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Chili Growth-Yield Improvement under Different Experience-Creativity Farmer Levels, Agronomical Components, and Their Partial Economic Analysis

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***Abstract*— Chili (*Capsicum annuum* L.), though it is one of the strategic and important vegetable commodities in Indonesia; still faces a main problem, i.e. low productivity with 7.78 tons ha^{-1} nationally and 6.45 tons ha^{-1} specifically in Jawa Tengah. Consequently, the improvement of chili growth yield under different experience and creativity farmer levels (ECFLs), components of agronomy (ACs), and their economic analysis partially was addressed as the main objective of the research. *C. annuum* 'Akar', healthy and farmer seedlings were used in the field research. The factorial experiment was arranged in a randomized complete block design with three replications. ECFLs from high (ECFL-1), moderate (ECFL-2), less (ECFL-3), and initially developed (ECFL-4) were used as the first treatment, and five different ACs with gradual component reduction of ACs-1, ACs-2, ACs-3, ACs-4 and ACs-5 as second treatment. The research clearly revealed that different seedlings, ECFLs, and ACs significantly affected the 'Akar' growth yield. Cultivation of the healthy seedlings by ECFL-1, who had ± thirty years' experience in chili cultivation and fast response to all and potential problems during chili cultivation, under ACs-1, as a complete and optimal ACs, increased vegetative growth and yielded 417.8 flowers and 289.7 fruits plant^{-1}, 1,040.6 g chili plant^{-1}, and 1,044.8 kg chili plot^{-1}; 110-337% improvement; IDR. 16,750,081 farmer income from 250 m^2 plot size; and 4.77 R/C ratio, respectively. However, for positive income, R/C ratio, and low production cost for all farmers, further applications of ACs-2 were promisingly chosen. Entirely the optimal growth yield of chili was established by using healthy seedlings, choosing suitable Acs, and paying more attention to the ECFL. The results can be applied to other chili types and varieties.**

***Keywords*—Chili; economy; farmer; growth; yield.**

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I. INTRODUCTION

Chili (*Capsicum annuum* L.) is a strategic and important vegetable commodity in Indonesia [1, 2]. In January 2023, increasing varied chili prices from IDR 33,150 to 103,150 kg^{-1} caused inflation of up to 0.41% nationally [3], 4]. The commodity had a high return cost ratio (R/C ratio), reaching 3.27 [1, 2, 5, 6]; cultivated in all Indonesian provinces with Jawa Tengah as one of the center production areas [1]; total production was 2.6 million tons in 2019 [2]; and sold in the range of IDR 33,150 – 103,150 kg^{-1} [3]. Although the commodity is strategic and important, low productivity of 7.78 tons ha^{-1} nationally and down to 6.45 tons ha^{-1} in Jawa Tengah is still a serious problem [7] 8]. So, the vegetative and generative results of the chili had to be improved optimally.

In chili farming, using varieties and their seedlings [9], applying different spacings and densities of the plant [1], processing soil, utilizing either organic or inorganic fertilizers [10], mulching black-silver plastic [11], and applying a barrier of plant physically [12] were important factors significantly affecting the growth-yield of the chili. To increase the growth yield of the plants, single or two combination treatments such as application of fertile Verde fertilizer [13], management of fertilization [14], plant architecture [15], bio- stimulants [16], of different shading levels and varieties [17], humic acid and NPK [18], organic and inorganic fertilizers [10], organic manure and decomposer [19], etcetera was generally applied.

However, using several factors of agronomical components (ACs) to improve the growth yield of the chili is a few.

There were several combination treatments applied to improve the growth yield of chili. Combination of 30 kg ha^{-1} Urea, 60 kg ha-1 Diammonium Phosphate, 30 kg ha^{-1} murate of Potash, and 50 g L^{-1} humic acid for High fly successfully stimulated maximum with 1.83 cm stem diameter, 57.5 fruits $plant^{-1}$, 204.5 g yield $plant^{-1}$, and 3.93 tons ha^{-1} [20], irrigation at 100% ET_{crop} every three days, rice straw mulch, and *Capsicum frutescens* L. cv. Kpakpo shito produced 19.1 tons ha^{-1} [11], 25% shading in a combination with PGPR and VAM induced high dry weight, absorption of N, P and K in shoots and roots [21], application of 2.7-3.4 g pot^{-1} Urea 5 times regularly with 2.7 g pot^{-1} TSP, 1.4 g pot^{-1} MOP, and 0.05% $CuSO_4.5H_2O$ for KA-2 variety resulted in 47 pots $plant^{-1}$ and 109 g $plant^{-1}$ [22], production of chili up to 40.61 tons ha^{-1} was derived from a combination treatment of 108 kg ha^{-1} NPK from organic fertilizer and 142 kg ha^{-1} NPK 15.10.30; 8.24.24 for Sigaretta in Bergamo [14]. So far, there is less information on exploring the role of farmers in the growth yield of chili directly. [23, 24, 25] found that farmer experience and skill had a high effect on chili production. However, the reports were not supported by representative data, especially the chili production. Therefore, revealing the effect of different experience and creativity farmer levels (ECFLs) in combination with different ACs applied to increase result performance of the chili and their economic analysis partially as the main objective and was importantly addressed in the research. It was hypothesized that an optimal EFCL and ACs giving high effect on chili result would be successfully established.

