D-5915
[1-5]

RESEARCH ARTICLE Agricultural Science Digest, Volume Issue : ()

Effect of Seasonal Variation on Growth and Nutritive Value of *Azolla pinnata* under Agro Climatic Condition of Assam

Mridushmita Sonowal[1], H.K. Bhattacharyya[1], M.C. Kalita[1], P. Boro[1], J. Brahma[1], D. Bharali[1]

10.18805/ag.D-5915

ABSTRACT

Background: *Azolla* is a free floating aquatic fern fixes atmospheric nitrogen in association with nitrogen fixing blue green algae. There have been some studies about the differences in temperature, rainfall and humidity influence on *Azolla* production. Hence, the present experiment was undertaken to study the effect of seasonal variation on growth and nutritive value of *Azolla* under the agro climatic condition of Assam.

Methods: *Azolla* beds were used to cultivate *Azolla pinnata* with three replications and the size of the individual beds were (10×4) m. Deep bore well was the source of water for growing with pH 5.8. The fresh *Azolla pinnata* was collected from the nearby pond of the farm and further cultured. The meteorological data were collected everyday and production data were collected fortnightly. Two samples of fresh *Azolla pinnata* were collected and analysed for its nutritive value during the month of January and June 2021 in order to evaluate the difference of nutritive value due to seasonal variation.

Result: Highest fresh *Azolla* was recorded in bed 2 (9.5 kg) in the month of May and lowest being recorded by the bed 2 (2.0 kg) during January. The increased *Azolla* production during May to June was attributed to the rise of temperature prevailed in the surrounding area of ZLRS, Mandira. There were no significant differences between the two seasons regarding the nutrient content of *Azolla.*

Key words: *Azolla pinnata*, Nutritive value, Seasonal variation.

INTRODUCTION

Azolla, a free floating aquatic fern fixes atmospheric nitrogen in association with nitrogen fixing blue green algae (Kannaiyan, 2002), making it an excellent source of protein for livestock and is very popular as an unconventional source of feed because of its capability to grow on artificial water pools, fast growth in nitrogen deficient habitats and production of enormous green and dry fodder with high nutrient content (Shukla *et al*., 2018; Rex Immanuel, 2019). Fresh *Azolla pinnata* a*lla pinnata* can act as best protein replacement source for protein in Sahiwal calves ration up to 30% level (Bhatt *et al.,* 2020) as well as has no impact on growth of calves (Bhatt *et al.,* 2022). Besides, it has no significant impact on haematological parameters like PCV, Hb, RBC and WBC (Singh *et al.,* 2023). It is rich in protein, essential amino acids (Kantwa *et al*., 2022), vitamins, growth promoter intermediaries and minerals. It is recognized as the cheapest and most abundant source of protein because of their ability to synthesize amino acids from a wide range of virtually unlimited and readily available primary materials.

It can be cultivated in nursery plots, ponds, cemented tanks, polythene sheets and readymade *Azolla* growing beds *etc* depending on requirement and availability. *Azolla* grows in full to partial shade (100-50 per cent sunlight) with growth decreasing quickly under heavy shade (Ferentinos *et al*., 2002). The biomass production greatly decreases at a light intensity lower than 1500 lux (Liu *et al*., 2008). The most favourable relative humidity for *Azolla* growth is between 85-90 per cent. Rate of plant growth and biomass production is dependent upon the temperature adjacent to the plant and each species has a specific temperature range represented by a minimum, maximum and optimum. Extreme weather events occurring during the summer period would have the most dramatic impact on plant productivity.

Under optimal conditions, *Azolla* species has a rapid vegetative multiplication with biomass doubling time of two to five days (Sadeghi *et al*., 2013). The mean air temperature ranging from 30-35°C which varies according to species and growth conditions (Uheda *et al*, 1999). There have been some studies about the influence of differences in temperature on responses of *Azolla* species and their eco-physiological strains indicated that a very high (above 30°C) or very low temperature (below -4°C) could play an inhibitory role in the growth of *Azolla* (Fernandez-Zamudio

[1]Zonal Livestock Research Station, Assam Agricultural University, Mandira-781 127, Assam, India.

