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Enhancing Rice Growth and Yield through Foliar Application of "Amino Sil."

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Abstract

The present investigation entitled "Enhancing Rice Growth and Yield through Foliar Application of "Amino Sil" was carried out during *kharif* season of the year 2021 and 2022 on the field of ASPEE, Agricultural Research and Development Foundation, Tansa Farm, At - Nare, Taluka - Wada, Dist - Palghar, Maharashtra, India. The experiment was laid out in Randomized Block Design (RBD). The five treatments (Control, Amino Sil @ 1 gm, 1.5 gm, 2 gm and 2.5 gm per liter of water) were replicated four times. The plant height (107.31 cm), number of tillers per plant (12.95), number of panicles per plant (11.1), number of panicles per square meter (277.5) and length of panicle (20.1 cm) was found maximum in the year 2021 and the maximum values for 2022 *i.e* The plant height (121.34 m), number of tillers per plant (13.05), number of panicles per plant (11.45), number of panicles per square meter (304.9) and length of panicle (21.3 cm) with application of Amino Sil @ 2.5 gm per liter of water. The highest number of seeds per panicle (181.1), test weight (18.42 gm), grain yield (57.45 q/ha) and straw yield (85.08 q/ha) was found with application of Amino Sil @ 2.5 gm per liter water. While, lowest number of seeds per panicle (149.3), test weight (16.39 gm), grain yield (33.66 q/ha) and straw yield (49.6 q/ha) was also found in treatment T_4. The maximum number of seeds per panicle (186.85), test weight (19.74 gm), grain yield (59.15 q/ha) and straw yield (88.75 q/ha) was found in year 2022, with application of Amino Sil @ 2.5 gm per liter water. However, the lowest values were observed in control for all the parameters. The data clearly indicates that, the yield obtained with treatment T_4 (Amino Sil @ 2.5 gm per liter water) was significantly higher than all other treatments and also for growth parameters in year 2021 and 2022. However, the values for the same parameters were found maximum in the year 2022 as compared to year 2021.

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Rice, human food crop, scarcity of water and labor, climatic change, silicon.

Introduction

Rice is deeply engraved in the rich tradition and culture of India. It is the most important human food crop in the world. In addition to this It is also known as backbone of livelihood for millions of rural households and plays vital role in the country's food security. It is critical to global food security and to the welfare of around 800 million impoverished people around the world. The total area under rice cultivation in India is 2.75 million hectares, with an annual production of 105.2 million tonnes and a productivity of 2 62 kg per ha. The area under rice cultivation in Maharashtra, India is 1.56 million ha, with an annual production of about 3.06 million tonnes and a productivity of 1963 kg per ha. The country has managed to maintain the balance between rice supply and demand by applying improved production techniques, including the use of high-yielding varieties/hybrids, expanding irrigation capacities and the use of various fertilizers.

As the population continues to increase, the demand for rice is expected to increase further in the future. Therefore, rice production must also increase. As the area under rice cultivation continues to decrease, there is a need to further improve rice productivity. To begin with limitation for the productivity of country's rice system the major limitations are inefficient use of fertilizers, the scarcity of water and labor, climatic change, inflation and rising socio-economics. In addition to this impacts occurs on the labor migration, urbanization, youth, barren land, and concerns about environmental pollution and climate change due to weather conditions. For overcoming from this alarming situation rice production should meet the needs of a growing population is to increase rice productivity per unit area through more efficient use of resources. To improve rice productivity in India, high-yielding varieties capable of tolerating abiotic and abiotic stress should be explored for climate change. Rice crop production technologies that increase factor productivity reduce farming costs, increase profits, and efficient use of inputs should be explored. Rice accumulates the most silicon. In addition to increasing the productivity of rice, silicon has many functions Benefits such as greater availability of primary and secondary elements and micro nutrients. Outside In addition, silicon in rice reduces biotic and abiotic stresses.

