Journal of Dry Zone Agriculture, 2019, 5(2): 26-32

ISSN 2012-8673

Effect of *Azolla filiculoides* Application on Weed Population in Paddy Fields

Sivaneson, S. and Ponnegippenthiraraja, A.
Rice Research Station, Department of Agriculture, Paranthan, Sri Lanka.

Abstract: The integrated use of organic and inorganic fertilizers is desirable to sustain paddy cultivation. Study was conducted at Rice Research Station, Paranthan, Sri Lanka to develop effective weed control method to gain economic return from irrigated paddy fields in the Dry Zone. The experiment was carried out during the period of November-February, 2017 (*Maha*), using randomized complete design with six treatments with three replicates; *Azolla* only, *Azolla* with three nitrogen levels (25%, 50%, 100% kg N/ha) of the recommended level of nitrogen, only recommended level of nitrogen (100 kg N/ha) and plot with absence of chemical fertilizer and *Azolla* (control). The nutrients potassium and phosphorus were applied to respective plots based on the recommended level. Results showed partial suppression of weed growth by *Azolla filiculoides* even under full plot area coverage. The range of weed suppression at rice 30 days after planting was 64.21 - 88.31%. However, *Azolla* failed to suppress the growth of some weeds such as *Aeschynomene indica, Ipomoea aquatic* and *Cyperus iria*. Plots with combined application of *Azolla* and different levels of nitrogen fertilizer revealed greater value for weed control efficiency the range of 76.81 – 80.93%. There was no significant difference in the yield in plots treated with *Azolla* + recommended level of N fertilizer, *Azolla* + 50 kg/ha recommended level of N fertilizer (6066 and 5966 kg/ha respectively) and only recommended level of N fertilizer without *Azolla* (5533 kg/ha). Therefore the use of *Azolla* in the rice cultivation has greater influence on suppressing the weeds and also reduces the nitrogen fertilizer and herbicides application requirements.

***Keywords*:** *Azolla*, Fertilizer, Nitrogen, Suppress, Weeds.

Introduction

Azolla has not been used traditionally as a green manure in Sri Lanka and has remained a mere botanically curiosity until recently. Research on *Azolla* in relation to rice cultivation began in the mid 1970 and a primary investigation revealed that, it could increase the rice yield. Using *Azolla* biomass as a bio fertilizer to replace artificial nitrogen fertilizer reduces pollution by nitrogen losses of rice cultivation and provides added value to farmers (Mishra and Dash, 2014).

With increasing cost of fertilizer, the cost of this input in rice cultivation is becoming problematic, as fertilizers

Corresponding author: S. Sivaneson, ssivaneson@yahoo.com

alone are reported to cost 40 to 50% of the total input. In order to decrease the cost towards fertilizer, organic fertilizers like *Azolla* can be substituted for chemical fertilizers. Use of organic fertilizer mobilizes cheap resources for productive purpose replacing high cost chemical fertilizers. One crop of *Azolla* provided 20 - 40 kg N/ha to the rice crop in about 20-25 days as reported by Watanabe *et al*. (1977). Singh *et al.* (1984) also reported that, the expenditure involved in production of inoculum + *Azolla* dual cropping, supplying almost 30 kg N/ha in rice field was lower price than the cost of 30 kg N/ha as urea.

Two incorporations of *Azolla* (grown in dual culture with rice) during a single crop cycle, resulted in grain yields equivalent to fields that received 55 to 84 kg N/ha of chemical nitrogen fertilizer (Kulasooriya *et al*., 1984). *Azolla* in dual culture with rice also brought about a 50 % reduction in weed growth. It increased rice yields 14 % and reduced weed growth 34 % in broadcast seeded rice, increased yield 22 % and reduced weed growth 52 % in transplanted rice, and increased yield 47 % and reduced weed growth 43 % in row-planted rice (Kulasooriya *et al*., 1984).

