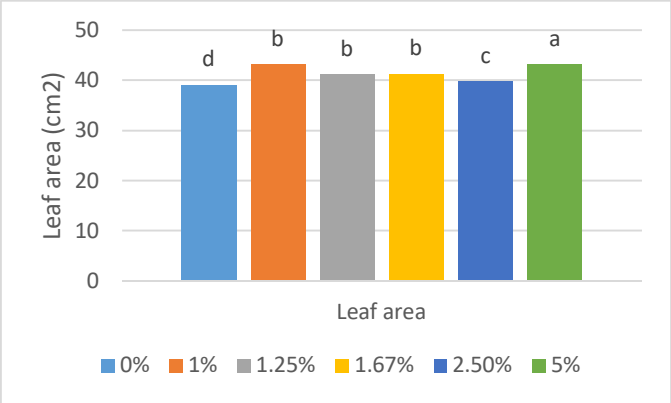

Fig. 4 Effect of weed extract application in different concentrations on leaf area of upland rice.

Application of different doses of N, P, K fertilizer did not affect the shoot and dry root weights, with the results in a range of 25 g – 28 g and 4 g – 5 g, respectively. However, shoot and dry root weights tended to increase with the highest shoot and dry root weights of 31.13 g and 6.03 g, respectively, recorded at the level of weed extract concentration of 5 %.

There was an interaction between N, P, K fertilizers, and weed extract applications on the shoot and dry root weights, as shown in Figures 5 and 6. These results indicated a strong relationship between both treatments on the shoot and dry root weights. An increase in N, P, K fertilizer dose and weed extract concentration significantly improved shoot and dry root weights, as shown in Figures 5 and 6.

Application of weed extract in the concentration of 1.25 – 5% with 100% recommended dose of N, P, K resulted in relatively higher shoot and dry root weights. However, the application of 100% N, P, K recommendation dose and weed extract in a concentration of 5% resulted in higher shoot and root dry weights compared to other treatments.

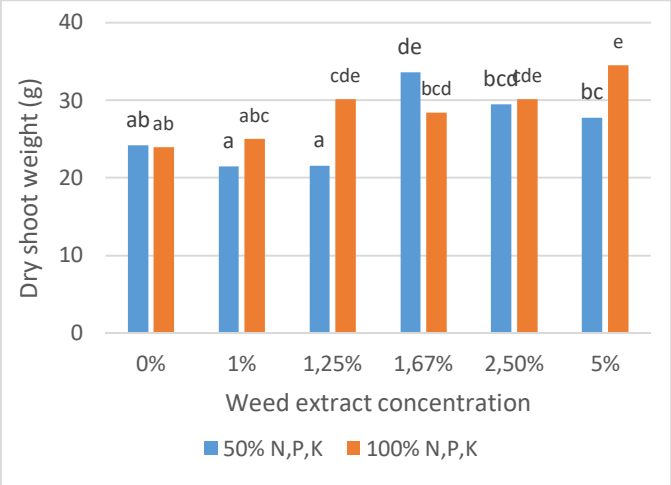

Fig. 5 Effect of N, P, K fertilizers and weed extract applications on upland rice dry shoot weight.

B. Physiological Characters

Table 3 shows that different dose of N, P, K fertilizers gave no statistical difference effect on leaf contents of proline [10 µmol g^{-1} – 13 µmol g^{-1}], chlorophyll a [3 mg g^{-1} – 4 mg g^{-1}], chlorophyll b [1 mg g^{-1} – 1.5 mg g^{-1}], and, N [27% – 30%] and P [2% – 3%] shoot contents of upland rice. Leaf contents of proline, Chlorophyll a, Chlorophyll b varied in range of 8 µmol g^{-1} – 17 µmol g^{-1}, 3 mg g^{-1} – 4 mg g^{-1} and 1 mg g^{-1} – 1.6 mg g^{-1}, respectively, with no significant differences. This result indicated that the application of N, P, K and weed extract in different rate could not affect in accumulation of proline, chlorophyll a and chlorophyll b.

