Interaction between Seed Rates, Weed Population and Yield Performance of Field Grown Irrigated Rice Variety *Cv. At362*

K. Fasmiya[1], W.G.R.S. Somarathna[2], M.N.F. Nashath[3] and A.N.M. Mubarak[4]

[1,3,4]*Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka, Oluvil, Sri Lanka*
[2]*Rice Research Institute, Sammanthurai, Sri Lanka*

[1]fasmiyak2@gamil.com, [2]somarathnarukman@gmail.com, [3]nasath17.mn@seu.ac.lk, [4]anmubarak@seu.ac.lk

Abstract

Rice (Oryza sativa L.) is an important economic food crop in Sri Lanka. Weeds are a major constraint to the success of rice production. Crop-weed competition has a profound effect on the grain yield of rice. However, using herbicides alone may not be considered sustainable in the long term. Hence, a field experiment was conducted at Rice Research Station, Sammanthurai to study the interaction between seed rates - weed population and yield performance of field-grown At362 rice variety. The treatment (T) consisted of six seed rates viz; 2 bushel/ac, 2.5 bushel/ac (as control), 3 bushel/ac, 3.5 bushel/ac, 4 bushel/ac and 4.5 bushel/ac. The field experiment was laid out in Randomized Complete Block Design (RCBD) with 6 treatments having 3 replications. Field data were collected on weed populations, rice crop growth and yield parameters throughout the cultivation season under field conditions. According to the results, plant height, the number of leaves per plant, root length, panicle length and number of panicles were significantly ($p<0.05$) affected by different seed rates. Lower seed rates resulted in increased values for the above-tested parameters in the At362 rice plant. Sedges were the most dominant weeds in this field plot compared to grasses and broad leaves. However, no significant differences were observed in the yield and weed population ($p>0.05$). Further research in various seasons and regions can offer a more thorough comprehension of the relationship among rice seed rates, weed dynamics, and yield.

Keywords: At362, Grasses, Oryza sativa L., Panicle, Sedges, Seed rates

I. INTRODUCTION

The rice (*Oryza sativa* L.) is one of the most important food crops in the world with 40 % of the world population depending on it. In Sri Lanka, rice is a staple diet food where 1.8 million farm families are engaged in paddy Cultivation Island-wide (Senanayaka and Premaratna, 2016). On average 560,000 hectare (ha) are cultivated during the *Maha* season and 310,000 ha during the *Yala* season making the annual extent sown with rice to about 870,000 ha (Department of census and statistics, 2022). Ampara district is a prominent rice-growing region in Sri Lanka, and a total of 136,036 hectares of paddy was planted largely using the At-362 and Bg-94-1 owing to its superior agronomic and yield features (Mubarak *et al*., 2022).

There are various obstacles to rice production, including limited soil, nutritional shortages, insect and diseases problems and water availability. One of the major biological constraints is weeds which leads to considerable amount of yield losses (Savary *et al*., 2000). Depending on the type of weeds, infestation level, establishment methods and weed management approaches, typical yield losses due to weed infestation in rice can range from 40 to 60 percent, with certain cases reaching 94-96 percent (Monira *et al*., 2022). *Echinochloa* spp. (barnyard grass), *Cyperus* spp. (nutgrass), *Leptochloa chinensis* (red spangletop), and *Ludwigia* spp. (water primrose) are some of the primary weeds in rice production in the country (Rajapakse *et al*., 2011). Herbicides for weeds are now widely used by farmers, harming the Environment and people's health as well as having the potential to breed resistant populations (Liebman *et al*., 2016). Therefore, it is important and encouraged to manage the weeds using environmentally friendly, sustainable methods.

The seed rate is considered one of the most agronomic factor for uniform growth of the rice production (Kassam *et al*., 2011). The interaction between seed rate and weed growth is complex and is affected by a number of factors, including the type of rice grown, local environmental circumstances, and weed species composition (Mahajan, Singh and Chauhan 2012). Higher rates, in general, result in increased plant density and faster canopy closure, which may restrict weed growth by lowering the available space and light for weeds to establish and thrive (Chauhan and Singh Mahajan 2012). A densely populated rice canopy can shade away developing weeds, restricting their growth and reproductive capacity. Excessive seed rates, on the other hand, can cause overcrowding and resource competition among rice plants, resulting in poor tillering, diminished panicle development, and ultimately, lower grain yield (Akilu, 2020). Furthermore, if the rice canopy does not shut rapidly due to poor early development, weeds may be able to sprout and grow, even in high-density plantings. Therefore, this study was aimed to evaluate the interaction between seed rates, weed population and growth and yield performances of field grown *cv*. At362 rice variety in Ampara district of Sri Lanka.

