# (2)_Nitrogen uptake of SRI paddy field compare to conventional field

*by* Krissandi Wijaya

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# NITROGEN UPTAKE OF SRI PADDY FIELD COMPARE TO CONVENTIONAL FIELD

Ardiansyah[a*], Chusnul Arif[b], Krissandi Wijaya[c]

[a]Department of Agricultural Engineering, Jenderal Soedirman University, Indonesia
[b]Department of Cvil and Environmental Engineering, Bogor Agricultural University, Indonesia
[c]Department of Agricultural Engineering, Jenderal Soedirman University, Indonesia

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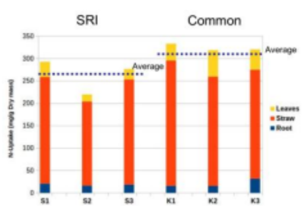
*Corresponding author
ardi.plj@gmail.com

**Graphical abstract**




**Abstract**

The aim of this research is to compare nitrogen uptake in SRI field and conventional paddy field. Three SRI plots and three conventional plots were given same amount of organic fertilizer and three different biochar amount. In SRI field, S1 were plot with 5 ton/ha biochar application, S2 were plot with 10 ton/ha biochar application, and S3 were plot with 20 ton/ha biochar application. Similarly, in conventional paddy field, K1, K2, and K3 were plots with 5 ton/ha, 10 ton/ha, and 20 ton/ha biochar application. Mineral fertilizer were not used in this research. Result shows that, Nitrogen uptake in SRI paddy field (average of 262.9 mg/g Dry mass) were less than Conventional paddy field (average of 323.8 mg/g Dry mass). However, average of the grain weight of 1000 paddy grain shows that grain from SRI field is heavier (average of 20.7 g) than conventional paddy field (average of 19.0 g). Biochar application of 5 ton/ha, for both SRI and conventional fields shows higher result in most of plant parameters (plant height, amount of grain, total weight). SRI method usually shows the high production compare to conventional method. However, in this experiment there is almost no difference in SRI field (3.6 ton/ha) and conventional field (3.7 ton/ha). Plant observation shows that SRI paddy develop good rooting system than conventional paddy field that implies on more nutrient uptake. Soil were suspected to be the cause of low nitrogen uptake in SRI field.

*Keywords*: System of Rice Intensification (SRI), nitrogen uptake, biochar application



## 1.0 INTRODUCTION

Many questioning, why SRI field generally has higher biomass (number of tillers, deep rooting system, crop yields, etc) than conventional field [1]. Where it does get the nitrogen and whether the mechanism is general rule for all type of soils. Nitrogen uptake related to crop biomass production. However it doesn't always connected to higher crop yield. Critics on SRI practice usually lies on the claims that the crop yield should be high, without explaining how, for example, deep rooting system resulting from the practice could increase yield [2].

Biomass and crop yield model has been an interesting subject for researchers for many years. In order to explain how biomass formed and what the involving factors are, model were made. The model describe biomass or crop yield as function of one or more factors. Some biomass model describing biomass growth simply as a function of meteorological factors

[3], another model also involves cultivar and crop management as additional factors influencing biomass [4]. Another model explains that radiation and nitrogen uptake (hence biomass) strongly related. Radiation were observed to be most influencing nitrogen uptake [5]. More specific model from the past considers evapo-transpiration (ET) as main factors that deterimines crop yield [6].

The mechanism of nitrogen uptake has also been evaluated from the point of view of biochemical [7], [8]. While it provide more detail information on the biochemical aspect, it still difficult to transform the mechanism into simple and easily understandable model equations. Thus, there is a need to recognize both SRI and non-SRI practice to understand simple mechanism for subsequent modeling purpose

The aim of this study are to observe nitrogen uptake in SRI and Conventional field and the differences in relating factors during crop growth. The factors is focused on soil nitrogen content and evapo-transpiration.

## 2.0 EXPERIMENTAL

Plot experiment were conducted to observe nitrogen uptake in SRI field and Conventional field. Soil nitrogen dynamic during crop growth were also observed. Three SRI plots (S1, S2, S3) and three conventional plots (K1, K2, K3) were given the same amount of organic fertilizer and three different biochar amount. In SRI field, S1 were plot with 5 ton/ha biochar application, S2 were plot with 10 ton/ha biochar application, and S3 were plot with 20 ton/ha biochar application. Similarly, in conventional paddy field, K1, K2, and K3 were plots with 5 ton/ha, 10 ton/ha, and 20 ton/ha biochar application. Mineral fertilizer were not used in this research.

Weather parameters consist of; radiation, air temperature, air humidity, wind speed, and rainfall were taken from weather station (Davis Vantage Vue-Davis Instrumen Corp.) installed in research location. Soil moisture sensors installed in SRI field in S1 plot. Soil nutrient were analyzed from soil samples taken in the field during crop growth. Total nitrogen (Total-N) and available nitrogen (available-N) were determined in the laboratory. Plant parameters observed were nitrogen content in biomass, crop yield, and grain weight.