The most widely used system is to raise *Azolla* in rice paddies, by floating *Azolla* in the paddy prior to rice planting, the water is drained after 6–8 weeks and *Azolla* is subsequently ploughed into the soil. This improves the soil quality by increasing organic-nitrogen levels, improving water-holding and cation-exchange capacities of the soil (Hill and McConnachie, 2009). Therefore, the aim of this study is to find out the effect of application of *Azolla* on weed growth and nitrogen use efficiency of irrigated rice in the Dry zone.

Materials and methods

Plot size of the experiment was 6 m × 3 m. Rice variety Bg300 was used. Experiment comprises 06 treatments with thee replicates as

T1: Absence of *Azolla* and chemical fertilizer as control

T2: *Azolla* only

T3: *Azolla* with application of 25 % recommended N fertilizer

T4: *Azolla* with application of 50% recommended N fertilizer

T5: Only recommended N fertilizer (100 kg N/ha)

T6: *Azolla* with recommended level of N fertilizer (100 kg N/ha).

The department of Agriculture recommended doses of K_2O: P_2O_5 at 35: 25 kg/ha were applied in the form of muriate of potash (MOP) and triple super phosphate (TSP) to all the treatments. Raised nursery bed was established, and fifteen days old seedlings were manually transplanted with the row spacing of 15 x 15 cm. At 3 days after planting, *Azolla filiculoides* was inoculated at a rate of 200 g fresh weight/m^2. Well grown *Azolla* mat in the plots was incorporated into the soil by Cono weeder at 20 and 40 days after planting (DAP) except treatment T1.

Data and statistical analyses

Five quadrate (30 × 30 cm) were sampled in each plot at vegetative (30 DAP) stage. Collected weed species by using a quadrant from each plot were identified, listed, grouped (grass, broadleaf and sedges) and counted. Collected weeds were washed, sorted by species, stages and expressed as number/m^2. Also the dry weight of the weed was recorded at 30 DAP. Data on weed density and weed dry weight were transformed using square root transformation. Paddy yield (kg/ha) of each plot was also recorded. Data were subjected to analysis of variance (ANOVA) using the SAS statistical software 9.2. Significant differences among means were separated using Least Significant Difference (LSD) test at 5% level of probability.

Weed indices

Weed indices were computed using the standard procedure according to Misra and Misra (1997) and Devasenapathy (2008) as follows:

Weed persistence index (WPI)

This index indicates the resistance in weeds against the tested treatments and confirms the effectiveness of the Azolla on weed control, using the given formula by Misra and Misra (1997)

$$WPI = \frac{Weed\ biomass\ of\ treated\ plot}{Weed\ biomass\ of\ control\ plot} \times \frac{Weed\ density\ of\ control\ plot}{Weed\ density\ of\ treatedplot}$$

Weed control efficiency (WCE)

Weed control efficiency measures the efficiency of any weed control treatment in comparison to weedy treatment (Mani *et al*., 1973: Das, 2008) as follows;

$$WCE = \frac{weed\ population\ control\ plot\ -weed\ population\ in\ treated\ plot}{weed\ population\ in\ control\ plot} \times 100$$

Weed management index (WMI)

This index is the ratio of yield increase over the control because of weed management and percent control of weeds by the respective treatment (Misra and Misra, 1997).

$$WMI = \frac{Precent\ yield\ increase\ over\ control}{Percent\ control\ of\ weeds}$$

Weed control index (WCI)

To compare the different treatments of weed control on the basis of dry weight, weed control index (WCI) was calculated (Mani *et al*., 1973: Das, 2008) as follows;

$$WCI = \frac{Dry\ weight\ of\ weeds\ in\ control\ plots - Dry\ weight\ of\ weeds\ in\ treated\ plots}{Dry\ weight\ of\ weeds\ in\ control\ plots} \times 100$$