II. MATERIALS AND METHODOLOGY

A. Study Area

The field experiment was conducted at the Rice Research Station in Sammanthurai located at Ampara district (7°21'18.4"N; 81°46'38.2"E) during the *Yala* season (April to August) in 2022. The mean annual temperature of this area is 27 °C to 30 °C and annual precipitation is between 1500 mm to 2225 mm. Soil type is non-calcic brown which contains sand with slightly acidic soil.

B. Planting Materials and Field Conditions

The rice variety *cv*. At362 was selected to conduct the trial since it is the most popular and high yielding rice variety in Ampara district (Sewwandi *et al*., 2023). At-362 was sown (Broad casting method) at different seed rates on April 2022. Before sowing the plot was kept weed-free conditions by hand weeding. Land was ploughed before sowing and then harrowed. Each treatments were prepared 6 m x 3 m field plots and replicated three-times. Paddy seeds were soaked in water at 24 hours for germination after that soaked seeds were removed from water and were sown in six different seed sowing rates (2.0 Bu/ac (T1), 2.5 Bu/ac (T6 Control), 3.0 Bu/ac (T2), 3.5 Bu/ac (T3), 4.0 Bu/ac (T4) and 4.5 Bu/ac (T5)). Field management practices such as irrigation, fertilizer application were done according to the Depatment of Agriculture (DOA) recommendations. Basal application of fertilizer rate of 1782 g /18 m^2 comprised Urea, Muriate of Potash (MOP), Triple super phosphate (TSP) were broadcast uniformly and incorporated into soil plots. Except urea, all other fertilizers were applied before rice sowing, and Urea was top dressed in three installments at 15, 30 and 45 days after sowing. The field plots were maintained under weed condition.

C. Data Collection

1) Growth and Yield Parameters of Rice Plant

Plant height (cm), root length (cm), and number of leaves/plant were recorded at 6 (vegetative stage), 8 (reproductive stage) and at 10 WAS (ripening stage). Plant height was obtained by measuring the main stem length from ground level to the tip of leaves using meter scale (Sivaneson and Vijayakumari, 2019). For root length measurement, the length of the longest root was measured from the base of the culm to the tip of the longest root using a scaled ruler (Himasha *et al*., 2022). At harvest, the panicle length (cm) was measured using scale ruler and grains per panicle (filled and unfilled grain) was counted and thousands grains weight was measured using electronic balance. All the above data were collected from 10 randomly selected plants in each plot. Finally, grain yield was determined from harvested area in each plot by avoiding the edge-effect of the field. Dry weights were determined by placing the plant samples inside an oven at 80 °C for 72 hours until a constant weight was observed.

2) Growth Measurements of Weeds

The weed density (weeds/m^2) was counted 6 and 10 was using 50 cm x 50 cm quadrate by randomly placing it in three places of each plot. The dry weight (g) of weeds samples were determined at 80 °C for 72 hours until a constant weight was observed.

D. Data Analysis

Statistical analysis for the collected data was performed using SPSS software (version 25) using the analysis of variance (ANOVA). To determine whether there was a significant difference between the treatment means at 0.05 probability levels, the Tukey's post-hoc test was used.

III. RESULTS AND DISCUSSION

A. Effects of Seed Rates on Plant Height

Rice plant height was significantly varied among treatments at 6, 8 and 10 WAS ($p<0.05$). The

Proceedings of Papers, 3rd International Conference on Science and Technology
Faculty of Technology, South Eastern University of Sri Lanka
e-ISBN: 978-955-627-022-8

tallest plants were observed in T 2 (44.7 cm) at 6 WAS, while, the T4 reached (71.5 cm) at 8 WAS. Meanwhile, at 10 WAS, treatments T2 (73.6 cm), T5 (73.9 cm) and T6 (73.1 cm) resulted the highest plant heights. Conversely, T 3 had the shortest plants. Accordingly, the lower seed rate increased the plant height during early stages, conversely, 10 WAS, taller plants were observed in higher seed rates (Table 01).