## 3.0 RESULTS AND DISCUSSION

### 3.1 Nitrogen Uptake

Figure 1 shows nitrogen uptake per gram of dry mass for three treatments of both SRI field and Conventional field. Visually, it appears that plant biomass in Conventional field has more nitrogen content than SRI field. Nitrogen content in straw seems to be a "difference maker", that influence total nitrogen uptake for both field type. Average of total N-uptake from Conventional field (323 mg/g_dry mass) is larger than SRI field (262 mg/g_dry mass). Straw, root and leaves are biomass formed in vegetative stage, thus it shows that in Conventional field, vegetative growth is higher than SRI field.

Weight of 1000 paddy grain shows that grain from SRI field is more weight (average of 20.7 g) than Conventional field (average of 19.0 g), as in Figure 2.

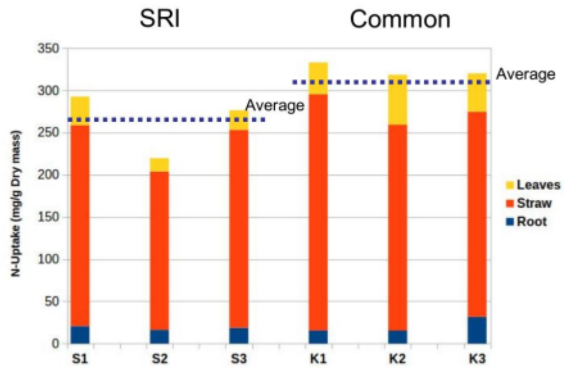



**Figure 1** Nitrogen uptake in SRI field and conventional field

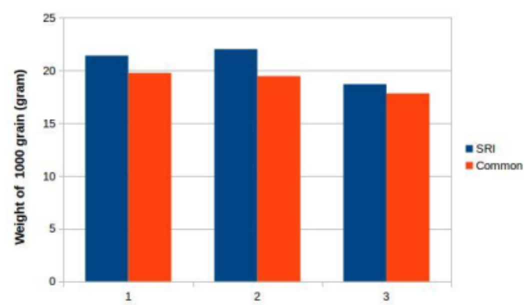



**Figure 2** Comparison of 1000-grains-weight for SRI and conventional field

### 3.2 Soil Nitrogen Content

Total-N and available-N measured from soil samples were observed on each of growth stage. Total-N is the amount of nitrogen that need to decompose to make it available for plant. It range from 0.26 to 0.42 %. Available-N is amount of nitrogen that is ready for plant uptake. It range from 73.46 to 135.2 ppm in this research. Comparison of nitrogen dynamics of conventional field and SRI field is given in Figure 3. The dynamics of nitrogen in soil is a result of decomposition of organic-N, plant nitrogen uptake and nitrogen loss through volatilization and leaching [9]. Either in Figure 3a. (total-N) or Figure 3b. (available-N), amount of nitrogen in conventional field were slightly higher than SRI field. Total-N is increasing in S3 field after fertilizer application, however it decreases below conventional field in the next stage.

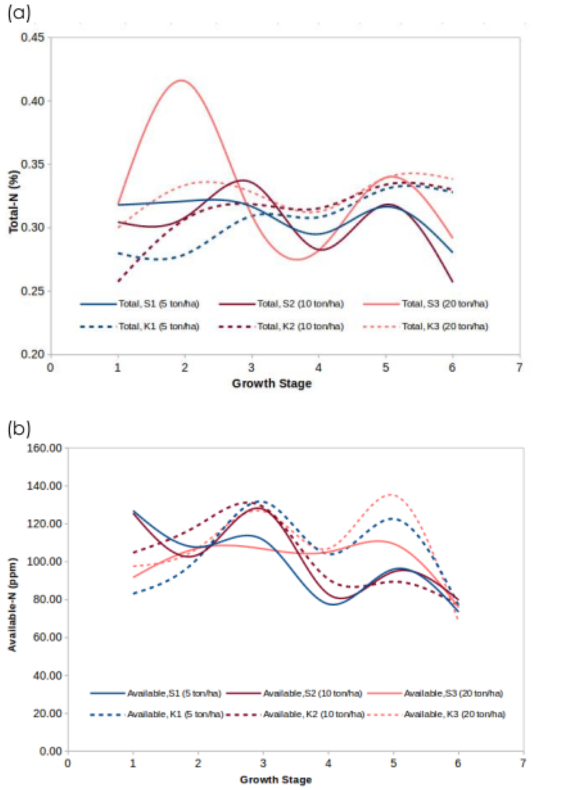



**Figure 3** (a) Soil Total Nitrogen (Total-N) and (b) Available Nitrogen (Available-N) on: 1.Before fertilizer application; 2.After fertilizer application; 3.Day 14; 4.Day 57; 5.Day 85; 6.Day 96(Before harvesting)

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### 3.3 Evapo-Transpiration (ET)

There is difference between evapo-transpiration (ET) in SRI field and Conventional field. Figure 4 Shows that during vegetative growth, ET in Conventional field is larger than SRI field, meanwhile the value is almost similar in generative stage, especially in stage of grain maturity.

