity is excessive (indicated by surface appearance) often inflict aeration stress, but if the quantity is lacking, often inflict drought stress.

Sesame plant is a plant that has so many taproots and fibrous roots. Explained that sesame plant has two forms of roots, spread and lengthwise strongly, in which with that sesame root plant can survive in the lack of water condition, compared to another type of plants. So that by doing tillage properly combine with good irrigation, can increase sesame plant productivity, whether on dryland or in wetland.

The purpose of this research was to determine the interaction of soil treatment effect and water supply to the growth and production of sesame plant in dryland and wetland. Specifically, it was to determine the best treatment combination for its effect on the production of sesame plants.

II. MATERIAL AND METHOD

This field research was conducted in April – September 2016, in dryland and wetland of Sugihwaras village, Saradan district, Madiun resident and also in dryland and wetland of Banjarejo Taman Madiun district. Indry season I (MKI) usedfactorial randomized block designand repeated three times. The first factor wastillage procedure with three levels, they werewithout tillage (P1), minimum tillage (P2), and full tillage (P3), and the second factor wasthe procedure of irrigation with three levels, they were sprinking (A1), trenches (A2) and surface (A3).

Land preparation wasdone by land opening, crop residue cleaning and doing tillage for about two weeks before cultivation. Terraces madewith waterways as its barrier werealso useful for drainage refinement that in accordance with the needed terrace measurement. Before cultivation and simultaneously with second tillage, ground leveling, manure fertilization or compost with dose of 1 ton/ha. Cultivation was in accordance with treatment, sliced, by 20 cm x 40 cm interval with 3 – 4 seeds each hole, meanwhile plants that spread in the plot were4 grams per terrace.

Cultivation including NPK fertilization (150 kg N given at the age of 15 and 25 HST, 50 kg P were given when planting and 50 kg K were given simultaneously with second N fertilization), irrigation in accordance with need, weed control by weeding manually also pest and disease control when it was required.

Variables observation involved; (1) plant height, (2) branch quantity, and (3) branch quantity. While the production of variables; (4) Number of pods, (5) 1000 seeds weight, and (6) production. The observation was conducted at the end of vegetative growth and harvest. Data were analyzed by duncan test 0.05% and continued with the correlation between treatments.

III. RESULTS AND DISCUSSION

Statistical analysis results showed that interaction between tillage treatment and irrigation method on the number of pods (Table 1).

It can be seen from Table 1 that the combined treatment of soil treatment and irrigation on the number of pods of cultivation, the highest value was obtained by combination of P3A3 treatment (full tillage and in the whole surface) of 104 Pods, but not significantly different from P3A2, P2A3, P3A2, and P2A2. However, it differs significantly from P3A1, meaning that minimum tillage and full soil processing are not significantly different as long as the given irrigation is provided on a ditch or surface. Although sesame does not need water.

Table 1: The average value of the observation of a combination of tillage and irrigation on the number of pods

Treatment	Pod Quantity			
	Dryland		Wetland	
P1A1	83.67	ab	122,33	a
P2A1	70.33	ab	126,33	a
P3A1	62.00	a	117,00	a
P1A2	75.67	ab	129,00	ab
P2A2	88.00	bc	115,67	a
P3A2	104.00	c	127,00	a
P1A3	81.33	abc	132,00	ab
P2A3	100.00	c	125,33	a
P3A3	104.00	c	141,33	b

Note: Numbers accompanied by same letters show there are no any significant different at 0.05 % degree (Duncan Test).

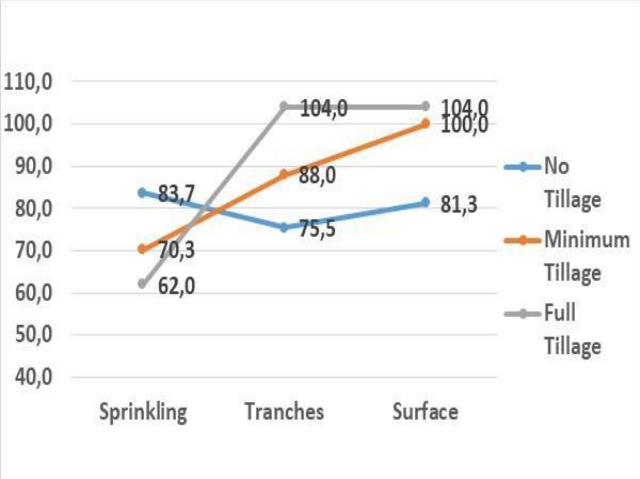

Fig. 1: Interaction curve of combination between tillage treatment (P) and irrigation (A) toward pod quantity variable on wetland

Similarly, what happens to the parameters of production per hectare, indicates the interaction between the combination of treatment of soil treatment and irrigation. The average value of the observed effect of the combined treatment of soil treatment and irrigation on the production of sesame is presented in Table 2.

