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TS Shinde

PG Student, Division of Soil Science and Agricultural Chemistry, RSCSM, College of Agriculture, Kolhapur, Maharashtra, India

Dr. RB Pawar

Associate Professor, Agriculture Research Station, Kabse Digraj, Sangli, Maharashtra, India

AV Satpute

PG Student, Division of Agronomy, RSCSM, College of Agriculture, Kolhapur, Maharashtra, India

SM Shende

PG Student, Division of Agronomy, RSCSM, College of Agriculture, Kolhapur, Maharashtra, India

Corresponding Author:**TS Shinde**

PG Student, Division of Soil Science and Agricultural Chemistry, RSCSM, College of Agriculture, Kolhapur, Maharashtra, India

Effect of zeolite on chlorophyll content, growth attributing characters and yield of *kharif* upland paddy grown on Inceptisol

TS Shinde, Dr. RB Pawar, AV Satpute and SM Shende

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Abstract

A field experiment was conducted in *kharif*-2019 at Agronomy Farm, Rajarshree Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur. An experiment was laid out in randomized block design with three replications and seven treatments comprising five levels of zeolite (60, 80, 100, 120 and 140 kg ha⁻¹). Application of zeolite significantly increases chlorophyll content of paddy leaves. The highest chlorophyll content (0.84 mg kg⁻¹ and 0.96 mg kg⁻¹) values were recorded with application of zeolite @ 140 kg ha⁻¹ (T₇) at maximum tillering and panicle initiation stage of paddy crop and it was significantly superior over rest of the treatments except T₅ (GRDF + Zeolite @ 100 kg ha⁻¹) and T₆ (GRDF + Zeolite @ 120 kg ha⁻¹). The significantly highest values of growth parameters and yield attributing characters viz. plant height (95.67 cm), number of tillers plant⁻¹ (24.33), number of panicles (23.33) and 1000 grain weight (26.11 g) were recorded with application of zeolite @ 140 kg ha⁻¹ (T₇) but it was at par with the treatment T₅ (GRDF + Zeolite @ 100 kg ha⁻¹) and T₆ (GRDF + Zeolite @ 120 kg ha⁻¹). There was no significant effect of application of zeolite on number of grains panicle⁻¹. The grain and stover yields of paddy increased significantly due to zeolite application. The application of zeolite @ 140 kg ha⁻¹ (T₇) showed significantly the highest grain yield (42.94 q ha⁻¹) and stover yield (59.20 q ha⁻¹) but it was at par with treatment T₅ (GRDF + Zeolite @ 100 kg ha⁻¹) and T₆ (GRDF + Zeolite @ 120 kg ha⁻¹) indicating response of zeolite application upto 100 kg ha⁻¹ (T₅). The results of the present investigation indicated that the application of zeolite @ 100 kg ha⁻¹ along with GRDF was found effective in increasing chlorophyll content, growth attributing characters and yield.

Keywords: Chlorophyll content, yield, paddy, clinoptilolite zeolite

Introduction

The zeolites are hydrated aluminosilicate minerals made from interlinked tetrahedral of alumina (AlO₄) and silica (SiO₄). The zeolites are composed of pores and corner sharing aluminosilicate (AlO₄ and SiO₄) tetrahedrons, joined into 3 dimensional frameworks. The pore structure is characterized by cages approximately 12 Å in diameter, which are interlinked through channels about 8 Å in diameter, composed of rings of 12 linked tetrahedrons (Kaduk and Faber, 1995) [2]. The zeolite has an ability to gain or lose water reversibly, without the change of crystal structure. They could be used as fertilizers, stabilizers and natural chelates (Perez-Caballero *et al.*, 2008) [5]. The zeolite enables both inorganic and organic fertilizers to slowly release their nutrients (Perez-Caballero *et al.*, 2008) [5]. The zeolite helps to increase crop yield (Valente *et al.*, 1982) [9].

Materials and Methods

Field experiment was conducted in *kharif*-2019 on sandy clay loam soil at Agronomy Farm, Rajarshree Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur located at latitude of 16°42' North and longitude 74°14' East. The field experiment site climatically belongs to Sub-Montane zone of Maharashtra with an average rainfall of 1057 mm, with 77 rainy days which are received mostly from south-west monsoon. Minimum and maximum mean temperature ranged from 11.83 to 20.9 °C and 24.9 to 33.1 °C, respectively. The soil of experimental plot was alkaline in reaction (pH 7.83), normal in electrical conductivity (0.17 dS m⁻¹), moderately high in organic carbon content (0.63%) and high in CaCO₃ content (9.86%), and have bulk density 1.27 g cm⁻³, CEC 16.91 cmol (p+) kg⁻¹. Soil was low in available nitrogen (171.29 kg

ha⁻¹), medium in available phosphorous (16.29 kg ha⁻¹) and high in available potassium (160.31 kg ha⁻¹) content sufficient in available Fe (4.52 mg kg⁻¹), available Mn (2.04 mg kg⁻¹), available Zn (1.54 mg kg⁻¹) and available Cu (1.63 mg kg⁻¹). The experiment was laid out in randomized block design with seven treatments and three replications. The treatments consisted of T₁: Absolute control, T₂: GRDF (100:50:50 kg ha⁻¹ N:P₂O₅:K₂O + FYM 10 t ha⁻¹), T₃: GRDF+ Zeolite @ 60 kg ha⁻¹, T₄: GRDF+ Zeolite @ 80 kg ha⁻¹, T₅: GRDF+ Zeolite @ 100 kg ha⁻¹, T₆: GRDF+ Zeolite @ 120 kg ha⁻¹, T₇: GRDF+ Zeolite @ 140 kg ha⁻¹.