Corresponding Author: P. Boro, Zonal Livestock Research Station, Assam Agricultural University, Mandira-781 127, Assam, India. Email: boroprasanta99@gmail.com

How to cite this article: Sonowal, M., Bhattacharyya, H.K., Kalita, M.C., Boro, P., Brahma, J. and Bharali, D. (2024). Effect of Seasonal Variation on Growth and Nutritive Value of *Azolla pinnata* under Agro Climatic Condition of Assam. Agricultural Science Digest. doi: 10.18805/ag.D-5915.

Submitted: 09-11-2023 **Accepted:** 03-07-2024 **Online:** 26-08-2024

et al., 2010; Liu *et al*., 2008; Sadeghi *et al*., 2013). At higher temperatures (38±1°C/25±1°C) *Azolla* consistently showed a superior growth rate (Kannaiyan and Somporn, 1989). Accordingly, the information about the effects of seasonal temperature during hot weather period on the green and dry biomass production of *Azolla* is necessary for its year round cultivation and management in artificial water bodies.

Hence, keeping in view of these facts, an experiment has been designed to evaluate the effect of seasonal variation on growth and nutritive value of *Azolla pinneta* under the agro climatic conditions of Assam.

MATERIALS AND METHODS

The experiment was conducted in the AAU-Zonal Livestock Research Station (LRS), under Assam Agricultural University, which is located at Mandira, Kamrup district of Assam. The latitude and longitude of this area is 26.51465°N and 91.1017°E respectively. The station is situated at medium low and low land, of which, 90% area submerges under water during last week of May to September, in each calendar year. The weather at the location of the experimental site was moderately warm with high relative humidity in hot summer months. The mean annual rainfall of the experimental farm was 1950mm distributed over 300 days. The potential evapotranspiration varies from 2.5 mm to 3.5 resulting in an annual water deficit of 705 mm year^{-1}. Temperature prevailed during the period is shown in Table 1. The maximum temperature ranged from 18.5 to 38.5°C with a mean of 28.5°C while the minimum temperature varied from 10.0 to 34.7°C with a mean of 22.0°C. The highest relative humidity was 85.50% (August) and lowest was 62.65% in the month of February. The rainfall was highest (158 mm) during the month of July. The experiment was conducted for one year, from 2nd January, 2021 to 2nd January, 2022.

Azolla beds were used to cultivate *Azolla pinnata* with three replications and the size of the individual beds were (10.0 m × 4.0 m). Deep bore well was the source of water for growing with pH 5.8. The fresh *Azolla pinnata* was collected from the nearby pond of the farm and further cultured in artificial water bodies in concrete tanks under homogenous conditions. Before the beginning of experiment, samples were washed thoroughly with tap water and rinsed with distilled water. Organic cultivation was practiced. As the Azolla plant is a N2 fixer, it has a competitive advantage over other floating plants for its production in water without added nitrogen fertilizer. Cow dung was added @ 100 g per bed and MOP and DAP were applied @ 200 g each per bed. First harvesting was done on 15th day after inoculation and the subsequent harvesting was done at fortnightly interval. The fresh weights were determined and recorded.

Table 1: Weather prevailed during the period (January, 2021 to Jannuary, 2022).