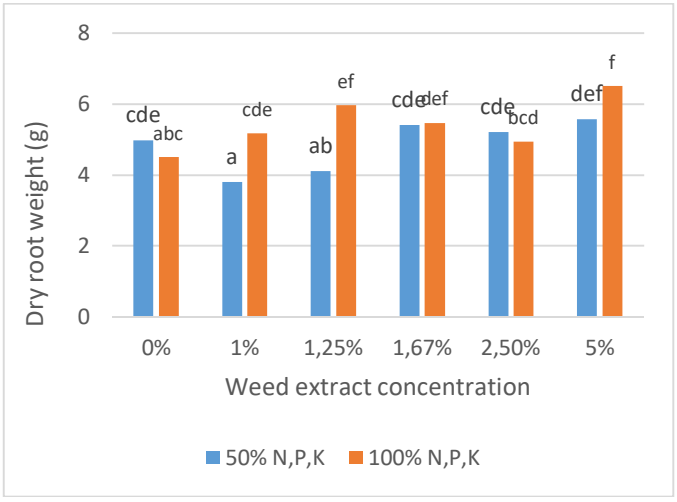

Fig. 6 Effect of N, P, K fertilizers and weed extract applications on dry root weight of upland rice.

TABLE III
APPLICATION OF N,P,K FERTILIZERS AND WEED EXTRACT ON PHYSIOLOGICAL CHARACTERS OF UPLAND RICE

Treatments	Proline content [µmol g^{-1} FW]	Chlor. a [mg g^{-1} FW]	Chlor. b [mg g^{-1} FW]
A. N, P, K [1]			
50%	10.59	3.69	1.41
100%	13.32	4.10	1.48
F-test	ns	ns	Ns
B. Weed extract[2]			
0%	8.54	4.06	1.59
1%	9.22	4.28	1.61
1,25%	17.90	3.94	1.33
1,67%	13.33	3.83	1.33
2,5%	12.90	3.57	1.47
5%	9.88	3.74	1.32
F-test	ns	ns	ns
%CV	24.96	17.19	14.55

FW = fresh weight; DW = dry weight, Chlor.=chlorophyll content. Values in the same column with different lowercase superscript letters differ significantly at $p \leq 0.05$, according to Duncan's Multiple Range Test. ns = non-significant; ** significantly different at 0.01 probability levels. CV = Coefficient of variation. 1. % of Recommendation dose viz. 50% [N, P_2O_5 and K_2O were 0 kg ha^{-1}, 50 kg ha^{-1} and 25 kg ha^{-1}, respectively] and 100% [N, P_2O_5 and K_2O were 100 kg ha^{-1}, 100 kg ha^{-1} and 50 kg ha^{-1}, respectively]; 2. % of concentration.

However, significant differences in N and P shoot contents varied from 21% – 33% and 2% – 3%, respectively, caused by weed extract application, as shown in Figures 7 and 8. A high N and P shoot content was found in the treatment of 2.5% weed extract concentration about 33.84% and 3.62%. Increasing the application of weed extract of 1.25% and above and the application of 100% N, P, K fertilizers improve N shoot content, as shown in Figure 7. Meanwhile, improving P shoot content happened with the application of weed extract in a concentration of 1.67% and above, as shown in Figure 8.

There was an interaction between N, P, K fertilizers, and weed extract on N shoot content. An increase in the dose of both applications significantly improved N shoot content as

indicated in a strong relationship as shown in Figure 7. But, different doses of N, P, K fertilizers have no effect on P shoot content with or without the application of weed extract. There was a positive response due to the application of weed extract to improve P shoot content.

Application of N, P, K fertilizers in the different recommended doses of 50% and 100% and weed extract in the concentration of 1.25 – 5% improved N shoot content. That indicated the combination treatments of low dose N, P, K fertilizers with weed extract had the potency to increase the accumulation of N in shoot rice plants and reduce the application of synthetic fertilizer.

There had a different response of N, P, K fertilizers, and weed extract applications on P shoot content. A high dose of N, P, K fertilizers could increase the accumulation of P in the shoot rice plant. Nevertheless, increasing the concentration of weed extract improved the P shoot content. Therefore, the application of weed extract had an advantage in improving P content in rice plants in a low dose of N, P, K fertilizers.