II. Materials and Methods

A. Location for Experiment and Condition of the Soil

The experiment was conducted at Maguan, Kaliori Sub-district, Rembang Regency, Jawa Tengah Province-Indonesia. The location had an altitude approximately ± 15 meters above sea level in 6,7389 South latitude; 111,2435 East longitude with the fluctuating precipitation amount of 0 to 286 mm $month^{-1}$ and the average was 100.2 mm $month^{-1}$; the temperature of the air was 28-33°C and 71-96% of the air humidity during the day; 21-27°C and 45-65% in the night. The experiment field was the loam type. Soil pH was 5.75; therefore, 2.8 kg m^{2-1} dolomite was added to increase soil pH in a range of 6.5 – 6.8, that were suitable for chili growth.

B. Nursery Practice, Plant Border, Planting Chili Seedlings, Land and Planting Bed Preparation

The healthy and farmer seedlings of *C. annuum* 'Akar' variety, plant border, and planting chili seedlings were prepared and carried out as described by [12]. The rice straw and grasses in the research field were cleared using a lawn mower. They were then discarded from the research area. The area was tilled with a big rotary tractor. The process left for two weeks. The processed area was then prepared as planting beds. ACs-2 to ACs-5 beds with 1 × 25 m in width and length and 1 × 22 m beds for ACs-1 were constructed with 20 cm in height for all beds. All beds of each ACs tested were fertilized manually and homogenized conventionally using hoes. Fertilizers in each ACs were poured in two long holes prepared evenly in all beds on the left and right sides with the distance between them in each plant bed, i.e., 50 cm, except for ACs-5 with 40 cm. The fertilizers were then mixed homogeny with all media manually using hoes. All beds were watered sufficiently and then covered by mulch plastic properly installed, except ACs-5. In ACs-1, each plot had five beds with border beds surrounding them, while in ACs-2 to ACs-5, each plot had seven planting beds. Each plot had a similar size, i.e., 250 m^2. 50 cm was the distance between beds, 100 cm was the distance between plots, and 200 cm was the distance between replications.

C. Maintenance of Plant

Watering, weeding of chili plants, and controlling pests and diseases were carried out regularly. In ACs-4 and ACs-5, a 100% suitable synthetic pesticide was used to protect the chili plant from attacking pests and diseases., while a combination of 50% synthetic pesticides and 50% biopesticides was applied for the ACs-1, ACs-2, and ACs-3. There were two important problems occurred during research, i.e., (1) dead of healthy and farmer seedlings reaching 15% total seedlings planted carried out by EFCL-3 who did not has serious awareness during seedling cultivation by over water flooding of the research bed planting. The problem was successfully overcome by re-planting of the seedlings; (2) chili plants thrips attacked during vegetative growth phase with 20% incidences noted and the pest was significantly reduced using high frequency spraying of the chili plants using garlic extract

D. Experimental design and treatments

The experiment of factorial type was arranged in a randomized complete block design with two treatments and three replications. The ECFLs as the first factor were (1) high ECFL (ECFL-1), (2) moderate ECFL (ECFL-2), (3) less ECFL (ECFL-3), and (4) initially developed ECFL (ECFL-4). The second factor was five different ACs with gradual component reduction *viz*, (1) ACs-1, (2) ACs-2, (3) ACs-3, (4) ACs-4 and ACs-5 (Table I). ECFL-1 was a cooperator farmer who had ± thirty years' experience in chili cultivation with fast response to all and potential problems during chili cultivation in conjunction to obtain an optimal the growth yield of chili from the initial cultivation to the end of the harvest period; ECFL-2 has ± fifteen years and moderate response; ECFL-3 has ± five years and less response; and ECFL-4 has less than two years experiences, and initial response developed.

TABLE I

VARIED-AGRONOMICAL COMPONENTS (ACS) WERE INVESTIGATED IN THE STUDY.

