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Growth of wheat plants influence by *Azolla* as organic manure

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Abstract
Wheat (*Triticum aestivum* L. var. PBW 343) plants raised in soil pot culture condition with different doses *viz*. nil (control), 50, 100, 150, 200 and 250 g *Azolla* /kg soil. As compared to control, 250 g *Azolla* per kg soil showed highly significant (P=0.01) increased in dry matter yield of tops of 40, 80 and 120 days old plants. Increase in chlorophyll content of leaves of both 40 and 80 days, and increase in ascorbic acid content on tops of both 40 and 80 days old plant was also observed as 250 g. *Azolla* as per kg soil over control. *Azolla* as organic manure proves beneficial for growth of wheat plant.

Keywords: *Triticum aestivum* L. *Azolla*, organic manure, beneficial

Introduction
In developing countries, the most important challenge is to produce sufficient food for the growing population from limited area available for cultivation. Biologically originated products can be beneficially blended to replace a part of the energy intensive inputs. In this context, biofertilizers can provide to the marginal farmers (which have limited economic status), a new strategy which is helpful for achieving the goal of increasing productivity. As the name indicates, these are fertilizers of biological origin. According to this, biofertilizers are green manures and organics. The objective to increase the number of such micro-organisms and to accelerate microbial activity to increase the availability of nutrients [1].
The importance of *Azolla* as an organic input in rice cultivation was first demonstrated in North Vietnam in 1957. Two method of *Azolla* applications have been recommended in India- as a green manure by incorporating in fields praise to rice planning and secondary by dual cropping with rice when the fern grows side by side with the main crop for same time [2].
Biofertilizers improve the general fertility of the soil by increasing the availability of a number of nutrients to crop, by increasing the organic matter in soil, and by improving soil structure. Incorporation of *Azolla* into the soil improves the release of nitrogen.
Increasing doses of *Azolla* increased the grain and straw yield almost linearly yield in the treatment of best application of nitrogen fertilizers and *Azolla* as top dressing was comparatively better [3]. Recently *Azolla* used as an organic composts and found encouraging results for growth and composition of different plants [4, 5, 6].
Thus the present investigation is meaningful original approach towards answering several problem in basic plant science as well applied areas of environment using *Azolla* in the rice and wheat fields to economics the heavy expenditure on chemical nutrients for the better yield of crops, for betterment of nation, due to very high cost of chemical nutrient in comparison to organic manure.

Material and Methods
Experimental plants were raised in soil culture under pot culture conditions. All the plants were raised in the soil, 2 cm deep holes were made with an acid washed clean glass rod of 3 mm diameter and seeds were put in these holes, covered loosely with soil of the same pot. After the seed emergence plants were thinned to a uniform number in each pot subsequent thinning was done whenever needed.
Soil was separately mixed with required amount of *Azolla*. There after it was air dried thoroughly ground and mixed. For through mixing required amount of *Azolla* were mixed with small amounts of soil, divided and mixed again and again. Then these amended soils were mixed with bigger amounts of soil similarly and finally these soils were mixed with bigger lots of calculated soils required for experiments. Soil mixing was done on separate clean alkathene sheets to avoid any contaminations. Mixed soils were filled in pots as described earlier.
Second calculated amount of similar dose in each treatment of *Azolla* were applied on the soil surface in each pot once after 8th day from the date of emergence of seedlings.
Soil (about 5 kg soil/bag) amendments with *Azolla* as organic compost was as under: content (without *Azolla* application, 50, 100, 150, 200 and 250 *Azolla* /kg soil.
For analysis, washed finely chopped and mixed plant material was used. For the determination of ascorbic acid and chlorophyll contents, fresh matter was used. For determination of dry matter yield, dry matter was used.
Dry matter yield was determined by drying and finely chopped and mixed plants samples in a forced draught oven at 65ºC for 24 hours to constant weight. The samples were taken out from the oven and placed in a desiccator, cooled for about an hours and weighed for the determination of yield. Since the dry matter was required for the estimation of different nutrient elements, fresh matter kept for drying was thoroughly cleaned against any surface contamination by first washing with running tap water, rinsing with distilled water and absorbing surface water with clean white blotting sheets.
Chlorophyll was determined by the method of Petering *et al.*, [7]. The chlorophyll content was measured by estimating the absorption of the acetone extract in referring the reading to the standard calibration curve prepared by the method of Comer and Zscheile [8].
Ascorbic acid content was estimated titrimetrically by the method of Harris and Roy [9].

The experiments dealt were aimed to re-examine some of the earlier findings and to investigate whether *Azolla* can have beneficial effect on plant growth, metabolites and concentrations of mineral nutrient elements of plants.

Results and Discussion (Table 1)

Dry matter yield of wheat plants increased with the increase in *Azolla* supply up to 250 g *Azolla* / kg soil level in tops of 40, 80 and 120 and grains of 120 days old plants.