Fortnight	Duration	Max. temp °C	Min. temp	Rainfall (mm)	Rh (%)
1	2-15 Jan	18.5	10.0	0	63.6
2	16-30 Jan	22.5	15.2	0	65.0
3	31-13 Feb	24.0	14.4	0	62.6
4	14-27 Feb	25.9	13.7	0	66.0
5	28 Feb-13 Mar	30.3	15.9	0	70.5
6	14-27 March	31.7	17.2	0.7	75.5
7	28-9 Apr	30.4	18.7	10.0	75.3
8	10-24 Apr	30.7	18.7	7.5	76.8
9	25 Apr-8 May	31.5	22.2	23.0	76.5
10	9-22 May	31.9	21.8	36.0	77.6
11	23 May-5 Jul	31.2	24.5	65.7	79.1
12	6 Jul-19 Jun	34.5	29.7	92.5	81.5
13	20 Jun-3 Jul	35.7	31.5	40.2	80.7
14	4 Jul-17 Jul	37.1	33.5	158.0	77.6
15	18-31 Jul	37.9	34.1	117.5	79.0
16	1 Aug-15 Aug	38.5	34.7	96.5	85.5
17	16 Aug-28	37.1	33.2	35.5	80.5
18	29 Aug-11 Sept	32.2	33.9	95.5	75.5
19	12th Sept	34.0	30.2	78.1	74.3
20	27-9 Oct	30.2	28.5	31.7	74.0
21	10-23 Oct	28.7	28.0	16.6	73.6
22	24 Nov-8 Dec	26.4	23.8	0.0	71.6
23	9 Dec-24 Dec	24.5	21.5	3.0	67.0
24	25 Dec-2 Jan	21.0	18.2	0.0	64.7

Two samples of fresh *Azolla pinneta* were collected and analysed for its nutritive value (AOAC, 2007) during the month of January and June 2021 in order to evaluate the difference of nutritive value due to seasonal temperature difference.

The observations recorded on the various parameters were computed with the help of MS Office Excel Worksheet. Statistical analyses were done as per Snedecor and Cochran (2000).

RESULTS AND DISCUSSION

Fresh weight of *Azolla* was recorded at every fortnight under three bed conditions. Highest fresh *Azolla* was recorded in bed 2 (9.5 kg) in the month of May and lowest being recorded as 2.0kg during January (in bed 2). The increased *Azolla* production (Fig 1 and 2) during May to June was related with the rise of temperature prevailed in the surrounding area of ZLRS, Mandira. Similar finding was also recorded by Kannaiyan and Somporn (1989). But, during the month of July, despite of higher environmental temperature, due to the higher rainfall (Fig 3), the night temperature in the surrounding area was found to be low compared to May and June. The relative humidity was also highest during this period (Fig 4). Due to that fact, the *Azolla* could be grown well in these two months (*viz* May and June) only comparing to the other months.

The mean temperature of 26°C to 30°C was recorded at ZLRS, Mandira and gradual increase production of *Azolla* was observed during the period of mid April to mid July. Thereafter, although the temperature was higher from July

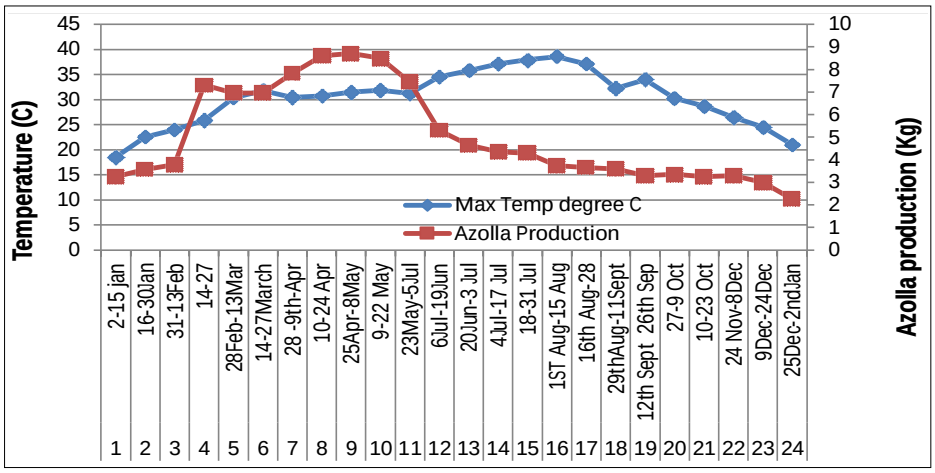

Fig 1: Effect of maximum temperature on the yield of *Azolla pinnata* under agro climatic condition of Assam.