No.	ACs	ACs-1	ACs-2	ACs-3	ACs-4	ACs-5
1.	Type of seedlings	- Healthy (Fig. 2A)	- Healthy	- Healthy	- Farmer (Fig. 2B)	- Farmer
2.	Plant density ha^{-1}	- 30,000	- 30,000	- 20,000	- 20,000	- 20,000
3.	Plant spacing	- .	- 50 × 70 cm	- 50 × 50 cm	- 50 × 50 cm	- 40 × 40 cm
4.	Basic fertilizers:					
	- Organic manure	- 30 tons ha^{-1},	- 15 tons ha^{-1}	- 7.5 tons ha^{-1}	-	-
	- Bionutrient	- 200 g ha^{-1}	- 100 g ha^{-1}	-	-	-
	- NPK 16:16:16	- 500 kg ha^{-1},	- 350 kg ha^{-1}	- 250 kg ha^{-1}	-	-
	- Phonska			-	- 250 kg ha^{-1}	- 250 kg ha^{-1}
	- ZA	- 200 kg ha^{-1}.	- 100 kg ha^{-1}	- 100 kg ha^{-1}	- 75 kg ha^{-1}	- 75 kg ha^{-1}
	- Tricho-G	- 0.5 kg ha^{-1}	- 0.5 kg ha^{-1}	- 0.25 kg ha^{-1}	-	-
	- Humate	- 0.5 mL ha^{-1}	- 0.5 mL ha^{-1}	- 0.5 mL ha^{-1}	-	-
5.	Supplements					
	- NPK 16:16:16 in ACs-1 to 3 & Phonska in ACs-4 and 5	- 1 kg in 100 L → 200 mL $plant^{-1}$; every 10 days after 30 days	- 0.5 kg in 100 L → 200 mL $plant^{-1}$; every 10 days after 30 days	- 0.25 kg in 100 L → 200 mL $plant^{-1}$; every 10 days after 30 days	- 0.5 kg in 100 L → 200 mL $plant^{-1}$ every 15 days after 30 days	- 0.5 kg in 100 L → 200 mL $plant^{-1}$ every 15 days after 30 days
	- Red KNO3	- 0.5 kg in 100 L → 200 mL $plant^{-1}$ at 30 and 50 days after planting (DAP)	- 0.5 kg in 100 L → 200 mL $plant^{-1}$ at 30 and 50 DAP	- 0.25 kg in 100 L → 200 mL $plant^{-1}$ at 30 and 50 DAP		
	- White KNO3	- 0.5 kg in 100 L → 200 mL $plant^{-1}$ at 60 and 80 DAP.	- 0.5 kg in 100 L → 200 mL $plant^{-1}$ at 60 and 80 DAP.	- 0.25 kg in 100 L → 200 mL $plant^{-1}$ at 60 and 80 DAP.	- 0.25 kg in 100 L → 200 mL $plant^{-1}$ at 15 and 21 DAP.	- 0.25 kg in 100 L → 200 mL $plant^{-1}$ at 15 and 21 DAP.
6.	Plastic mulch	- Applied	- Applied	- Applied	- Applied	- Not applied
7.	Physical Border	- Applied (Fig. 2G)	- Not applied	- Not applied	- Not applied	- Not applied
8.	Synthetic & bio-pesticide	- 50% : 50%	- 50% : 50%	- 50% : 50%	- 100% : 0%	- 100% : 0%

E. Variables of Experiment

The variables that were observed in the experiment were (1) height of the plant (cm), (2) diameter of the stem (mm), (3) width of the canopy (cm), (4) total flowers $plant^{-1}$, (5) total fruits $plant^{-1}$, (6) number of harvested-fruit periods $plant^{-1}$, (7) chili productivity $plant^{-1}$ (g), and (8) chili productivity $plot^{-1}$ (kg). Data measured followed the chili growth stage, once a week periodically from initial plant cultivation to the end of harvest period. Total research times were 180 days. Furthermore, the farming income was calculated by the following formula: $\pi = TR - TC$; π = Income, TR = Total revenue, and TC = Total costs. While the R/C ratio calculation based on revenue and production cost was used to determine farming efficiency [1]. R/C ratio = Total Revenue (TR)/Total Costs (TC). Efficient farming is noted when the R/C ratio is > 1; the equal point is recorded when the R/C ratio = 1, and inefficient farming happens when the R/C ratio is < 1. Production costs were calculated based on the seed cost, fertilizers, pesticides, labor, etcetera.

F. Analysis of Data

The analysis of variance was used to analyze the research data. The data were analyzed with SAS 9.1 (SAS Institute Inc., Cary, NC). The mean differences were further tested using the Tukey test at a confidence level of 95%.

III. RESULTS AND DISCUSSION

It was noted that flower immersing was noted ± 16 days after planting (DAP) when the height of plants reached 17.9 – 28.7 cm with a plant canopy width of ± 15.3 cm. In ± 20 DAP, the young fruits were observed when the height of chili plants was 28.2 – 34.4 cm, and the width of the plant canopy was ± 24.2 cm. Pick flower number and fruit number produced $plant^{-1}$ of up to 140.1 flowers (Fig. 1C) and 177.7 fruits (Fig. 1C) and reduced after that was observed on 90 DAP. The developing height of the plant up to 81.3 cm (Fig. 1A) and canopy width up to 75.9 cm (Fig. 1B) reached the maximal size after 105 DAP and tended to be stable afterward.

Utilization of healthy seedlings compared to farmer seedlings in the study, in fact, improved significant effect in almost all of the variables observed. The height of the plant increased up to 33% (Fig. 2A; Fig. 3C to Fig. 3D); 66% for stem diameter (Fig. 2A; Fig. 3E to Fig. 3F); 33% for canopy width (Fig. 2A); 79% for total flowers $plant^{-1}$ (Fig. 2A); 75% for total fruits $plant^{-1}$; 97% number of harvested-fruit periods $plant^{-1}$ (Fig. 1D; Fig. 2B); 104% for chili productivity $plant^{-1}$ (Fig. 2B), and 119% for chili productivity $plot^{-1}$ (Fig. 2B). Furthermore, more extended experience of farmer with fast response character in solving and finishing all and potential problems during cultivation gave the optimal result in all variables, with EFCL-1 as the best (Table II), at the same time more complete ACs produced the maximal growth and result as noted at ACs-1 (Table III). The results confirmed that more extended experience with fast response habits and complete ACs resulted in optimal growth yield of the chili.