Table 2: The average value of the observation of a combination of tillage and irrigation on the production

Treatment	Production (Ton/Ha)			
	Dryland		Wetland	
P1A1	0.76	a	1.19	a
P2A1	0.68	a	1.35	ab
P3A1	0.65	a	1.34	ab
P1A2	0.70	a	1.28	ab
P2A2	0.86	ab	1.21	a
P3A2	1.10	bc	1.56	ab
P1A3	0.76	a	1.31	ab
P2A3	1.06	bc	1.42	ab
P3A3	1.18	c	1.72	b

Note: Numbers that accompanied by same letters show there are no any

significant difference at 0.05 % degree (Duncan Test)

It can be seen in Table 2 that on dryland indicates interaction where the combined treatment of full soil treatment and irrigation of the surface giving the highest value of production reached 1.18 T / Ha but not significantly different from P3A2 and P2A3. On wetland does not show any interaction where including influence of each treatment also did not show any real difference. It is suspected that paddy land after rice generally has a good condition for the growth of sesame plants [8].

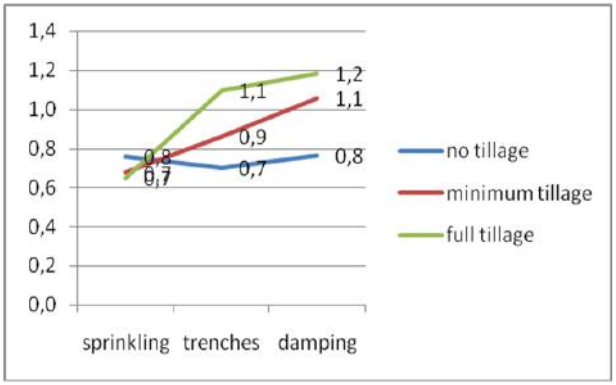

Fig. 2 Interaction curve of combination between tillage treatments (P) and irrigation (A) toward production variable on dryland

Interaction also occurs at the variable weight of 1000 seeds in wetland experiment (Table 3).

As seen in Table 1 experiment in field show combination of fully treatment tillage and irrigation with surface method that prove give high result of pod but it didn't show significant difference with another several treatment combinations except in flush irrigation method which shows significant difference. While in production variable shows that full tillage treatment combination with surface method irrigation give the highest production average up to 1.18 Ton/ha though it is not much different between combination of full tillage and gutter irrigation method and minimum tillage and surfaceirrigation method.

Table 3: Average Value of Influence 1000 Seeds Weight Combination on Rice Field

Treatment	1000 seeds weight (gr)			
	Dryland		Wetland	
P1A1	2,65	a	2.70	a
P2A1	2,69	ab	2.71	a
P3A1	2,68	ab	2.68	a
P1A2	2,65	a	2.71	a
P2A2	2,69	ab	2.72	ab
P3A2	2,69	ab	2.72	ab
P1A3	2,72	ab	2.71	ab

P2A3	2,75	b	2.72	ab
P3A3	2,71	ab	2.77	b

Note: Numbers that accompanied by same letters show there are no any significant difference at 0.05 % degree (Duncan Test)

The interaction variable analysis result of pod quantity and production in field experiment shows that good cultivation demand more of irrigation (Fig. 1 and 2) in which interaction pattern relatively similar to full tillage which more responsive towards water so that gutter irrigation method and surface method have unreal result.On the other hand, without tillage procedure doesn't support plant growth so it has lowest result.

Analysis result in wetland experiment shows that there is only real interaction on 1000 seeds weight variable (Table 2). As seen on table 2, combination between full tillage treatment and surfaceirrigation method are different significantly with treatment combination of without tillage with all of irrigation method that used in this experiment, but doesn't significantly differentfrom combination of minimum tillage treatment or full tillage treatment with gutter irrigation method. Average value of 1000 seeds weight (g) is 2.77 grams. As for interaction pattern on 1000 seeds weight variable (Fig. 3)