B. Effect of Seed Rate on Number of Leaves/Plant

The number of leaves produced on the main culm of the rice plant was significantly differed among treatments (p<0.05). Highest number of leaves were produced by T 1 and T 6 (control) compared to other treatments during all three times (Table 02).

C. Effect of Seed Rate on Rice Plant Root Length

Lengthier root system contributes to the rice plant in obtaining water and nutrients from deeper soil layers (Himasha *et al*., 2021). Root length of plant was significantly affected (p<0.05) by different seed rates at 6 and 10 WAS. The root length progressively increased from 6 th, 8 th and 10th WAS. At 10 WAS, all the treatments except the control resulted significantly increased root length. Among those treatments, T2 (9.4 cm) and T3 (9.5 cm) had the highest root lengths (Table 03).

D. Effect of Seed Rate on Number of Weeds /m ^{2}

Three types of weeds were identified in the experimental field including the grasses: (Barnyard grass, *Isachne globosa*, *Echinochloa galabrescenns*, *Ischaemum rugosum*), broad leaves: Water cloves, *Commelina diffusa* and sedges: *Cyperus irrialinn*, *Cyperus rotundus*, *Fimbristylis miliacea*, *Cyperus difformisli*.

The most prominent type was *Cyprus sedges* in this field. There was no significant variation (p>0.05) in weed levels between treatment combination. However, the weed population was higher in the early stages of crop establishment (6 th WAS), than in the subsequent rice growth stages (10 th WAS). Similar trends were observed for sedges and grasses. Moreover, sedges were particularly prominent in the experimental field, and even in the 10 th WAS the sedge population was higher (Table 04).

Table 01: Plant Height at 6th, 8th and 10th Weeks after Field Sowing of Rice Variety *cv*. At-362

Treatment	Plant height (cm)		
	6 WAS	**8 WAS**	**10 WAS**
T1	40.63±1.0^{b}	69.40±1.1^{ab}	70.60±1.6^{ab}
T2	44.73±0.8^{c}	71.26±1.9^{b}	73.63±1.9^{b}
T3	35.86±0.6^{a}	62.13±2.4^{a}	66.33±1.5^{a}
T4	40.10±0.1^{b}	71.56±1.9^{b}	72.20±1.9^{ab}
T5	40.40±0.9^{b}	67.56±1.4^{ab}	73.96±1.0^{b}
T6 (control)	41.20±0.8^{bc}	66.43±1.8^{ab}	73.16±2.0^{b}
CV	13.70%	15.40%	13.30%
P	0.001	0.001	0.001

Values shown are mean ± S.E. Means with different letters across the column represent significant differences at Tukey's p <0.05.n=30

Proceedings of Papers, 3rd International Conference on Science and Technology
Faculty of Technology, South Eastern University of Sri Lanka
e-ISBN: 978-955-627-022-8

Table 04: Effect of Seed Rate on Weed Population (Number of Weeds/m^2)

Treatment	Broad leaves/m^2		Sedges/m^2		Grasses/m^2	
	6 WAS	10 WAS	6 WAS	10 WAS	6 WAS	10 WAS
T1	17.3±4.8[a]	8.6±6.1[a]	158.6±32.8[a]	149.0±52.2[a]	36.0±2.3[a]	10.0±2.0[a]
T2	28.0±6.1[a]	1.0±0.5[a]	240.0±32.8[a]	140.3±38.5[a]	30.6±4.8[a]	9.6±2.0[a]
T3	32.0±8.3[a]	2.6±1.1[a]	149.3±35.9[a]	137.3±74.8[a]	26.3±1.6[a]	11.3±2.9[a]
T4	12.0±0.0[a]	7.3±4.0[a]	132.3±7.2[a]	114.6±17.4[a]	33.3±10.9[a]	13.0±5.0[a]
T5	28.0±18.0[a]	14.6±13.6[a]	118.6±24.9[a]	99.0±34.0[a]	34.6±18.6[a]	17.3±0.6[a]
T6 (Control)	13.3±1.3[a]	7.3±5.4[a]	120.0±16.6[a]	102.0±21.0[a]	24.0±8.3[a]	27.3±9.5[a]
CV	69%	84%	37.80%	66%	46.70%	14.80%
P	0.475	0.762	0.072	0.941	0.936	0.141

Values shown are mean ± S.E. Means with different letters across the column represent significant differences at Tukey's $p<0.05$. n=30