Results and Discussion

Weed occurrence

All three major weed groups; grasses, broadleaves and sedges were recorded. *Echinochloa colonum*, *Echinochloa glabrescens* and *Leptochloa chinensis* as grasses; *Ipomoea aquatica*, *Monochoria viginalis* and *Aeschynomene indica* as broad leaves; and *Cyperus iria* and *Cyperus difformis* as sedges. Altogether, broad leaf weeds *Aeschynomene indica* and *Ipomoea aquatica* were predominant, followed by sedges, especially, *Cyperus iria* in the experimental field. Sivakumar *et al*. (1999) reported that, the addition of *Azolla* in rice fields suppressed the weeds such as *Echinochloa crusgalli* and *Cyperus difformis* and the degree of suppression increased with the increase in percentage of *Azolla* cover and water depth.

Weed Density

Emergences of grasses, broad leaves and sedges were shown significant (p<0.05) decrease in the *Azolla* treated plots compared with, only recommended level of nitrogen fertilizer (T5) and without *Azolla* and chemical fertilizer plots (T1) at 30 DAP (Table 1). Without *Azolla* and chemical fertilizer plot (T1) recorded maximum number of weeds per plot followed by only recommended level of nitrogen fertilizer (T5). As well, the lower weed density was recorded in *Azolla* with recommended level of nitrogen (T6). It is evident from this experiment that *Azolla* treated plots were significantly reduced the weed population that ranged from 64.21 % - 88.31 % at vegetative stage compared with the without *Azolla* and chemical fertilizer treatment. This reduction may be due to the dense mat of *Azolla* which developed a few days after inoculation and effectively reduced the light available for weed growth (Gnanavel and Kathiresan, 2002). However, among the *Azolla* treated plots, weed emergence were observed, due to the needle like leaves that easily pierce the thick *Azolla* mat (Singh *et al*., 1984; Satapathy and Singh, 1985).

Weed Control Efficiency

The values of weed indices are presented in table 2. Application of *Azolla* gave higher weed control efficiency (WCE), weed management index (WMI), weed control index (WCI) and lower weed persistency index (WPI), than the other treatments. However, higher weed density was in without *Azolla* and chemical fertilizer resulted in highest WPI, and lower WCE, WMI and WCI.

Yield (kg/ ha)

Paddy yield was maximum (6066 kg/ ha) in *Azolla* with recommended level of nitrogen (Figure 1). However, it was pared with only recommended level of nitrogen and *Azolla* with application of 50 kg N/ha (5533 and 5966 kg/ha, respectively). Similarly, there was no significant difference between the *Azolla* only and *Azolla* with application of 25 kg N/ha (4783 and 5283 kg/ha). It revealed that, there are possible to improve the paddy yield by using *Azolla* which providing of 50 % required nitrogen for rice crop without using of fertilizer, if the environmental condition favours for growth of *Azolla* (Watanabe *et al*., 1977).

Table 1: Effect of different treatments on weed density and weed dry weight at 30 DAP.

Treatments	Weed density (number/ m^2)				Weed dry weight (g/ m^2)			
	Grass	Broad leaf	Sedge	Total	Grass	Broad leaf	Sedge	Total
T1	72.44	57.33	113.33	247.11	322.8	65.45	61.06	449.31
	(8.47)	**(7.57)**	**(10.65)**	**(15.72)**	**(17.97)**	**(8.09)**	**(7.81)**	**(21.20)**
T2	8.0	20.0	31.56	59.56	54.63	20.46	29.93	105.02
	(2.83)	**(4.47)**	**(5.62)**	**(7.72)**	**(7.39)**	**(4.52)**	**(5.47)**	**(10.25)**
T3	8.89	35.11	41.78	85.78	37.53	27.45	16.59	81.57
	(2.98)	**(5.93)**	**(6.46)**	**(9.26)**	**(6.13)**	**(5.24)**	**(4.07)**	**(9.03)**
T4	4.44	32.44	51.56	88.44	44.46	25.01	23.08	92.55
	(2.11)	**(5.7)**	**(7.18)**	**(9.4)**	**(6.67)**	**(5.0)**	**(4.8)**	**(9.62)**
T5	23.56	56.44	45.33	125.33	45.33	27.63	39.55	112.51
	(4.85)	**(7.51)**	**(6.73)**	**(11.20)**	**(6.73)**	**(5.26)**	**(6.29)**	**(10.61)**
T6	2.22	11.11	15.56	28.89	23.8	23.06	19.29	66.15
	(1.49)	**(3.33)**	**(3.94)**	**(5.37)**	**(4.88)**	**(4.80)**	**(4.39)**	**(8.13)**
SE ± m	**1.04**	**0.68**	**0.91**	**1.43**	**1.97**	**0.53**	**0.57**	**1.98**
LSD (0.05)	**0.24**	**0.10**	**0.33**	**0.27**	**0.28**	**0.29**	**0.22**	**0.45**