Begin with Silicon advantages it promotes photosynthesis, prevents fungal and insect injuries and alleviates lodging. In addition to this, Silicon acids in plants varies from acting as osmolyte, regulation of ion transport, modulating stomatal opening, and detoxification of heavy metals. Amino acids also affect synthesis and activity of some enzymes, gene expression, and redox-homeostasis. Amino Acids are also supplied to plant by incorporating them into the soil and through foliar. Glycine and Glutamic Acid are fundamental metabolites in the process of formation of vegetable tissue and chlorophyll synthesis. These Amino Acids help to increase chlorophyll concentration in the plant leading to higher degree of photosynthesis. This makes crop lush Green. Silicon application is more an important in the later growth stages mean at panicle initiation stage. The content of silicon in the hull always much higher in fertile than in sterile panicles, and that the higher silicon content in the fertile panicles due to the transpiration of the panicle. The grain weight increased with the increase in the silicon content of the hull.

Silicon is the eighth most common element by mass and the second most abundant element on Earth after oxygen. Rice is a silica-accumulating plant and tends to accumulate actively at tissue concentrations of 5% or more (Epstein, 2002). Reduced amount of silicon in plant produces necrosis, disturbance in leaf photosynthetic efficiency, growth retardation and reduces grain yield in cereals especially rice. The positive effects of silicon on rice growth and production, manifested when it was specifically supplied during the reproductive growth stage (panicle initiation to heading) than that of vegetative and ripening stages, which exerted a feed-forward effect on photosynthesis coupled with increased in both stomatal conductance and biochemical capacity to fix CO_2 was reported by Lavinsky *et al.*, (2016), who surmised that proper levels of Si in reproductive structures played an unidentified role in increasing the yields of rice. Silicon plays an important role in plant growth and development. It increased the photosynthetic rate (Detmann *et al.*, 2012), leaf area (Gong *et al.*, 2003; Pati *et al.*, 2016 and Jan *et al.*, 2018) and chlorophyll content (Ranganathan *et al.*, 2006).

Keeping in view the above facts, the present study was designed with the objective to study the effect of foliar application of amino acids and silicon on growth and yield attributes of transplanted rice crop.

Materials and Methods

The experimental plot was conducted at ASPEE, Agricultural Research and Development Foundation Farm, Village - Nare, Tauka - Wada, District - Palghar in *kharif* season during 2021 and 2022 in Randomized Block Design (RBD) with four replications (r=4) (Panse and Sukhatme, 1967). The experimental site was situated at 19.65^0 N latitudes and 73.13^0E longitudes with average annual rainfall of 3600 mm. Five treatments consist of different levels of Amino Sil such as T0 - Control (Amino Sil @ 0 gm), T1 - Amino Sil @ 1 gm, T2 - 1.5 gm, T3 - 2 gm and T4 - 2.5 gm per liter water were tested in rice grains production. Treatments are given twice by spraying over standing crop. First spray conducted at 40 days after transplanting, while second spray conducted at 75 days after transplanting. Interestingly, the only non-essential nutrient that is included in the guidelines for rice fertilization is silicon (Si).

The recommended dose of fertilizer (120 kg N: 50 kg P2O5: 50 kg K2O: 6 kg Zn) was applied. The recommended dose of NPK was applied in the form of urea (46-0-0), single super phosphate (0-16-0), and the muriate of potash (0-0-60). Recommended management practices and plant protection measures were taken.

The data obtained during the study were subjected to statistical analysis using the WASP (Software developed by ICAR Research complex Goa).

Results and Discussion

Plant growth parameters

The growth period of the rice plant has divided into three stages; vegetative stage, reproductive stage, and ripening stage. Silicon also has a major role in increasing yield attributing characters like number of spikelets, filled spike-let percentage, test weight and total grain yield (Rani *et al.*, 1997; Ahmad *et al.*, 2013; Jawahar *et al.*, 2015 and Patil *et al.*, 2017) in rice. Rice variety 'GR-11' was sown in first fortnight of June during 2021 after seed treatment with the fungicide thiram @ 3 g kg-1 seeds. Twenty five days old seedlings were transplanted at spacing of 20 cm x 15 cm. The bed size was 3.30 m x 3.0 m. Randomly five plants (n=5) were selected from each plot for recorded regular biometric observations from 30 days after transplanting to till harvest. Data were compiled and analyzed using appropriate statistical method.