The treatment wise application of zeolite and fertilizers mixture was done before sowing of paddy seed and covered with soil. The FYM was applied @ 10 t ha⁻¹. The general recommended dose of fertilizer (100 kg N + 50 kg P₂O₅ + 50 kg K₂O ha⁻¹) were applied per hectare at the time of sowing as per the treatments.

The variety *Indrayani* was grown by adopting standard package of practice for the region. The plant height (cm) was measured from ground level by adopting standard procedure at harvest. The number of tillers plant⁻¹ and number of panicles plant⁻¹ were recorded at harvest from five randomly selected and marked plants and average of five plants was worked out at each observation for comparing treatment effects. The grains obtained after threshing and winnowing of the produce from each net plot were sun dried and their final air dried weight per plot was recorded in kg and was expressed in q ha⁻¹. The stover yield per net plot was obtained by weighing the sun dried stover and chaff which remained after removal of grains. It was recorded as stover yield per net plot (kg) and was expressed in q ha⁻¹. The 4th leaf of plant

collected as plant sample at maximum tillering and panicle initiation stage for estimation of chlorophyll content from plants. The chlorophyll of fresh plant leaves (4th leaf) collected at tillering stage was extracted in 85% acetone and the absorbance at 663 nm and 645 nm wavelength on spectrophotometer (Arnon, 1949) [1].

Results and Discussion

Chlorophyll content

The data pertaining to chlorophyll content of crop is presented in Table 1. The data clearly indicated that there was significant influence of different treatments on chlorophyll content of paddy. The treatment T₇ (GRDF + Zeolite @ 140 kg ha⁻¹) applied to paddy registered significantly highest chlorophyll content at maximum tillering and panicle initiation stage of paddy (0.85 mg kg⁻¹ and 0.97 mg kg⁻¹) over all the treatments except T₅ (GRDF + Zeolite @ 100 kg ha⁻¹) and T₆ (GRDF + Zeolite @ 120 kg ha⁻¹). Increase in chlorophyll content at maximum tillering and panicle initiation stage of paddy was observed due to application of zeolite. Chlorophyll coloration is related to the amount of nutrients absorbed by plant from the soil. Chlorophylls have nitrogen structure and zeolite cause increase in efficiency of elements consumption especially nitrogen as well, therefore using zeolite can increase chlorophyll content considerably. Higher chlorophyll content at two stages of paddy observed due to combined effect of GRDF and zeolite application to the field over other treatments.

The results are close conformity with the findings reported by Majid *et al.* (2012), Shahsavari *et al.* (2014), Shahrzad Alfi and Farhad Azizi (2015) [3, 8, 7].

Table 1: Chlorophyll content in 4th leaf of paddy at maximum tillering and panicle initiation stage as influenced by different levels of zeolite

Tr. No.	Treatment Details	Chlorophyll content (mg g ⁻¹) in 4 th leaf of paddy	
		Maximum tillering stage	Panicle initiation stage
T ₁	Absolute control	0.51	0.55
T ₂	GRDF (100:50:50 kg ha ⁻¹ N: P ₂ O ₅ : K ₂ O + FYM 10 t ha ⁻¹)	0.59	0.66
T ₃	GRDF+ Zeolite @ 60 kg ha ⁻¹	0.69	0.76
T ₄	GRDF+ Zeolite @ 80 kg ha ⁻¹	0.76	0.86
T ₅	GRDF+ Zeolite @ 100 kg ha ⁻¹	0.83	0.95
T ₆	GRDF + Zeolite @ 120 kg ha ⁻¹	0.84	0.96
T ₇	GRDF + Zeolite @ 140 kg ha ⁻¹	0.84	0.96
	SE±	0.02	0.03
	CD (0.05)	0.07	0.08

Growth and yield attributing characters

The data pertaining to growth and growth parameter are presented in Table 4.4. The data clearly indicated that there was significant influence of GRDF alone and with different levels of zeolite on growth and growth parameters of paddy.

In case of plant height, it was observed that the treatment T₇ (GRDF+ Zeolite @ 140 kg ha⁻¹) registered significantly highest plant height (95.67 cm) over all the treatments except T₅ (GRDF + Zeolite @ 100 kg ha⁻¹) and T₆ (GRDF + Zeolite @ 120 kg ha⁻¹).

The significantly highest number of tillers per plant (24.33) were observed with the treatment T₇ (GRDF+ Zeolite @ 140 kg ha⁻¹), however it was at par with T₅ (GRDF + Zeolite @ 100 kg ha⁻¹) and T₆ (GRDF + Zeolite @ 120 kg ha⁻¹).