DAP; Days after planting, SE ± m; Standard error of means, LSD; Least significance difference at p<0.05

Table 2: Effects of *Azolla* on various weed indices in paddy

Treatments	**WPI**	**WCE**	**WMI**	**WCI**
Without *Azolla* and chemical fertilizer	1.00	0.00	0.00	0.00
Azolla only	0.68	80.93	0.25	81.31
Azolla + 25 kg N. ha^{-1}	0.75	79.82	0.39	84.83
Azolla + 50 kg N. ha^{-1}	0.56	70.54	0.60	83.40
only recommended level of nitrogen (100 kg N. ha^{-1})	0.84	31.56	0.52	76.41
Azolla + recommended level of nitrogen (100 kg N. ha^{-1})	0.52	76.81	0.59	87.85

WPI = weed persistence index, WCE= weed control efficiency, WMI = weed management index, WCI = weed control index,

Further, it may be due to timely and effective control of weeds by competing for light, space and nutrient. This favoured the crop to produce more leaf area and biomass production. The results were in conformity to those of Castro *et al*. (2003) and Satapathy (1993) who reported that it was due to soil that was supplemented with availability of organic nitrogen and organic matter supported larger and diverse population of micro organisms and more nitrogen

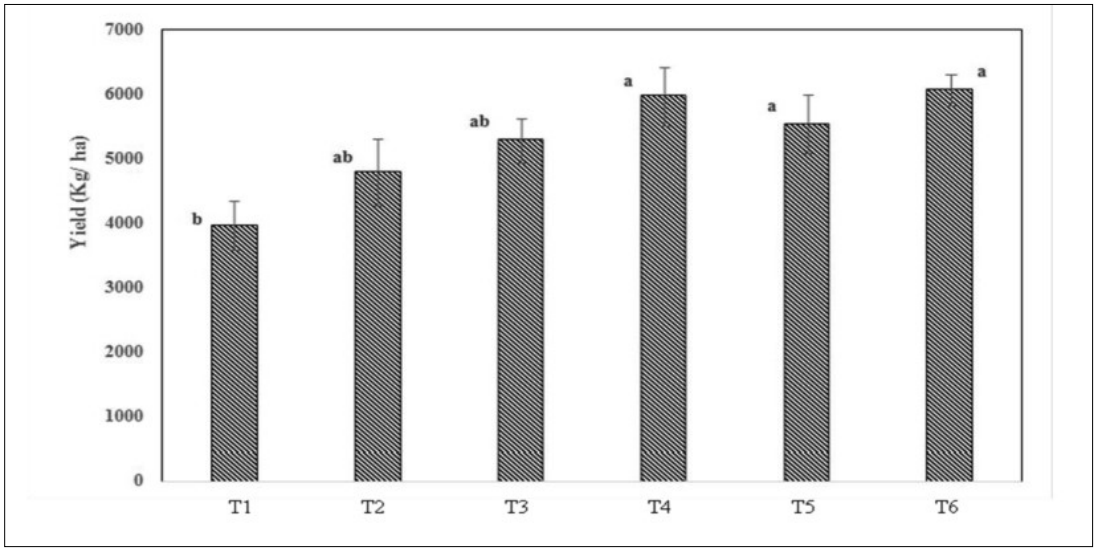

Figure 1: Effect of paddy yield under different conditions of nitrogen fertilizer and Azolla.