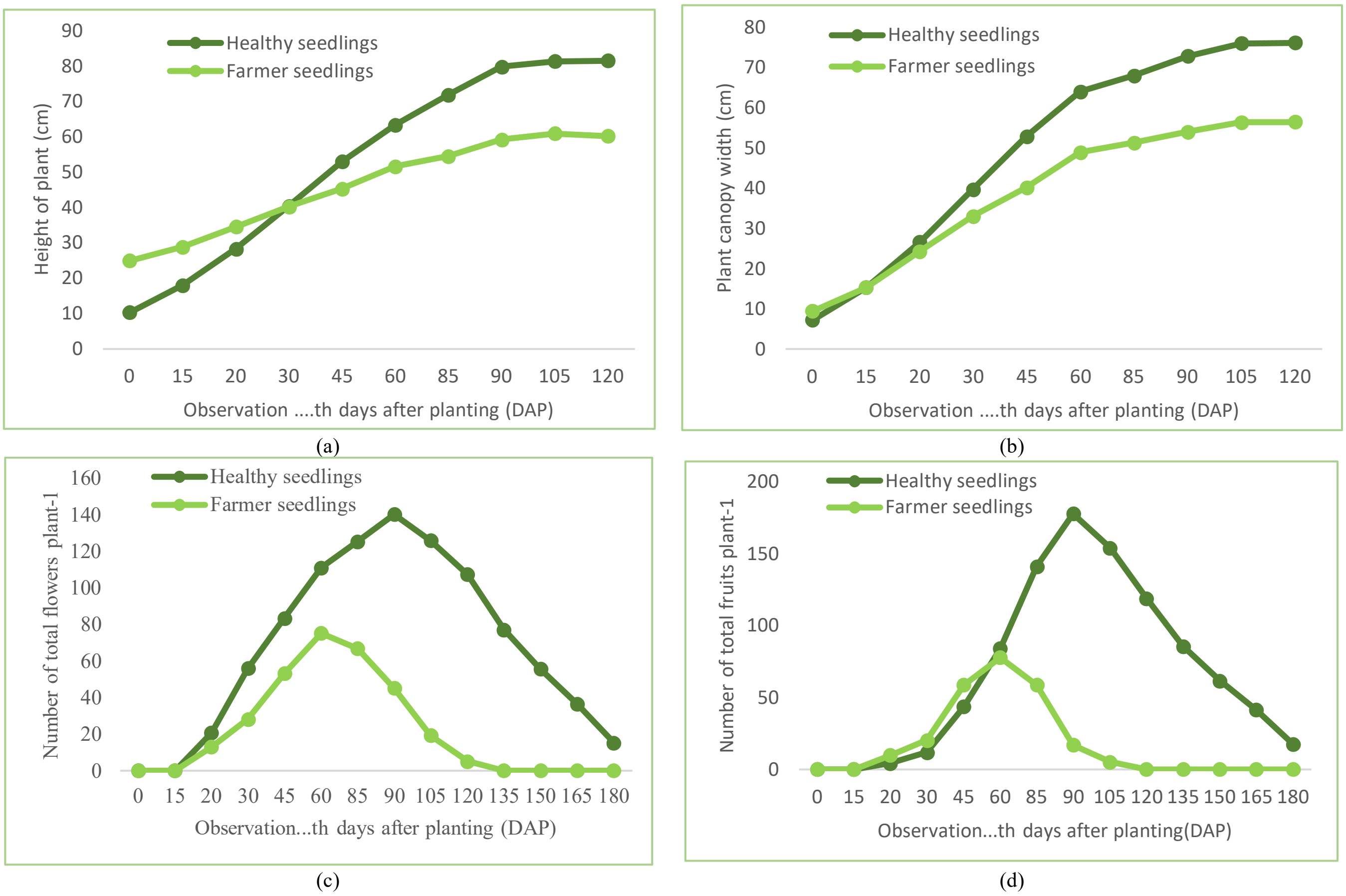

Fig. 1 Effect of different seedlings on performing results of the 'Akar' variety under periodical observation from 0 – 120 DAP. A. Altering the height of plants, B. Changing the plant canopy width, C. Varying the number of flowers plant^{-1}, and D. Fluctuating the number of fruits plant^{-1}.