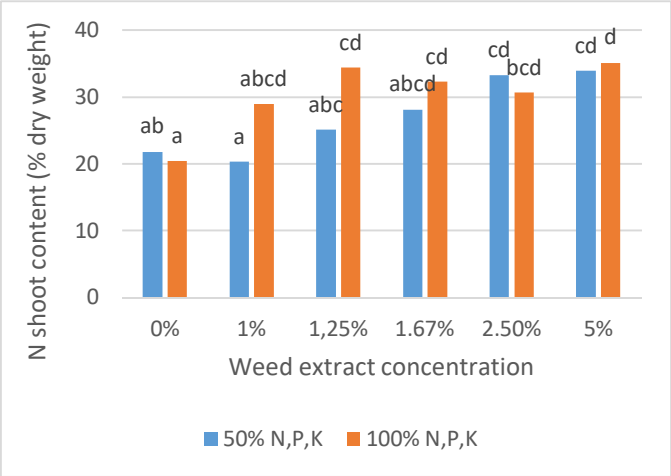

Fig. 7 Effect of N, P, K fertilizers and weed extract applications on N shoot content of upland rice.

C. Yield and Yield Components

Yield components were significantly affected due to N, P, K fertilizers, and weed extract application. The application of 100% recommended dose of N, P, K fertilizers significantly improved the number of productive tillers, weight of grain hill^{-1}, number of grain hill^{-1}, and grain weight ha^{-1} but did not affect the weight of 1000 seeds and number of productive tillers.

The highest result of a number of productive tillers, weight of grain hill^{-1}, number of grain hill^{-1}, and grain weight ha^{-1} obtained in application of 100% recommended dose of N, P, K fertilizers viz. 20.40, 30.03, 1670.21, and 4.80 t ha^{-1}, respectively. But the weight of 1000 seeds [23 g] and the percentage of filled grains [61%] were not affected by the different doses of N, P, K fertilizers, as shown in Table 4. The weight of grain hill^{-1}, number of grain hill^{-1}, weight of 1000 seeds, number of productive tillers, and grain weight ha^{-1} tended to increase in the weed extract application of 2.5% and 5% with the highest results about 34, 1790, 24 g, 64 and 5 t ha^{-1}, respectively as shown in Table 4.

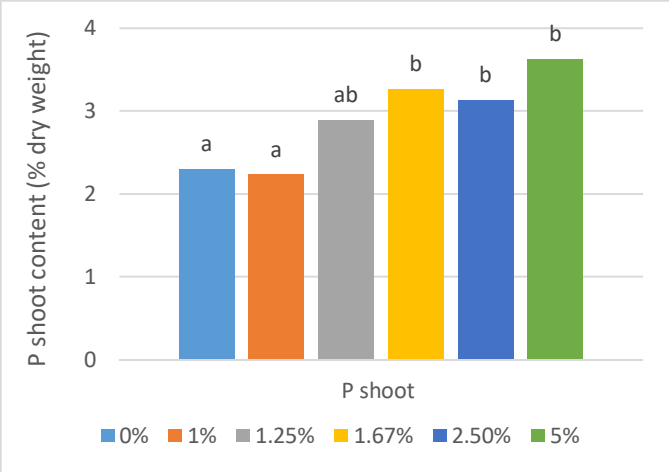

Fig. 8 Effect of weed extract application in different concentrations on P shoot content of upland rice.

There were significant differences in yield components due to the application of high doses of N, P, K fertilizers, and weed extract concentration, but there was no interaction.

TABLE IV
APPLICATIONS OF N, P, K FERTILIZERS AND WEED EXTRACT ON YIELD AND YIELD COMPONENTS OF UPLAND RICE

Treatment	NP	WGH	NGH	W1000	PFG	GW
A. N, P, K[1]						
50%	18.93^{b}	26.76^{b}	1467.32^{b}	23.62	61.65	4.28^{b}
100%	20.40^{a}	30.03^{a}	1670.21^{a}	23.08	60.75	4.80^{a}
F-test	**	**	**	ns	ns	*
B.Weed extract[2]						
0%	18.97	23.52^{c}	1357.43^{c}	22.88^{d}	57.94^{c}	3.76^{c}
1%	19.20	23.89^{c}	1389.99^{c}	22.61^{d}	59.73^{b}	3.82^{c}
1,25%	19.23	23.44^{c}	1424.68^{c}	22.11^{e}	55.38^{d}	3.75^{c}
1,67%	20.00	31.63^{b}	1684.33^{b}	23.60^{c}	64.96^{a}	5.06^{b}
2,5%	19.87	34.34^{a}	1765.98^{ab}	24.66^{a}	64.95^{a}	5.49^{a}
5%	20.73	33.55^{a}	1790.15^{a}	24.24^{b}	64.26^{a}	5.37^{a}
F-test	ns	*	*	**	**	*
%CV	14.49	16.02	15.52	4.18	3.94	16.08