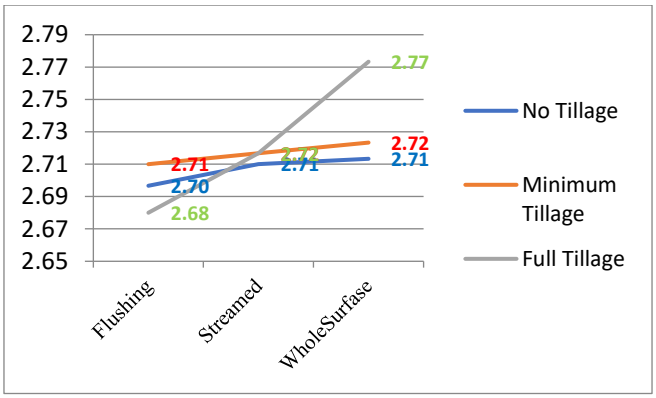

Fig. 3 Interaction curve of combination between tillage treatment (P) and irrigation method (A) seed weight variable on wetland experiment.

indicate that there is interaction on full tillage treatment that show significant respond toward irrigation method, while without tillage treatment and minimum tillage treatment show same respond toward irrigation method so that doesn't show any interaction.

Next,the analysis result on influence of treatment separately toward plant height variable shows that on field experiment indicate significant difference only on treatment tillage influence on all observation age while irrigation method didn't show any difference (Table 4).

Table 4: average value of tillage treatment and irrigation method influence toward plant height variable (cm) in various age of observation on wetland experiment.

Treatment	Plant height in various age of observation			
	45	60	75	90
P1	71.78a	79.89a	88.56 a	104.56a
P2	81.22b	88.44ab	96.22 b	112.22ab
P3	81.56b	89.78b	97.44 b	113.44b
A1	75.67a	83.78a	90.67 a	111.22a
A2	78.44a	86.56a	95.22 a	112.33a
A3	80.44	87.78a	96.33 a	330.22a

Note: Numbers that accompanied by same letters show there are no any significant difference at 0.05% degree (Duncan Test)

As seen in Table 4, full tillage treatment givesthe highest variable average value up to 113.44 cm on 90 days old after planting.Although it is not different significantly from minimum tillage treatment on all observation age, while without tillage treatment has the lowest average value.Although it is not different significantly with minimum tillage treatment.

In contrast, experiment on field, the influence of separately treatment,irrigation method precisely indicate significant difference on seed quantity per pod's variable and weight of 1000 seeds (Table 5).

Table 5: average value of observation results separate treatment influence toward seed quantity per pod and 1000 seeds (g) variables on field experiment.

Treatment	Seed Quantity/Pod		1000 Seeds Weight (gr)	
P1	132.56	a	2.67	a
P2	131.00	a	2.68	a
P3	131.44	a	2.69	a
A1	132.89	b	2.67	a
A2	128.33	a	2.67	a
A3	133.78	b	2.70	b

Note: Numbers that accompanied by same letter show there are no significant difference at 0.05 % degree (Duncan Test)

As seen in (Table 5) surface irrigation method show significant difference with flush irrigation method whether on seed quantity per pod variable or 100 seeds weight variable. The average value of quantity seed per pod is 133.78 when use surface irrigation method and the lowest value is 128.33 when use gutter irrigation method.

Analysis result towards production variable on wetland experiment indicates that there is no interaction. only indicated that there is influence on tillage (Table 6).

Table 6: Average Value Observation Result Of Separate Treatment Influence Toward Production Variable On Wetland

Treatment	Production (Ton/Ha)	
P1	1.26	a
P2	1.33	b
P3	1.54	b
A1	1.29	a
A2	1.35	a
A3	1.48	a

Note: Numbers that accompanied by same letters show there aren't anysignificant difference at 0.05 % degree (Duncan Test)

As seen at Table 6, influence of full tillage treatment gives highest total production up to 1.5 Ton/ha. but didn't significantly different from minimum tillage treatment, while the lowest production achieved by influence of without tillage treatment that 1.26 Ton/ha.

Analysis result towards production variable on field and wetland as shown in Fig. 4 indicates that in wetland, tillage has more significant difference, while field experiment shows that tillage has more significant influence and on field experiment shows that tillage and irrigation method give similar influence.