As compared to control, dry matter yield of wheat plants were found to be highly significant (P=0.01) at 150, 200 and 250 g *Azolla*/ kg soil levels in tops of 40 and 80 days and both tops and grains of 120 days, and at 100 g *Azolla* / kg soil in both tops and grains of 120 days old plants, significant at tops 50 g *Azolla* / kg soil in tops of 120 days, and insignificant at tops of 40 days and 80 days and grains of 120 days old plants, and at 100 g *Azolla* / kg soil in tops of 40 days old plants. Maximum value for dry matter yield of tops of both 40 and 80 days and both tops and grains of 120 days old wheat plants were observed at 250 g *Azolla* / kg soil.

Chlorophyll

Up to 200 g *Azolla* / kg soil in leaves of 40 days and 150 g *Azolla* / kg soil in leaves of 80 days, increase in *Azolla* supply increased the chlorophyll content of wheat plants. Beyond these levels further increase in *Azolla* supply decreased the chlorophyll content of leaves of 40 and 80 days old plants. As compared to control, all the levels of *Azolla* supply increased the chlorophyll content of leaves of both 40 and 80 days old plants highly significantly (P=0.01), except at 50 g *Azolla* / kg soil where increase in chlorophyll content was found to be significant (P=0.05) over control. Maximum value for chlorophyll content were observed at 150 g *Azolla* / kg soil in leaves of 80, and at 200 g *Azolla* / kg soil in leaves of 40 days old wheat plants.

Ascorbic Acid

Ascorbic acid content of wheat plants increased with the increase in *Azolla* supply level up to 250 g *Azolla* / kg soil (last level tested) in tops of both 40 and 80 days old plants.

As compared to control, increase in ascorbic acid content at 200 g *Azolla* / kg soil in tops of 40 days and at 150, 200 and 250 g *Azolla* / kg soil in tops of 80 days were found to be highly significant (P=0.01), and at 150 and 200 g *Azolla* / kg soil in tops of 40 days was found to be significant (P=0.05). However, all level tested in tops of 40 and 80 days failed to show any significant increase in ascorbic acid content over control.

250 g *Azolla* / kg soil showed maximum value for ascorbic acid content of tops of both 40 and 80 days old wheat plants.

The results presented here indicate that application of *Azolla* as organic compost upto 250 g *Azolla* / kg soil (highest level tested) increased the dry matter yield of wheat plants is in agreement with the findings of Singh [10].

Kannaiyan and Subramani [11] observed encouraging results, while using *Azolla* as green manure for betterment and growth of plants. Venkataraman [12], Mohan *et al.*, [13], Mohan *et al*, [14], Saxena *et al.* [15], who reported increase in yield of crop using *Azolla* as green manure, Saxena and Mohan [16]. Mahadev and Mohan [6], Agnihotri *et al.*, [5] also recorded beneficial results while using *Azolla* alone as biofertilizer of along with nitrogen fertilizer in combination.

Maximum chlorophyll content in leaves of wheat plants were observed at 200 g *Azolla* / kg soil level in leaves of 40 days and at 150 g *Azolla* / kg soil in leaves of 80 days old plants. The results presented here are in conformity with findings of Kalita and Sharma [17], Sahoo and Dutta [18], Agnihotri *et al.*, [4], who reported increase in chlorophyll content with Azolla supply.

Table 1: Effect of *Azolla* as organic composts on dry matter yield, chlorophyll and ascorbic acid content of wheat plants

Plant		g *Azolla* / kg Soil						LSD at	
Age (days)	Part	Nil	50	100	150	200	205	P = 0.05	P=0.01
dry matter yield / plant (gm)									
40	Tops	0.11	0.12	0.12	0.15	0.17	0.18	0.02	0.03
80	Tops	2.16	2.42	2.67	3.52	4.11	4.59	0.51	0.72
120	Tops	20.37	21.80	24.06	24.98	27.54	30.32	1.05	1.49
120	grains	1.17	1.35	1.75	1.97	2.28	2.56	0.28	0.39
chlorophyll / 100 g FM (mg)									
40	Leaves	87	93	99	106	121	100	6	9
80	Leaves	173	186	190	199	186	173	12	17
ascorbic acid / 100 g FM (mg)									
40	Tops	154	157	164	176	238	270	16	23
80	Tops	157	160	179	211	246	278	35	50

200 g *Azolla / kg* soil showed maximum value for ascorbic acid content of plants. Similar increase in ascorbic acid content has been reported by Gupta [19], Mohan *et al.*, [13], Mohan *et al.*, [14], Saxena and Mohan [16].

The adoption of organic manure as compared to nitrogen fertilizer would be very less expensive, besides being quite safer as compared to the chemical fertilizer.

It is concluded that *Azolla* as biofertilizer can prove very efficient tool for boosting green revolution, though the effectiveness of different interactions varies to some extent. Further work is needed to understand the mode of action of other biofertilizer including blue green algae and their effect on metabolic activities and food values of plants to make a better use of these compounds.

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