NP= Number of productive tillers; WGH= Weight of grain hill^{-1} [g]; NGH=Number of grain hill^{-1}; W1000=Weight of 1000 grains [g]; PFG=Percentage of filled grains [%]; GW=Grain weight [t ha^{-1}].
Values in the same column with different lowercase superscript letters differ significantly at $p \leq 0.05$, according to Duncan's Multiple Range Test. ns = non-significant; *, ** significantly different at 0.05 and 0.01 probability levels, respectively. CV = Coefficient of variation. 1. % of Recommendation dose viz. 50% [N, P_2O_5 and K_2O were 0 kg ha^{-1}, 50 kg ha^{-1} and 25 kg ha^{-1}, respectively] and 100% [N, P_2O_5 and K_2O were 100 kg ha^{-1}, 100 kg ha^{-1} and 50 kg ha^{-1}, respectively]; 2. % of Concentration.

Application of fertilizer with a dose of 50% N, P, K was able to produce plant growth characters and equivalent to a dose of 100% N, P, K, especially in plant height and leaf area as shown in Table 3. This showed that the application of 50% N, P, K fertilizer was more efficient in producing plant height and leaf area. Upland rice responded application of weed extract by producing the greater shoot and root biomass. Due to a strong relationship between N, P, K fertilizers and weed extract, the application of weed extract was also able to increase the efficiency of using synthetic fertilizers to produce the shoot and root dry weights as shown in Figures 2 and 3.

Natural resources have the potency to explore as an external input in the agricultural system method and no harm to the environment. Appropriate combinations to reduce

synthetic external application must find to maintain crop production and be environmentally safe. Some studies have been done to explore the capacity of natural material on crop performance. Ozpinar *et al.* [18] reported that the application of *Persica vulgaris* (Mill.) leaf extract improved the root and stem growth. The use of natural materials as a biofertilizer could reduce the use of synthetic fertilizers to increase rice production and maintain environmental sustainability [4], such as integrated nutrition management with the application of weeds extract. Moreover, long-term organic farming systems without synthetic fertilizer application improve soil organic carbon and crop production [7].

Secondary metabolites are produced to maintain the cellular functions for physiological processes [19]. There are some chemical content, i.e., alkaloids, phenol, and flavonoid as secondary metabolites in weed extract of *Mimosa invisa* as shown in Table 2. Secondary metabolite contents in *Mimosa invisa* have no interfered with rice growth. The secondary metabolites as allelopathy inside weeds, when converted into extracts, have a different role when applying to plants. The application of weed extract during the plant's growth period was an influence on the yield of upland rice. The presence of secondary metabolites improves adaptability to biotic and abiotic stresses in plants, so it enhances plant growth rate [19]. Secondary metabolites such as phenolic and flavonoid have a function as plant protection against herbivory, pathogenic microbes [20]. Various abiotic stresses and flavonoid support plant growth and development, respectively [19].

Therefore, alkaloid, phenol, and flavonoid availability improved plant performance to obtain optimal growth and avoid pests and diseases. Secondary metabolites in *Mimosa invisa* in the form of extracts were proven to suppress pests and diseases. The level of pest and disease attacks that occurred during the study was very low so that it did not disrupt the growth and development of rice plants.

Application of weed extract at a concentration of 1.67% - 2.5% was gained a higher N shoot content as well as P shoot content as shown in Figures 7 and 8. Also, there had a high impact relation between the application of N, P, K fertilizers, and weed extract on N shoot content. The availability of synthetic fertilizer of N, P, K, along with an increase in the concentration of weed extract, increased N shoot content. Nutrient uptake in plant tissue will affect plant growth and development.