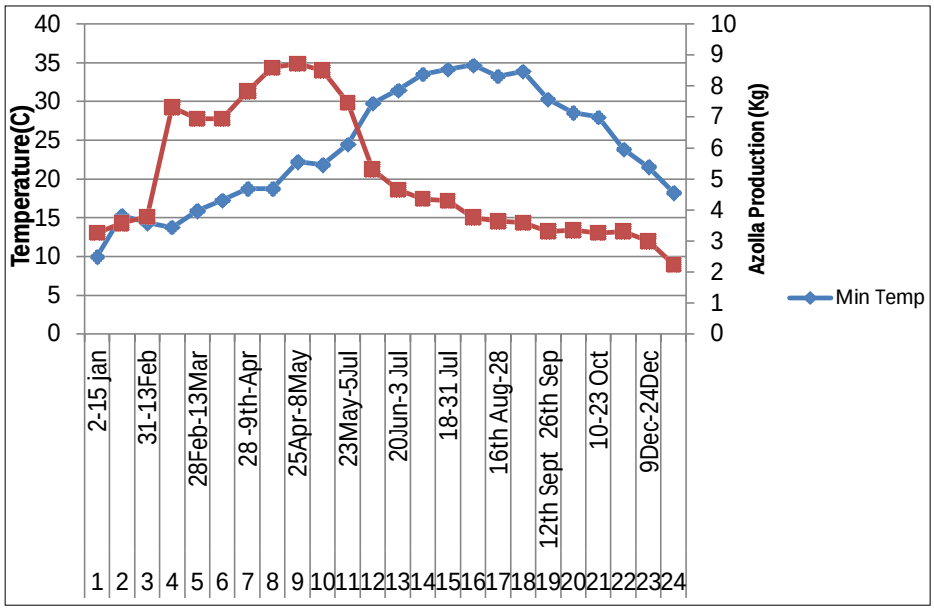

Fig 2: Effect of minimum temperature on the yield of *Azolla pinnata* under agro climatic condition of Assam.

Table 2: Nutritive values of fresh *Azolla pinnata* in summer and winter.

Chemical analysis (%)	Summer	Winter
DM	4.97±2.86	4.95±1.85
CP	24.2±4.91	24.1±0.95
EE	4.2±2.42	4.2±1.12
CF	14.68±3.83	14.35±1.85
Ash	13.98±3.73	13.95±2.75
NFE	42.94±6.16	43.4±2.80

DM- Dry matter, CP- Crude protein, EE- Ether extract, CF- Crude fibre, NFE- Nitrogen free extract.

to August, its growth was retarded due to huge quantities of rainfall during this period (Fig 3). Thus it may be confirmed that, the biomass production of *Azolla* was also dependant on particular specific growing period. This is in conformity with the findings of Rex Immanual (2019). Low temperature occurs during winter period; while highest production was recorded during the period of summer and pre monsoon having higher temperature of more than 30°C. Similar findings were also reported by Speelman *et al.* (2009) and Aziz (2012).

The values of dry matter, crude protein, crude fat, ether extract, total ash and nitrogen free extract of *Azolla* cultivated