Vertical bars represent the SD. Different letters indicate a significant difference at $p<0.05$.

uptake was observed in *Azolla* inoculated treatments than the control, which was due to the mineralization of *Azolla* nitrogen and its simultaneous uptake by rice plants.

Conclusion

Azolla in rice field does not only use as a source of organic nitrogen fertilizer, it also effectively supress the 64.21 - 88.31 % of weed population for a certain extent under the suitable growing conditions of *Azolla*. Further, replacing of *Azolla* reduce the cost incurred for the nitrogen fertilizer and increase the profit of paddy cultivation.

References

Castro, R., Novo, R. and Castro, R.I. 2003. Influence of *Azolla*-anabaena symbiosis on rice (*Oryza sativa* L) crop as a nutritional alternative. *Cultivos Tropicales*. *24*(3):77-82.

Das, T. K. 2008. Weed science: basics and applications. 1st Edition: Jain Brothers Publishers, New Delhi.

Devasenapathy, P. 2008. Efficiency Indices for Agriculture Management Research. New India Publishing Agency, New Delhi, India.

Gnanavel, I. and Kathiresan, R.M. 2002. Sustainable weed management in rice-rice cropping system. *Indian Journal of Weed science*. 34:192-96.

Hill, M.P. and McConnachie, A.J., 2009. *Azolla filiculoides* Lamarck (Azollaceae). *In:* Biological control of tropical weeds using arthropods. Muniappan, R., Reddy, G.V.P. and Raman, A. (Eds.). Cambridge University Press, New York. pp: 74-87.

Kulasooriya, S.A., Hirimburegama, W.K. and Abeysekera, S.W. 1984. *Azolla* as a bio-fertilizer for rice in Sri Lanka. Practical Application of

Azolla for Rice Production. Springer, Dordrecht. pp:188-201.

Mani, V.S., Malla, M.L., Gautam, K.C. and Das, B. 1973. Weed killing chemical in potato cultivation. *PANS.* 23(8): 17-18.

Mishra, P. and Dash, D. 2014 Rejuvenation of bio fertilizer for sustainable agriculture and economic development. *The Journal of Sustainable Development.* 11:41-61.

Misra, M. and Misra, A. 1997. Estimation of IPM index in Jute: a new approach. *Indian Journal of Weed Science*. 29: 39–42.

Satapathy, K.B. 1993. Effect of different plant spacing pattern on the growth of *Azolla* and rice. *Indian Journal of plant physiology*. 36:98 – 102.

Satapathy, K.B. and Singh, P.K. 1985. Control of weeds by *Azolla* in rice. *Journal Aquatic Plant Management*. 23: 40-42.

Singh, P.K., Mishra, S.P and Singh, A.L, 1984. *Azolla* bio-fertilization to increase rice production with emphasis on dual cropping. Practical Application of *Azolla* for Rice Production, Springer, Dordrecht. pp: 132-144.

Sivakumar, C., Kathiresan, R.M. and Kalyanasundaram, D. 1999. Effect of *azolla* on yield and weed suppression in rice. Proceedings of the 8th Biennial conference on ISWS, February 5-7, 1999, Banaras Hindu University, Varanasi, pp: 6.

Watanabe, I., Espinas, C. R., Berja, N.S. and Alimagno, B. U. 1977. Utilization of *Azolla* Anabaena complex as a nitrogen fertilizer for rice. International Rice Research Institute, Research Paper Series No. 11, pp:1-8