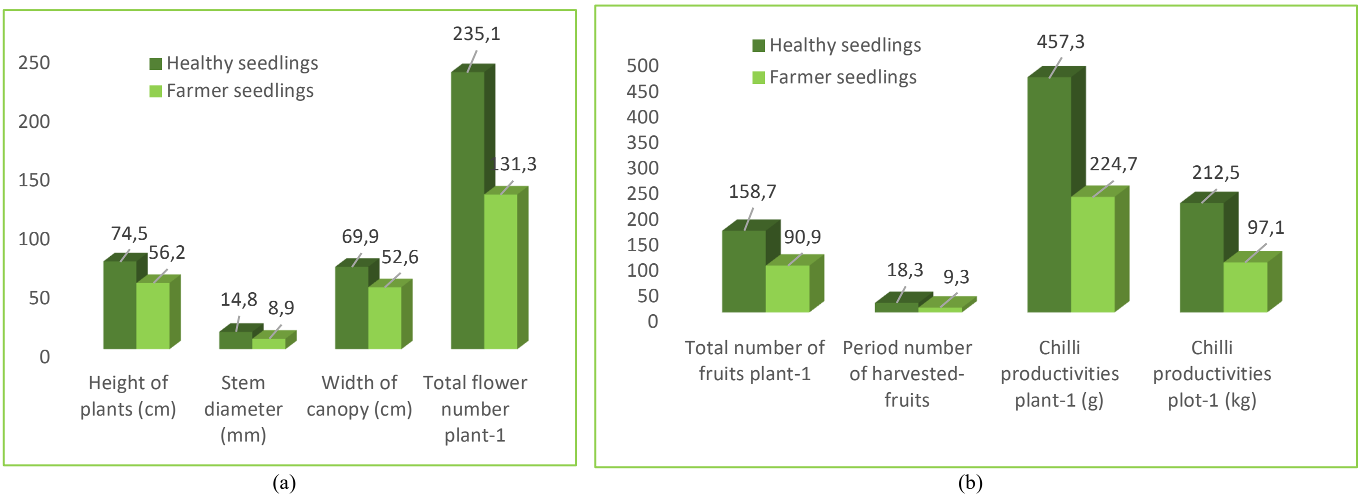

Fig. 2 The growth-yield performances of two different seedlings of the 'Akar' in all variables observed (2A and 2B)

Combination treatment of ECFLs and ACs tested in the study also had significant interaction effects in all variables observed. The ECFLs induced a higher significant interaction effect on plant height, stem diameter, width canopy of plant, number of harvested-fruit periods plant^{-1}, and productivity of chili plant^{-1} than ACs. The ECFL-1, in combination with ACs-1, produced optimal plant height up to 90.4 cm with 17.7 mm stem diameter (Table IV) and 83.9 cm canopy width, 19.9 number of harvested-fruit periods plant^{-1} (Supplement data: Table I), and 1,044.8 kg chili productivity plot^{-1} (Table IV). While the ACs stimulated significant results with 417.8 total flowers plant^{-1}, 289.7 whole fruits plant^{-1} (Table V), and 1,040.6 g chili productivity plant^{-1} (Table V). These results gave evidence that ECFL-1 and ACs-1 were the best combination treatment in obtaining optimal results of the 'Akar' variety and reducing after that due to reducing gradual ACs and lowering the ECFLs (Fig. 3D)

TABLE II
DIFFERENT EXPERIENCE AND CREATIVITY FARMER LEVELS (ECFLS) AFFECTED THE RESULT OF CHILI OF THE 'AKAR' VARIETY

No	Experience and creativity farmer level (ECFL)	Plant height (cm)	Stem diameter (mm)	Plant canopy width (cm)	Total flowers plant^{-1}	Total fruits plant^{-1}	Harvested-fruit periods plant^{-1}	Chili productivity plant^{-1} (g)	Chili productivity plot^{-1} (kg)
1	ECFL-1	75.4 a	13.4 a	68.1 a	264.3 a	182.2 a	15.0 a	567.4 a	485.7 a
2	ECFL-2	67.8 c	10.4 b	62.6 b	229.9 b	153.4 b	14.7 ab	384.1 b	330.6 b
3	ECFL-3	71.3 b	10.4 b	63.7 b	159.4 c	107.8 c	14.4 bc	285.5 c	245.4 c
4	ECFL-4	54.6 d	8.9 c	62.5 b	126.8 d	85.9 d	13.9 c	224.6 c	186.4 c
CV (%)		3.46	6.91	5.52	9.23	7.34	7.34	10.78	8.16

Note: CV-coefficient of variation, ECFL-1 was a cooperator farmer who had ± thirty years' experience in chili cultivation and fast response to all and potential problems during chili cultivation in conjunction to obtain an optimal growth yield of chili from the initial to the end of the harvest period; ECFL-2 has ± fifteen years and moderate response; ECFL-3 has ± five years and less response; and ECFL-4 has less than two years experiences, and initial response developed. Mean values with similar letters in the similar column differ by the Tukey test at a confidence level of 95%.

TABLE III
DIFFERENT AGRONOMICAL COMPONENTS (ACS) INFLUENCED RESULT OF CHILI OF THE 'AKAR' VARIETY

No	Agronomical components (ACs)	Plant height (cm)	Stem diameter (mm)	Plant canopy width (cm)	Total flowers plant^{-1}	Total fruits plant^{-1}	Harvested-fruit periods plant^{-1}	Chili productivity plant^{-1} (g)	Chili productivity plot^{-1} (kg)
1	ACs-1	80.3 a	13.5 a	78.2 a	277.7 a	192.1 a	19.4 a	587.8 a	590.2 a
2	ACs-2	74.4 b	12.1 b	70.5 b	234.3 b	148.6 b	18.8 a	420.2 b	421.8 b
3	ACs-3	70.1 c	11.1 c	67.6 b	201.6 c	141.0 b	16.3 b	378.8 b	253.4 c
4	ACs-4	61.7 d	9.5 d	59.0 c	154.9 d	107.6 c	11.1 c	267.9 c	179.3 cd
5	ACs-5	49.9 e	7.6 e	45.7 d	107.2 e	72.3 d	6.9 d	172.4 d	115.3 d
CV (%)		3.46	6.91	5.52	9.23	7.34	7.34	10.78	8.16

Mean values with the similar letter in the similar column differ by the Tukey test at a confidence level of 95%.