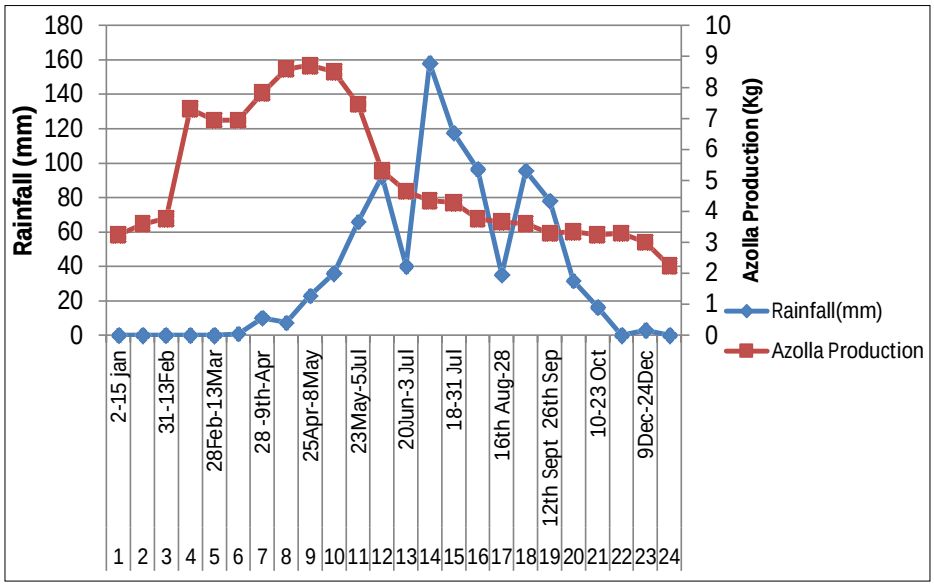

Fig 3: Effect of rainfall on the yield of *Azolla pinnata* under agro climatic condition of Assam.

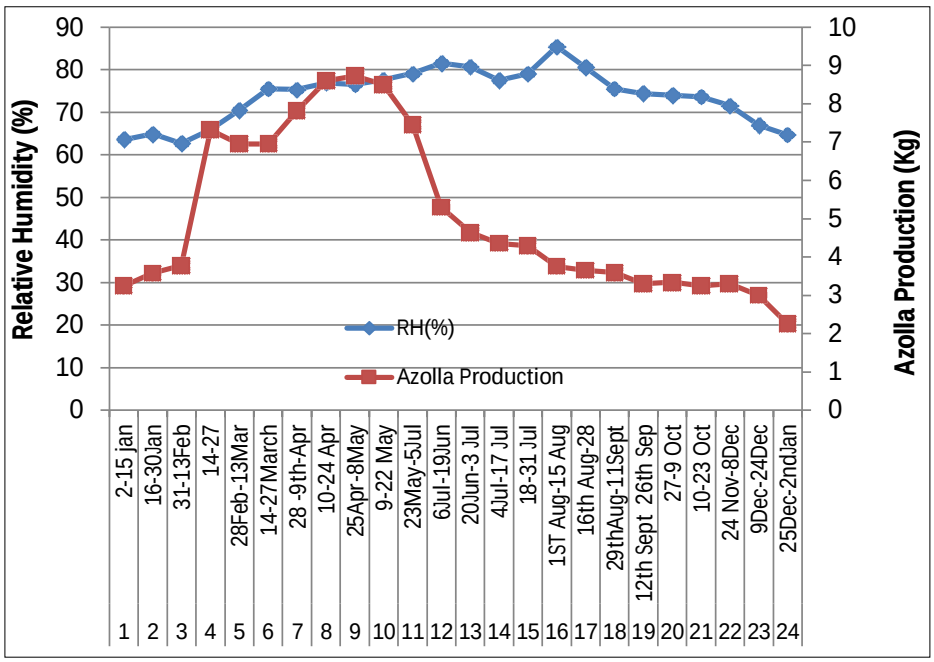

Fig 4: Effect of relative humidity on the yield of *Azolla pinnata* under agro climatic condition of Assam.

in both summer and winter season has been presented in Table 2. It has been observed that, there were no significant differences between the two seasons regarding the nutrient content of *Azolla*. The values of nutrient content are similar with the values that reported by Bhatt *et al*. (2020).

CONCLUSION

It can be concluded from the study that, growth of *Azolla* is affected by seasonal variations *viz.*, maximum and minimum temperature, rainfall and humidity. Under the agro climatic condition of Assam, it grows well during April to May. From the nutritional value point of view, there is no significant differences occur between summer and winter production of *Azolla*.

Conflict of interest

All authors declare that they have no conflict of interest.

REFERENCES

AOAC. (2007). Official Methods of Analysis (18th ed). Association of official Analytical Chemists. Washington, D.C.

Aziz, A. (2012). New method of large-scale production of *Azolla pinnata* var. pinnata R. Brown: A multipurpose crop. International Journal of Applied Agricultural Research. 7(1): 1-9.

Bhatt, N., Tyagi, N., Chandra, R., Meena, D.C. and Prasad, C.K. (2020). Growth performance and nutrient digestibility of *Azolla pinnata* feeding in Sahiwal calves (*Bos indicus*) by replacing protein content of concentrate with *Azolla pinnata* during winter season. Indian Journal of Animal Research. 55(6): 663-668. doi: 10.18805/ijar.B-4004.