The accumulation of plant biomass is closely related to the accumulation of nutrients in plants. The accumulation of N shoot increased with a higher concentration of *Mimosa invisa* extract and the high application of N-P-K fertilizer. This showed that synthetic fertilizers of N still play an important role in N accumulation in plants even though *Mimosa invisa* extract was given. However, P shoot accumulation showed a different response where the low synthetic fertilizer dosage and the high application of Mimosa invisa extract were able to increase its accumulation in rice plants. The fertilizer doses given will affect the uptake and accumulation of nutrients in plants even though it is supported by other materials to support plant growth and development. Appropriate N, P, K fertilizers application stimulate plant growth and development [21], [22].

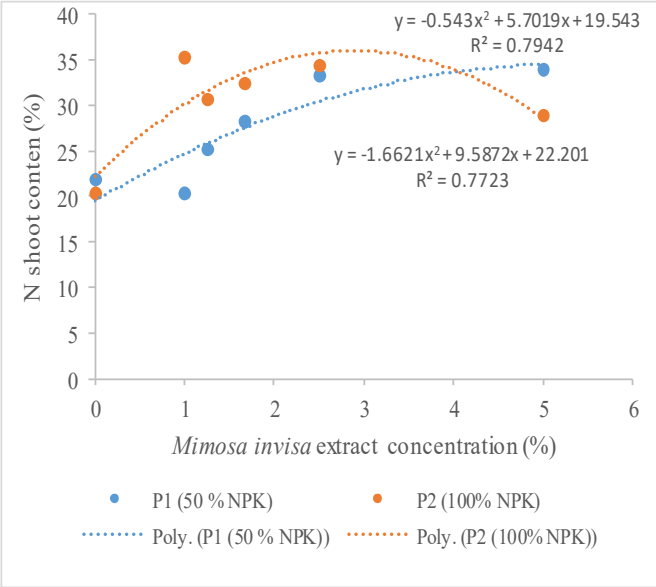

Fig. 9 N shoot content in different doses of N-P-K along with incresing *Mimosa invisa* extract concentration.

Figure 9 shows that the application of 50% and 100% N-P-K recommended doses with the increasing concentration of weed extract increased the N shoot content with almost the same R^2 viz. 0.79 and 0.77, respectively. That revealed the application of N-P-K and weed extracts affected improving the N shoot content. Application of 100% N-P-K recommended dose with 2.88% weed extract gained the optimal N shoot content, but then, the increase in weed extract concentration decreased in the N shoot accumulation. However, the application of 50% N-P-K recommended dosage showed an increase in N shoot accumulation by increasing the concentration of weed extracts. The accumulation of N shoot increased due to higher application of weed extract at low N-P-K dose. Therefore, it indicated an increase in the efficiency of the application of N-P-K fertilizers. Thus, the accumulation of N shoot content reflects the plant biomass and directly contributes to establishing the grain yield.

Biomass dry weight because of plant growth reflects nutrient status and nutrients absorbed by plants. This can occur because photosynthate accumulation in plants is supported by more optimal nutrient uptake. Nutrient quality traits through balanced N, P, and K fertilizers must maintain soil fertility and produce higher plant biomass and grain yield [23]. Therefore, adequate nutrient uptake will encourage the optimum physiological process by which it will increase crop uptake of nutrients and improve the formation of plant organic substances [24]. Plant biomass in seasonal crops such as rice is closely related to seed formation. High biomass will be a source of nutrients distributed to the seeds during seed filling up to harvesting. It was evident that the grain yield shown in Table 4 was supported by high P accumulation, as shown in Figure 8.

Rice leaf biomass contains chlorophyll that is an important part of the process of plant growth and development. Photosynthetic activity is related to leaf chlorophyll content, which, if the levels are low, it will reduce plant productivity in accumulating biomass. Thus, abiotic and biotic environmental stress conditions will affect chlorophyll

contents and photosynthetic activity. Stress conditions will inhibit chlorophyll synthesis in leaves due to decreased photosynthesis rate and finally cause chlorophyll disintegration [25], [26].