(a) 3.77 cm (b) 7.54 cm (c) 22.73 cm
(d) 10.37 cm (e) 2.85 cm (f) 2.85 cm
(g) 30.76 cm (h) 5.88 cm (i) 4.73 cm

Fig. 3 Growth-yield performances of the 'Akar' variety derived from the study. A. The healthy seedlings, B. The farmer seedlings, C. Vegetative-generative plants originated from the healthy seedlings, D. Vegetative-generative plants produced from the farmer seedlings. E. Stem diameter induced from the healthy seedlings, F. Stem diameter from the farmer seedlings, G. The healthy seedlings surrounded by corn plants as border plants. H. Chili fruits harvested from healthy seedlings. I. Chili fruits from the farmer's seedlings.

Interesting information was noted, i.e., higher harvest periods plant^{-1} up to 18.3 periods for the healthy seedlings and 9.3 for the farmer seedlings; higher prices IDR 2,030 kg^{-1} for chili fruit derived from the healthy seedlings (Fig. 3H), and IDR 18,250 for the chili fruits of the farmer seedlings (Fig. 3I) in average price. The chili fruits were sold from IDR 7,500 to 27,000 kg^{-1}. Furthermore, under simple economic analysis was clearly revealed that higher ECFLs were owned, and higher farming income was noted (Supplement data: Table II).

TABLE IV

INTERACTION EFFECTS OF EXPERIENCE AND CREATIVITY FARMER LEVELS (ECFLS) AND AGRONOMICAL COMPONENTS (ACS) ON HEIGHT OF PLANT (CM), DIAMETER OF STEM (MM), AND PRODUCTIVITY OF CHILI PLOT-1 (KG).

Treatments	height of plant (cm)					Diameter of stem (mm)					Productivity of chili plot^{-1} (kg)				
	ACs-1	ACs-2	ACs-3	ACs-4	ACs-5	ACs-1	ACs-2	ACs-3	ACs-4	ACs-5	ACs-1	ACs-2	ACs-3	ACs-4	ACs-5
ECFL-1	90.4 a	80.0 a	82.3 a	71.5 a	50.3 b	17.7 a	14.8 a	13.7 a	12.3 a	8.5 a	1044.8 a	544.0 a	396.0 a	284.3 a	75.8 b
ECFL-2	83.5 ab	77.6 a	68.7 b	64.8 b	59.4 a	12.7 b	11.8 b	10.4 b	9.0 b	7.9 a	571.2 b	532.7 a	249.7 ab	178.9 b	159.2 a
ECFL-3	79.4 b	75.9 a	73.8 b	60.9 b	54.2 b	12.0 b	11.7 b	11.4 ab	9.2 b	8.1 a	458.7 b	355.7 ab	216.5 b	133.7 bc	120.7 ab
ECFL-4	68.0 c	64.0 b	55.7 c	49.4 c	35.7 c	11.6 b	10.3 b	9.0 b	7.6 c	5.9 b	286.1 b	254.9 b	151.5 b	120.3 c	105.7 b
CV (%)	3.63	4.84	3.96	3.24	3.42	9.12	7.47	9.61	5.20	4.49	10.54	13.09	11.66	10.96	16.92

Mean values with similar letters in the similar column differ by the Tukey test at a confidence level of 95%.

TABLE V

INTERACTION EFFECT OF AGRONOMICAL COMPONENTS (ACS) AND EXPERIENCE AND CREATIVITY FARMER LEVELS (ECFLS) ON TOTAL FLOWERS PLANT-1, TOTAL FRUITS PLANT-1 AND PRODUCTIVITY OF CHILI PLANT-1 (G).

Treatments	Total flowers plant^{-1}				Total fruits plant^{-1}				Chili productivity plant^{-1} (g)			
	ECFL-1	ECFL-2	ECFL-3	ECFL-4	ECFL-1	ECFL-2	ECFL-3	ECFL-4	ECFL-1	ECFL-2	ECFL-3	ECFL-4
AC-1	417.8 a	307.1 a	239.2 a	146.5 a	289.7 a	213.0 a	166.5 a	99.1 a	1,040.6 a	568.9 a	456.8 a	285.0 a
AC-2	283.2 b	323.3 a	206.8 ab	147.6 a	168.5 bc	203.4 a	129.5 b	93.0 ab	591.6 b	530.5 ab	354.3 ab	253.9 ab
AC-3	259.5 bc	211.6 b	183.6 b	127.9 ab	202.7 b	147.5 b	126.2 b	87.5 bc	541.9 b	373.5 abc	323.6 abc	226.4 ab
AC-4	230.8 c	171.3 bc	99.0 c	118.4 ab	159.4 c	118.6 c	69.6 c	82.8 c	424.9 b	267.3 bc	179.7 bc	199.8 bc
AC-5	130.1 d	136.5 c	86.6 c	93.5 b	90.6 d	84.5 d	47.0 c	67.1 d	237.9 b	180.3 c	113.2 c	158.0 c
CV (%)	7.32	11.62	9.24	10.81	7.78	6.68	8.76	3.97	10.55	11.65	13.09	10.68

Mean values with similar letters in the similar column differ by the Tukey test at a confidence level of 95%.