Bhatt, N., Chandra, R., Prasad, C.K., Tyagi, N and Mishra, D.B. (2022). Effect of *Azolla pinnata* feeding on linear type traits and its relation to economic feasibility in sahiwal calves. Asian Journal of Dairy and Food Research. pp 1-6. doi: 10.18805/ajdfr.DR-1853.

Bhatt, N., Chauhan, R., Kumar, S., Singh, K., Singh, N.P., Singh A.K.R. And Chauhan, S.P.S. (2020). Nutritive analysis of fodder *Azolla pinnata* and its cultivation during winter season. International Journal of Current Microbiology and Applied Sciences. 9(3): 2012-2018.

Fernandez-Zamudio, R., García-Murilloa, P. and Cirujano, S. (2010). Germination characteristics and sporeling success of *A. filiculoides* Lam., an aquatic invasive fern, in a Mediterranean temporary wetland. Aquatic Botany. 93: 89-92.

Ferentinos, L., Smith, J and Valenzuela, H. (2002). Azolla: Green manure crop. In: Sustainable Agriculture in Hawaii. University of Hawaii, Manoa, USA.

Kannaiyan, S. and Somporn, C. (1989). Effect of high temperature on growth, nitrogen fixation and chlorophyll content of five species of *Azolla* anabaena symbiosis. Biology and Fertility of Soils. 7(2): 168-172. https://doi.org/10.1007/BF00292577.

Kannaiyan, S. (2002). Biotechnology of Biofertilizer. Kluwer Academic Publishers, ISBN: 978-1-4020-0219-9, India.

Kantwa, C.S., Kumar, U., Patel, S.J. (2022). Azolla as a green fodder feed supplent of cross breed cows in District-Sehore (M.P.). Bhartiya Krishi Anusandhan Patrika. 36(4): 280-284. doi: 10.18805/BKAP378.

Liu, X., Min, C., Xia-Shi, L. and Chungchu, L. (2008). Research on some functions of *Azolla* in CELSS system. Acta Astronautica. 63(7): 1061-1066. doi: 10.1016/j.actaastro.2008.03.001.

Rex, I.R. (2019). Seasonal temperature effect on the biomass productivity of fodder *Azolla.* International Journal of Research and Analytical Reviews. 6(1): 237-241.

Sadeghi, R., Zarkami, R., Sabetraftar, K and Van Damme, P. (2013). A review of some ecological factors affecting the growth of *Azolla* spp. Caspian Journal of Environmental Sciences. 11(1): 65-76.

Shukla, M.A., Bhattacharyya, P.K., Shukla, D., Roy, B. Yadav and Sirohi, R. (2018). Effect of *Azolla* feeding on the growth, feed conversion ratio, blood biochemical attributes and immune competence traits of growing turkeys. Vetirnary World. 11(4): 459-463. doi: 10.14202/vetworld.2018.459-463.

Singh, V.T., Prasad, R.M.V., Madhuri, B.S., Jayalaxmi, P., Kumar, S.M. (2023). Effect of *Azolla* (pinnata) supplementation on the haematological and blood biochemical parameters of deccani ram lambs reared under grazing based production system. Indian Journal of Animal Research. 57(9): 1258-1261. doi: 10.18805/IJAR.B-4375.

Speelman, E.N., Van Kempen, M.L., Barke, J., Brinkhuis, H., Reichart, G.J., Smolders, A.J.P., Roelofs, J.G.M., Sangiorgi, F., De Leeuw, J.W., Lotter, A.F. and Sinninghe Damste, J.S. (2009). The eocene arctic Azolla bloom: Environmental conditions, productivity and carbon drawdown. Geobiology. 7: 155-170.

Snedecor, G.W. and Cochran, W.G. (2000). Statistical Methods, 8th Edition; Oxford and IBH Publishing Company, New Delhi, India.

Uheda, E., Kitoh, S. and Shiomi, N. (1999). Response of six *Azolla* species to transient high-temperature stress. Aquatic Botany. 64: 87-92.