Table 05: Panicle and Yield Characteristics of Paddy under Different Seed Rate

Treatment	Panicle length (cm)	Total grains / panicle	No of filled grains/ panicle	No of unfilled grains /panicle
T1	19.58±0.42[a]	85.96±5.06[a]	62.70±4.14[a]	23.33±2.01[a]
T2	18.31±0.54[bc]	67.36±5.67[ab]	50.13±4.50[abc]	17.23±1.66[ab]
T3	17.18±0.39[ab]	52.90±3.25[c]	36.0±2.88[c]	16.90±0.94[ab]
T4	16.31±0.57[b]	53.80±4.75[c]	58.33±3.49[ab]	15.46±1.85[c]
T5	18.30±0.35[bc]	68.23±4.49[ab]	51.20±3.14[bc]	17.03±1.8[ab]
T6 (control)	19.78±0.38[a]	82.26±4.57[b]	63.01±3.47[a]	19.26±1.3[ab]
CV	14.90%	41.30%	44.50%	51.30%
P	0.01	0.01	0.01	0.02

Values shown are mean ± S.E. Means with different letters across the column represent significant differences at Tukey's $p<0.05$. n=30

Table 06: Mean Yield and Biomass Features of Rice Plant Biomass Production

Treatment	1000 grain weight (g)	Straw weight (g/10 stem)	Grain yield (kg/12m^2)
T1	21.98±1.47[a]	4.93±0.32[a]	3.74±0.34[a]
T2	27.48±6.50[a]	5.66±0.31[a]	3.83±0.06[a]
T3	20.58±0.76[a]	5.06±0.92[a]	3.56±0.58[a]
T4	21.78±0.81[a]	5.23±0.31[a]	3.21±0.45[a]
T5	23.15±1.97[a]	5.0±0.75[a]	4.43±0.42[a]
T6 (Control)	18.63±5.16[a]	4.83±0.37[a]	3.66±0.10[a]
CV	24.60%	14.20%	17.64%
P	0.55	0.83	0.4

Values shown are mean ± S.E. Means with different letters across the column represent significant Differences at Tukey's $p<0.05$. n=30.

E. Effect of Seed Rate on Rice Grain Characteristics

All the tested panicle characteristics were significantly affected by seed rates ($p<0.05$).

Higher panicle length and number of filled grains per panicle were recorded in T 1 (19.5 cm and 62.7 respectively) and control (19.7 cm and 63.0 respectively). Meanwhile, T 1 resulted the highest total number of grains per panicle (86) and unfilled grains per panicle (23.3) compared to other treatments. In contrast, T 3 and T 4 recorded the lowest values for the panicle parameters (Table

Proceedings of Papers, 3rd International Conference on Science and Technology
Faculty of Technology, South Eastern University of Sri Lanka
e-ISBN: 978-955-627-022-8

05). The result indicates that increased seed rates reduced the panicle length and grain numbers.

Grain yield is a complex character which depends on several factors (Begum Pavithra and Mubarak 2018). There was no significant effect on the biomass and yield of rice plants in the present study. Phuong *et al*. in 2005 demonstrated that raising the seed rate strengthens the crop's ability to suppress weeds and increases crop yields by reducing weed densities in low-land rice. In a previous study, Gunawardana *et al*. (2013) conducted a field experiment with rice variety Bg300, under aerobic conditions with three seed rates (100, 150, and 200 kg/ha) and reported that larger seed paddy rates (150 and 200 kg/ha) resulted in lower grain yield (0.49 and 0.33 t/ha, respectively) than the recommended seed rate (100 kg/ha). Furthermore, the rate of seed paddy used had no effect on the number of seeds per panicle of rice plants ($p>0.05$). Field experiments sown with 100 kg/ha and 200 kg/ha produced statistically identical results, however plots sown with 150 kg/ha produced considerably lower full grain% than the other seed rates. Among the treatments utilized, application of 3,4 dichloropropionanilide or bispyribac sodium at the recommended dosage at the weed's 2/3 leaf stage, paired with the recommended rate of seed paddy at 100 kg/ha, is an effective integrated weed management approach for *E. colona* control in aerobic rice.

IV. CONCLUSION

The current study found substantial differences in the plant height, number of leaves, root length, panicle, and grain properties of the At362 rice variety. Notably, lower seed rates including the recommended rate performed better in terms of plant growth indices and panicle characteristics; as a result, decreasing seed rates positively influenced the number of grains and filled grain percentages. However, no significant differences were observed in weed populations and rice plant yield among different seed rate treatments.