TABLE VI

ACS EFFECT ON FARMER INCOME IN DIFFERENT EXPERIENCE AND CREATIVITY FARMER LEVELS (ECFLS)

Experience and creativity farmer levels (ECFLs)	ACs-1	ACs-2	ACs-3	ACs-4	ACs-5
ECFL-1	16,750,081	7,068,045	4,392,505	2,330,137	- 695,313
ECFL-2	7,145,473	6,838,881	1,415,541	406,637	856,737
ECFL-3	4,863,973	3,249,321	742,245	- 418,263	124,112
ECFL-4	1,363,645	1,205,097	- 575,955	- 662,813	- 149,638

Note: Plot size was 250 m^2; average price of chili kg^{-1} for ACs-1, ACs-2 and ACs-3 was IDR 20,280, - and IDR.18,250, - for ACs-4 and ACs-5

TABLE VII

ACS EFFECT ON R/C RATIO ON DIFFERENT EXPERIENCE AND CREATIVITY FARMER LEVELS (ECFLS)

Experience and creativity farmer levels (ECFLs)	ACs-1	ACs-2	ACs-3	ACs-4	ACs-5
ECFL-1	4.77	2.78	2.20	1.82	0.67
ECFL-2	2.61	2,73	1.39	1.14	1.40
ECFL-3	2.10	1.82	1.20	0.85	1.06
ECFL-4	1.31	1.30	0.84	0.77	0.93

Note: Plot size was 250 m^2; average price of chili kg^{-1} for ACs-1, ACs-2 and ACs-3 was IDR 20,280, - and IDR.18,250, - for ACs-4 and ACs-5

The ACs-1applied by ECFL-1 had high income up to Rp. 16,750,081 from 250 m^2 plot size (Table VI) and reduced by lowering ECFLs. However, reasonable income for all ECFLs with a reduction of production costs was determined by the application of ACs-2 (Table VI). Furthermore, optimal ACs were applied, high EFCL was owned, higher R/C ratio was established (Supplement data: Table III). Under the best combination treatment of ECFL-1 and ACs-1, the highest R/C ratio up to 4.77 was proved and reduced after that due to lowering the ECFL (Table VII) and ACs (Supplement data: Table III). Furthermore, for lower cost production and to keep positive income for all ECFLs, utilization of ACs-2 was promisingly applied (Table VII). The study also clearly found that using ACs-4 and ACs-5 under farmer habits resulted in lower income and R/C ratio, though plastic mulch was added (Tables VI and VIII).

From previous studies, Sukarami variety stimulated 10.6 tons ha^{-1} than 6.1 tons ha^{-1} for farmer seedlings with 57.4% increment [26], ‘OR 42’ healthy seedlings increased chili fruit productivity plant^{-1} up to 1,111.4 g than 794 g for farmer’s seedlings with 39.9% improvement [12], Indrapura variety produced 20 tons ha^{-1} than 11.1 tons ha^{-1} for farmer seedlings with 55.6% increment [1], Rampati hybrid variety induced 16.5 tons ha^{-1} than 8.25 tons ha^{-1} for farmer seedlings with 100% improvement [27], while in the present study, application of the healthy seedlings of ‘Akar’ variety successfully increased total flowers plant^{-1}, total fruits plant^{-1}, chili plant^{-1} and chili plot^{-1} and others with 75-119% improvement (Fig.2A and 2B). These results confirmed that the application of healthy seedlings significantly improved chili productivity.

By farmer roles, [23] reported that labor has a significant effect on the income of chili farmers. Higher proportion of member farmers (48%) had technical efficiency of more than 60% as compared to non-members (18%) [28]. Focus farmer to farming cultivation gave high effect on chilli production [24]. Young farmers having 4-13 years experiences influenced curly red chili in one planting period [29]. Less skillful farmer inhibited developing chili agribusiness [25]. However, the information was not completed by representative data. While from the study, it was known that ECFL-1 significantly induced optimal vegetative and generative growth of chili in all variables recorded (Table II).