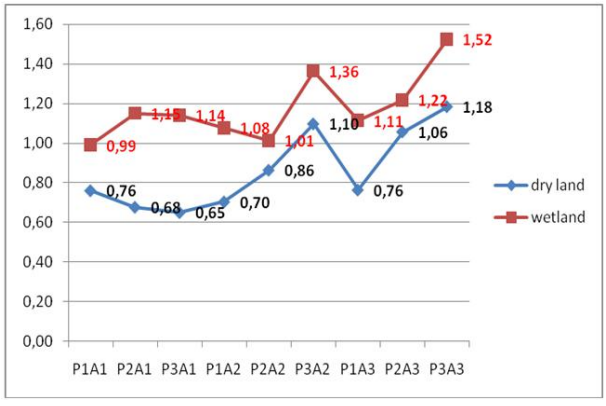

Fig. 4 Production variable between dryland and wetland

A. Discussion

Analysis result shows that combination between tillage treatments and irrigation methods indicate the significant interaction between the number of pods variable and production on field experiment. It is expected because field soil's characteristic is very influenced by tillage and water availability. Whereas, full tillage is strongly corresponded with water availability compared to without tillage treatment. As the research conducted on the growth of sweet corn has positive correlation between the depths of tillage with the availability of water in the land[13].Dryland has lower fertility rate and low organic substance so that resistance towards water availability is low. Meanwhile, tillage had strong influence toward growth and plant production because tillage can control weed.Destroy soil's chunk so formation of planting medium that suitable for seeding and nursery. Also, ease the root growth through soil tilling on surface layer and beneath surface at the same time form aeration throughout minimum tillage, but organic substance and fertilization should be balance [14]. Experiment shows that without tillage treatment can increase usage of available water.Result and water productivity from all plant give contribution in reducing plant water stress' risk on dry land farming [15].

Analysis result shows the combination between tillage treatment and irrigation method indicatesthe significant interaction on 1000 seeds weight variable on the wetland experiment. It is because wetland, generally sesame plant, is planted in the second planting season after paddy so soil still in good condition for sesame growth and production although without tillage. Also, rooting is able to growth well and soil is able to keep enough water. However, interaction pattern is more dominated by irrigation method, so that it is also an influence on the seed-forming process. As statedthat seed forming or filling is strongly influenced by soil's water availability, for example paddy that encounter drought will yield less weight of rice [6]. The difference on irrigation method doesn't significantly influence growth variety, result variety, and rice component result. The height of rice harvest is more related to rice quantity per tassel and 1000 fascicles compared with tassel component per cluster [16]. Also, sesame plant has many and strong adventitious roots type that able to penetrate soil. It is supported with regular irrigation that will give significant influence toward result [17].

The analysis result of the plant height variable on wetland experiment didn't show any interaction, but separate tillage treatment indicates significant difference (Table 4). It is assumed that tillage influence gives high

respond toward water availability.It means that soil with good tillage can reserve and provide enough water for plant compare to without tillage or minimum tillage soil. The proper usage of plant type and population in the marginal area included dryland will determine nutrition efficiency; plant height is used as an indicator [18]. The sufficient water in the field of routing means that providingplant nutrition substance because it can be absorbed by the plant in solution form and solution availability which is circulated within the plant will have positive correlation with photosynthesis process that produces carbohydrate for plant growth.

The analysis result of tillage influence and irrigation toward production variable separately indicates that there is a significant difference in the variable of seed quantity per pod and 1000 seeds weight (Table 5).This occurredon field experiment. In which treatment that significantly influence is the availability of water treatment. It probably because field need more water to support plant growth, so surfaceirrigation method give significant influence compared with flush or gutter irrigation method. However, plant's irrigation should be in adequate quantity and adequate period.
water use on different media shows different effects on plant growth [19]. If water quantity is excessive (surface occurring as the indicator) often inflict aeration stress, while if the water is deficient often inflict drought stress [20]. Onthe other hand, experiment of separatedtreatment influence in field shows tillage give significant influence (Table 5). It probably because experiment in wetland is second planting season after paddy, so the influence of irrigation make growing space distinct better while water availability in soil still adequate for sesame growth. that's why irrigation method didn't influence significantly because sesame classified as drought resist plant or need a little amount of water[21].

The analysis result of influence tillage treatment and irrigation method on the field and rice field mainly production variable (Fig. 4) shows that rice field has adequate water availability.Tillage has more significant influence. It is possibly relatedto texture or physical of soil where wetland was planted before, so the soil condition still very supportive. Meanwhile, on field experiment,Tillage treatment didn't significantly influence. It can be assumed that area is usually planted only on the earlier rainy season so that quantity of detention water level is strongly influenced plant growth. It is stated that irrigation frequency treatment has significant influence toward result.Result component, plant height, and branch quantity,by increasing duration between irrigation frequency and result.

IV. CONCLUSIONS

Application of tillage and irrigation combination for sesame plant cultivation on the field give significant influence especially toward number of podsand production variables, as well as on wetland experiment although only 1000 seeds weight variable that important.

From Separate treatment, it can be concluded that research on the field is more influenced by water availability where surfaceirrigation method proved to be better.While experiment on wetland is influenced dominantly by tillage treatment where full tillage treatment proved to be better.

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