One indicator of the level of plant stress is leaf proline content. High proline content indicates that plants are stressed and will interfere with metabolic processes in plants. An increase in stress condition declined chlorophyll content [27] cause inhibits vegetative and generative stages and extensive reduction in its yield [26], [27]. The most important information showed in this study that low N, P, K fertilizers of 50% recommended dose and weed extract applications did not cause plants to stress by indicated in leaf proline and chlorophyll contents as shown in Table 3. An another study stated that weeds extract of *Avena fatua*, *Melilotus officinalis* and *Polypogon hissaricus* significantly increased chlorophyll content [28]. This revealed that the application of weed extract has a role in the physiological process of plants, especially on leaf chlorophyll content as a source of energy through the photosynthesis process; even this study has not shown a significant impact yet.

Weed extract concentrations of 2.5% – 5% produced a high yield of upland rice, as shown in Table 4. The content of alkaloids in weed extracts can act as a supplier of nitrogen that plant roots can absorb into plant tissues. Alkaloids are nitrogen-containing compounds as growth regulators or as mineral bases to maintain ion balance [29]. The application of weed extract of concentration 2.5% – 5% was able to provide a high yield and was a correlation between plant growth and physiological processes. The high number of productive tillers supported optimal crop production in which was related to the amount of grain $hill^{-1}$. Also, high grain weight was supported by the number of filled grains and finally obtained greater the weight of grain as shown in Table 4. Rusdiansyah and Saleh [30] and Liu *et al.* [31] stated that the optimal metabolic process would gain a high yield with filled rice grains.

Grain weight is an indicator of the ability of the sink organ, in which the seeds attract the assimilation of photosynthesis. The greater sink strength will affect the proportion of assimilates that are partitioned in the shoot [32]. The production of photosynthate correlates to the metabolic rate that is affected by phosphorus. Therefore, the high weight of seeds responded to the high uptake of P nutrient with high P shoot content due to weed extracts application by concentrations of 2.5% – 5%, as shown in Figure 8.

This study revealed that plant metabolism was not disrupted due to low N, P, K fertilizers and weed extract, including plant growth, nutrients absorption, and yield. The application of weed extract of *Mimosa invisa* could improve the absorption of plant nutrition and gained a high yield of upland rice even in a low dose of N, P, K fertilizers. Thus, the availability of *Mimosa invisa* is abundant in every dryland area, especially in tropical areas, and of course, it will not be difficult to utilize as an extraction. Also, research related to their effect on soil microbes due to the application of weed extract with the contents of secondary metabolites is interesting to find out, which was not explored in this study. As mentioned by Jacoby *et al.* [33] that secondary metabolite enhancement beneficial to microbes.

Organic farming systems are commonly lower in crop yield than the conventional farming system by the input of synthetic fertilizers and pesticides, but variation is substantial [34]. Based on the philosophical point of view, organic agriculture is a concept about nature and not a biological science [35]. In this study, N-P-K and weed extract applications in the concentration of more than 1.67% gained grain yields of more than 4.0 t ha^{-1} and 5.0 t ha^{-1}, respectively, as shown in Table 4. This result indicated that the application of *Mimosa invisa* extract has the potency to develop as complementary natural resources with a low dose of synthetic fertilizer to gain the optimal crop yield. However, this study was carried out in one season, so further studies must be conducted to explore the deep result to find the pertinent scientific information, and it could make it possible to apply in different concentrations or various crops.

In the future, organic farming systems should be developed to fulfill secure and healthy food demand. As mentioned by [36], organic farming systems through proper application can increase yields that support sustainable agriculture in meeting food needs in the future.

IV. Conclusion

Overall, weed extract of *Mimosa invisa* L. had the opportunity to be developed as a source of nutrition from natural resources in reducing the use of synthetic fertilizers. Through the use of weeds as nutrients for plants will increase its function as a useful biological resource and can be used in agricultural systems. Also, the use of this weed which has large availability in many areas and has not been utilized optimally. Weed extract of *Mimosa invisa* L. with a concentration of 2.5%-5% could increase the efficiency of N, P, K fertilizers dose up to 50% on plant growth characters, N and P shoot contents, and upland rice yield. Therefore, reducing synthetic fertilizers by applying weed extract of Mimosa invisa L. still provides high production and supports an environmentally friendly sustainable farming system.

Acknowledgment

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