In previous studies, 30 kg ha^{-1} Urea combined with 60 kg ha^{-1} NH_2PO_4, 30 kg ha^{-1} KCl, and 50 g L^{-1} humic acid induced maximum results for High fly variety with 243.7 leaves $plant^{-1}$, 5.5 branches $plant^{-1}$, 47.3 cm plant height, 1.83 cm stem diameter, 57.5 fruits $plant^{-1}$, 204.5 g yield $plant^{-1}$, and 3.93 tons ha^{-1} with 8-16.6% improvement [20], improving chili productivity by up to 55% than others were resulted under the application of biofertilizer in 10 ml L^{-1}, Magnesium in 1.5 kg ha^{-1}, and Boron in 1.5 kg ha^{-1} for Kastilo variety with 61.8 cm plant height, 72.0 cm canopy width, 8.6 branches $plant^{-1}$, 180.3 flowers $plant^{-1}$, 164.9 fruits $plant^{-1}$ [30], 47 pots $plant^{-1}$, and 109 g $plant^{-1}$ with 25% improvement was stimulated by application of copper in 0.05% and standard concentrations of N, P, K [22], 120 cm plant height, 14.6 mm stem diameter, 88 cm canopy width, 292.7 flowers $plant^{-1}$, 216 fruits $plant^{-1}$, 1,111.4 g chili fruits $plant^{-1}$, and 167 kg $plot^{-1}$ for OR 42 variety with various increment of 26-43% was established by the application of chicken manure in 20 tons ha^{-1}, Bionutrient in 200 g ha^{-1}, equal NPK in 500 tons ha^{-1}, ZA in 200 tons ha^{-1}, humic acid in 0,5 kg ha^{-1}, optimal supplement fertilizers, plastic mulch and physical border [12]. While in the study, ACs-1 supported maximal growth and yield of the 'Akar' variety (Table III). These reports confirmed that suitable ACs induced the result of chili maximally.

The AC-1, containing application of chicken manure in 20 tons ha^{-1}, Bionutrient in 200 g ha^{-1}, equal NPK in 500 tons ha^{-1}, ZA in 200 tons ha^{-1}, humic acid in 0,5 kg ha^{-1}, optimal supplement fertilizers, plastic mulch and physical border, was called as produksi lipat ganda (Proliga) technology for chili [12]. The technology was successfully applied to improve productivity of Indrapura variety up to 155% from 8.0 to 20.4 tons ha^{-1} [1], 100% increment chili productivity from 8.25 to 16.5 tons ha^{-1} for Rampati hybrid variety [27], 40% increasing percentage of chili productivity from 11.9-16.7 tons ha^{-1} for OR 42 variety [12]. While from the study, the combination of ECFL-1 and ACs-1 for the 'Akar' variety induced 126% productivity increment from 6.9-15.6 tons ha^{-1} produced the optimal results with 417.8 flowers and 289.7 fruits $plant^{-1}$, 1,040.6 g chili $plant^{-1}$ and 1,044.8 kg chili $plot^{-1,}$ with an increasing percentage of 221, 220, 337 and 265%, respectively. These results also confirmed that a suitable combination treatment application supported a high optimal result of chili.

Under optimal combination treatment it was clearly confirmed that higher R/C ratio values established give higher effect on farmer income that led to a high economic viability of the established treatment and was easily applied in practical uses. The farmer income ha^{-1} under *Proliga* technology using Sukarami variety was IDR 209,448,000 [26], IDR 485,806,500 with Indrapura variety [1], IDR 204,836,000 using OR 42 variety [12], IDR 265,935,690 with Akar variety [2], and the study was IDR. 670,003,240 using Akar variety. In other researches, farmer income reached IDR 182,148,700 using integrated plant and resources management (IPRM) for Chiko variety [31], IDR. 20.276.704 for cultivation of chili in Karnataka condition [32]. While based on R/C ratio as farming efficiency indicator, application of AC-1 by EFCL-1 for Akar variety regenerated high R/C ratio up to 4.77. In other reports, the proliga technology resulted in 2.30 with similar variety [2], 3.27 for Indrapura variety [1], 1.51 for Sukarami variety [26], 2.95 for local variety under Prima tani chili-celery intercropping [5], and 1.51 for Chiko variety under IPRM technology [31], 2.04 for 'OR 42' variety [12]. While from the study, a 4.77 R/C ratio of the 'Akar' variety was established. These results proved that the optimal combination treatment induced more efficient farming, led to higher profit, and R/C ratio established.

IV. Conclusion

Optimal vegetative and generative results of the 'Akar' variety were significantly influenced by the application of the healthy seedlings, ECFL-1, ACs-1, and their combination treatments with the various improvement. The healthy seedlings of the 'Akar' variety planted by ECFL-1 under ACs-1 produced optimal vegetative performances of chili plants with significant improvement. However, further utilization of ACs-2 was promisingly chosen as a suitable ACs to obtain competitive profit and to reduce production costs for all ECFLs for 'Akar' cultivation. The successful results for the "Akar' have high potential applied to other varieties underutilization of the healthy seedlings, ACs-1, and skillful-fast response habit to control and overcome all problems that occurred during cultivation.

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Authors Contribution

Research planning, B.W., J.T., J.P., Ag.S.; Experimental Methodology, B.W, J.T., J.P., Ag.S.; Observation and data measurement, B.W., Ar.S., I.G.C., D.S., W.H.; Analysis of Data, B.W., J.T., D.S. Original draft writing-, B.W. J.T.; Manuscript review and edit, B.W., J.T., J.P., Ag.S., Ar.S. I.G.C., D.S., W.H.; Supervision, B.W., J.T., J.P., Ag.S.; Project administration, B.W., J.T., Ar.S.; Funding acquisition, J.T., J.P., Ar.S. All co-authors reviewed the final version and approved the manuscript before submission.

Conflicts of Interest

We declare that there is no conflict of interest in the publication of the paper.

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