REFERENCES

Begum, S.L.R., Pavithira, E. and Mubarak, A.N.M. (2018) " Contribution of growth and physiological characteristics in yield of field grown rice varieties in low country dry zone", Proceedings of 8th International Symposium, SEUSL, pp.197-204.

Chauhan, B.S., Singh, R.G. and Mahajan, G. (2012) " Ecology and management of weeds under conservation agriculture: a review", Crop Protection, 38, pp.57-65.

Department of census and statistics Sri Lanka, (2022), http://www.statistics.gov.lk/ Accessed on 17.07.2023.

Gunawardana, W.G.N., Ariyaratne, M., Bandaranayake, P. and Marambe, B. (2013) " Control of Echinochloa colona in aerobic rice: effect of different rates of seed paddy and post-plant herbicides in the dry zone of Sri Lanka", In Weed Science Society Conference October 22-25, 2013, Bandung Indonesia. pp. 431-437.

Himasha, P.S.S., Millawithanachchi, M.C., Nashath, M.N.F. and Mubarak, A.N.M. (2022) "Screening of rice germplasms for superior root, shoot morphologies and dry matter productivity under anaerobic conditions in Sri Lanka", In 10TH YSF SYMPOSIUM, pp. 311.

Himasha, P.S.S., Millawithanachchi, M.C., Nashath, M.N.F. and Mubarak, A.N.M. (2021) " Evaluation of root morphology of selected rice varieties under anaerobic and aerobic conditions in Sri Lanka" 10th Annual Science Research Sessions 2021 (ASRS-2021). pp. 7-9

Kassam, A., Stoop, W. and Uphoff, N. (2011)" Review of SRI modifications in rice crop and water management and research issues for making further improvements in agricultural and water productivity", Paddy and Water Environment, 9, pp.163-180.

Liebman, M., Baraibar, B., Buckley, Y., Childs, D., Christensen, S., Cousens, R., Eizenberg, H., Heijting, S., Loddo, D., Merotto Jr, A. and Renton, M. (2016) " ecologically sustainable weed management: how do we get from proof-of-concept to adoption?" Ecological applications, 26(5), pp.1352-1369.

Mahajan, G., Singh, S. and Chauhan, B.S. (2012) " Impact of climate change on weeds in the rice-wheat cropping system", Current science, 102(9), pp.1254-1255.

Monira, S., Ali, M.I., Sarker, U.K., Begum, M. and Uddin, M.R. (2022) " Floristic divergence of weeds in rice fields under subtropical condition", Archives of Agriculture and Environmental Science, 7(3), pp.450-462.

Mubarak, A.N.M., Musthapha, M., Roshana, M.R. and Kumara, A.D.N.T. (2022) " Influence of canopy architecture on the light interception, photosynthetic and biomass productivity in irrigated elite Sri Lankan rice varieties", The Journal of Agricultural Sciences-Sri Lanka, 17(1), pp.148-160.

Phuong, L.T., Denich, M., Vlek, P.L.G. and Balasubramanian, V. (2005) "Suppressing weeds in direct-seeded lowland rice: Effects of methods and rates of seeding", Journal of Agronomy and Crop Science, 191(3), pp.185-194.

Rajapakse, R., Chandrasena, N., Marambe, B. and Amarasinghe, L. (2011) " Planning for effective weed management: lessons from Sri Lanka", In 23rd Asian-Pacific Weed Science Society Conference. Volume 2: weed management in a changing world, Cairns, Queensland, Australia, 26-29 September 2011 pp. 116-126.

Savary, S., Willocquet, L., Elazegui, F.A., Castilla N.P. and Teng, P.S. (2000) "Rice pest constraints in tropical Asia: quantification of yield losses due to rice pests in a range of production situations", Plant disease, 84(3), pp.357-369.

Sewwandi, M.C., Somarathna, W. G. R. S., Mubarak, A. N. M., Nashath, M. N. F. and Kumara, A. D. N. T. (2023) " Evaluating the growth and yield performances of selected rice (Oryza sativa L.) varieties grown in organic fertilizer", AGRIEAST, 17(1), pp. 54-67.

Sivaneson, S. and Vijayakumari, V. (2019) " Impact of different depths of transplanting by machine transplanter on growth and yield performance of rice variety (Bw 361)", *Journal of Dry Zone Agriculture*, 2(1), pp.417-424.