The significantly highest number of panicles per plant (23.33) were recorded with the treatment T₇ (GRDF+ Zeolite @ 140

kg ha⁻¹) but it was at par with T₅ (GRDF + Zeolite @ 100 kg ha⁻¹) and T₆ (GRDF + Zeolite @ 120 kg ha⁻¹).

The treatment T₇ (GRDF+ Zeolite @ 140 kg ha⁻¹) recorded significantly highest 1000 grain weight of paddy crop (26.11g), however it was at par with, T₅ (GRDF + Zeolite @ 100 kg ha⁻¹) and T₆ (GRDF + Zeolite @ 120 kg ha⁻¹).

The number of grains panicle⁻¹ were not influenced significantly due to different treatments.

The increase in plant height, number of tillers, number of panicles and 1000-grain weight of paddy due to application of fertilizer alongwith different levels of zeolite might be due to favourable effect of zeolites in increasing the nutrient use efficiency of paddy. These results are in accordance with those reported by Mevlut *et al.* (2006), Sembiring *et al.* (2017), Walundari *et al.* (2019) [4, 6].

Table 2: Effect of zeolite application on growth and yield attributing characters of paddy at harvest as influenced by different levels of zeolite

Tr. No.	Treatment Details	Plant height (cm)	No. of tillers plant ⁻¹	No. of panicles plant ⁻¹	No. of grains panicle ⁻¹	1000 grain weight (g)
T ₁	Absolute control	62.33	13.00	11.67	84.67	17.65
T ₂	GRDF (100:50:50 kg ha ⁻¹ N: P ₂ O ₅ : K ₂ O + FYM 10 t ha ⁻¹)	69.67	15.89	15.00	88.00	19.61
T ₃	GRDF+ Zeolite @ 60 kg ha ⁻¹	77.00	17.98	17.50	90.33	21.81
T ₄	GRDF+ Zeolite @ 80 kg ha ⁻¹	84.00	20.51	20.00	92.00	23.85
T ₅	GRDF+ Zeolite @ 100 kg ha ⁻¹	91.00	22.60	22.33	95.67	25.81
T ₆	GRDF + Zeolite @ 120 kg ha ⁻¹	93.33	23.30	22.67	96.67	25.96
T ₇	GRDF + Zeolite @ 140 kg ha ⁻¹	95.67	24.33	23.33	97.67	26.11
	SE±	2.20	0.61	0.58	3.74	0.61
	CD (0.05)	6.79	1.88	1.78	NS	1.89

Yield

The data pertaining to yield and yield contributing characters are presented in Table 3. The data clearly indicated that there was significant influence of different treatments on grain yield and stover yield of paddy. The treatment T₇ (GRDF+ Zeolite @ 140 kg ha⁻¹) recorded significantly highest grain yield and stover yield (42.94 q ha⁻¹ and 59.20 q ha⁻¹) over all the treatments except T₅ (GRDF + Zeolite @ 100 kg ha⁻¹) and T₆ (GRDF + Zeolite @ 120 kg ha⁻¹) indicating favourable effect of zeolite upto 100 kg ha⁻¹ along with GRDF. The significantly higher yield and yield parameters of the paddy crop were recorded due to combined effect of GRDF and zeolite application to the field than the treatment with only GRDF to the crop.

The increase in grain yield and stover yield due to zeolite

application to paddy might be due to constant steady supply of nutrient throughout the crop growth period. The zeolite with honeycomb structure acts as a store house of macro and micronutrients. Zeolite with permanent negative charge is responsible for adsorption of nutrient cations and their subsequent release by ion exchange throughout the growth period of paddy. Improvement in nutrient use efficiency by increasing the availability and uptake of some macronutrients and micronutrients led to increase yield of paddy. Also zeolite has positive effect on physical and chemical properties of soil like higher available water holding and high adsorption capacities which helps to increase the yield.

Similar beneficial effect of zeolite reported by Mevlut *et al.* (2006) [4], Sepaskhah and Barzegar (2010), Ozbahce *et al.* (2015), Qi *et al.* (2016), Junlin *et al.* (2018).

Table 3: Grain and stover yield of paddy as influenced by different levels of zeolite

Tr. No.	Treatments details	Grain yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)
T ₁	Absolute control	12.83	17.31
T ₂	GRDF (100:50:50 kg ha ⁻¹ N: P ₂ O ₅ : K ₂ O + FYM 10 t ha ⁻¹)	31.54	41.34
T ₃	GRDF+ Zeolite @ 60 kg ha ⁻¹	35.49	46.71
T ₄	GRDF+ Zeolite @ 80 kg ha ⁻¹	38.68	52.59
T ₅	GRDF+ Zeolite @ 100 kg ha ⁻¹	41.86	58.00
T ₆	GRDF + Zeolite @ 120 kg ha ⁻¹	42.21	58.23
T ₇	GRDF + Zeolite @ 140 kg ha ⁻¹	42.94	59.20
	SE±	1.02	1.67
	CD (0.05)	3.16	5.16

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