The difference among treatments for both SRI field and Conventional field is not shown here. ET in SRI field were calculated using water balance method, considering changes in soil moisture content throughout the day. ET in Conventional field were calculated from Penman-Monteith equation and using FAO crop coefficient [10], assuming in wet condition, ET value is mostly potential.

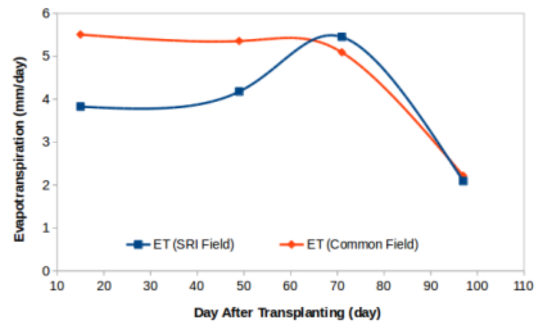


**Figure 4** Evapo-Transpiration for SRI field and Conventional field

### 3.4 Discussion

Crop yield in this experiment shows almost no difference for both SRI field (3.6 ton/ha) and Conventional field (3.7 ton/ha), but still, Conventional field shows higher result. Visual observation in root shows that SRI paddy develops good rooting system than conventional paddy. It implies that SRI paddy was supposed to have more space for higher nutrient uptake. However, the opposite were happened. The yield itself were unlike many other research that showed dramatic increase in biomass and crop yield for SRI field [9], [11]–[13] Comparison for some items observed in both SRI and Conventional field showed in Table 1. The only item that SRI field is higher than Conventional field is Weight of 1000 grains.

Observing Available-N and ET in above data, it can be concluded that both parameters interact simultaneously to create uptake process for paddy. Available-N act as stock factor which determine how much maximum nitrogen can be absorbed by plant root, while ET act as pulling factor which the uptake energy is provided from. Simple if-then conclusion could be made such as; if available-N is enough, and ET is high, than Nitrogen uptake is also high. Conversely, lower available-N and lower ET resulting low nitrogen uptake. Hence, filling the gap between low-high ET and low-high Available-N, the possibilities of nitrogen uptake are presented in Table 2.

**Table 1** Comparison of Items, observed for SRI field and conventional field

| Items Observed | SRI field | Conventional field |
|---|---|---|
| Nitrogen content per gram of dry mass | | v |
| Weight of 1000 grains | v | |
| Soil Available-N | | v |
| Vegetative stage of Evapo-Transpiration | | v |
| Crop Yield | | v |

**Table 2** Possibility of nitrogen uptake considering Available-N and Evapo-Transpiration

| | Available-N Low | Available-N medium | Available-N high |
|---|---|---|---|
| **Evapo-traspiration low** | low | low | low |
| **Evapo-traspiration medium** | low | medium | medium |
| **Evapo-traspiration potential** | low | medium | high |

Available-N is suspected to be the result of aerobic microbial activity. It provides more available-N to soil by decomposing organic-N. The only factor that suspiciously limiting available-N in soil is decomposition rate or mineralization, as the amount of total-N is abundant in soil.

Generally, N mineralization decreases in lower soil moisture especially in dry-air soil [14]. It restrains microbial activities for decomposing organic matter. However, alternate wetting-drying irrigation in SRI field don't create dry-air soil. Soil were drying to certain level of moisture content that still tolerable for plant to grow well. The possibility is now lies on biochar application. Biochar application to soil were reported to reduce $N_2O$ emissions. In addition to biochar application, soil aeration may also contribute to the suppression of $N_2O$ release [15]. In the nitrogen cycle, $N_2O$ emission comes from mineralized Organic-N that finally released into air. Reducing $N_2O$ emissions means decreasing in nitrogen mineralization.

Soil in SRI field develop cracks when drying, which means it shrinking. The shrinking causes void ratio reduces and makes the air difficult to enter (low aeration) [16]. Different from soil without shrinking-swelling properties, reducing moisture content still maintain it void ratio and spare some pore spaces for aeration. Thus, the soil condition in SRI field is soil with biochar application and low aeration. There is challenging question to understand aerob-anaerob or shrinking-swelling condition in SRI field related to available-N.

Evapo-Transpiration is always in potential value during vegetative stage, because soil is sufficiently wet for paddy to grow. However, there is a difference in ponding and non-ponding evaporation for Conventional and SRI field. There is also possibility of difference in fraction of Evaporation and Transpiration for both SRI and Conventional field that make most SRI practice resulting higher biomass and yield. Although evapo-transpiration in Conventional field higher during vegetative stage, this research shows only slight difference in crop yield.

## 4.0 CONCLUSIONS

It is shown that nitrogen uptake is a product of soil nitrogen availability and evapo-transpiration. High nitrogen uptake is usually a result of high evapo-transpiration that brings soil nutrition to leaves. However the available-N in soil act as limiting factors for nitrogen uptake. Slight difference in available-N for SRI and Conventional field and its respective crop yields confirms the hypothesis. It is still unkown the effect of shifting from anaerob-aerob or shrinking-swelling combine with biochar applicaition to nitrogen availability.

## Acknowledgement

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# (2)_Nitrogen uptake of SRI paddy field compare to conventional field

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