The vegetative stage refers to the period from transplanting to panicle initiation, the reproductive stage from panicle initiation to heading, and the ripening stage from heading to maturity. Fundamental functions of the amino acids in plants are anti-stress agent, chelating agent, cold weather resistance, generative development of plants and improvement of the plant pollen fertility, growth stimulator, precursor of auxin, precursor of chlorophyll, precursor of polyamines: necessary to start the cell division, precursor to the formation of lignin and woody tissues, regulation of the water balance, reserve of organic nitrogen necessary for the synthesis of other amino acids and proteins, stimulation of the chlorophyll synthesis, stimulation of the ethylene synthesis, stimulation of the germination, stimulation of the hormone metabolism, and stimulation of the resistance mechanism to viruses.

The plant growth parameters *viz.*, plant height and numbers of tillers were significantly influenced by various doses of Amino Sil applied in rice. The maximum values of these parameters were recorded with treatment T4 *i.e.* Amino Sil @ 2.5 gm/liter water for year 2021 and 2022 in table 1a. In which plant height was at par with treatments T1, and T2. Similar findings was observed by Detmann *et al.*, (2012) and Lavinsky *et al.*, (2016) who demonstrated that Si played an important functions in enhancing the sink size and strength, which in turn, exerted a feed-forward effect on photosynthesis that coupled with increased in both stomatal conductance and biochemical capacity to fix CO2 when Si is specifically supplied during the reproductive growth stage (panicle initiation to heading) of rice. This might be due to Si fertilization improving the resistance to lodging and also increases the erectness of leaves and leaf blades; which allow better light transmittance through plant canopies and thus indirectly improve whole-plant photosynthesis in rice (Savant *et al.*, 1997; Tamai and Ma, 2008). Application of Amino Sil didn't show any significant effect on plant population and number of days to 50% flowering.

Yield parameters

Yield contributing parameters viz. number of panicles per plant, number of panicles per square meter, length of panicle, seeds per panicle, test weight, grain and straw yields were measured at harvest of the crop.

The result in table 1b indicated that different treatments induced marked variations in number of panicles per plant, number of panicles per square meter, length of panicle, seeds per panicle, test weight, grain and straw yields. Highest values of all these parameters were found with treatment T4 (Amino Sil @ 2.5 gm/liter water). The higher number of panicles per plant (11.1), number of panicles per square meter (277.5), length of panicle (20.1 cm), seeds per panicle (181.1), test weight (18.42 g), grain (57.45q/ha) and straw (85.08 q/ha) yields were recorded in treatment T_4 for year 2021 and for year 2022 highest number of panicles per plant (11.45), number of panicles per square meter (304.9), length of panicle (21.3 cm), seeds per panicle (186.85), test weight (19.74 g), grain (59.15q/ha) and straw (88.75 q/ha) yields, was found in treatment T_4 *i.e.* application of Amino Sil @ 2.5 gm/liter water.

Table.1(a) Enhancing Rice Growth and Yield through Foliar Application of "Amino Sil

Treatment	Plant population (m^2)		Plant height (cm)		No. of tillers per plant		No. of days to 50% flowering		No. of panicles per plant		No. of panicles (m^2)	
Year	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
T_0	30.75	31	99.05	106.59	10.9	9.4	77.75	80	9.3	7.85	232.5	234
T_1	32	32	101.24	110.67	11.5	11.2	72.25	73.75	10.05	9.7	251.25	265.3
T_2	33.25	33.5	103.19	112.8	11.6	11.65	68.75	71.25	10.25	10.2	256.25	280.4
T_3	33.75	34.75	104.98	114.85	11.9	12.1	71	67	10.7	10.55	267.5	287.5
T_4	34.75	35.25	107.31	121.34	12.95	13.05	66.5	62.5	11.1	11.45	277.5	304.9
S.Em. (±)	0.93	1.05	0.96	2.89	0.27	0.32	3.44	2.03	0.21	0.24	5.37	9.08
CD	NS	NS	2.95	8.9	0.83	0.98	NS	6.27	0.66	0.73	16.54	27.99

Table.1(b) Enhancing Rice Growth and Yield through Foliar Application of "Amino Sil

Treatment	Length of panicle (cm)		No. of seeds per panicle		Test weight (1000 grain wt.)		Grain Yield (q/ha)		Straw Yield (q/ha)	
Year	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
T_0	18.8	17.8	149.3	141	16.39	15.61	33.66	34.28	49.6	51.43
T_1	19.4	19.7	160.45	158.03	16.64	17.11	42.68	42.28	62.95	63.45
T_2	19.6	20.1	172.95	169.35	16.78	17.52	42.8	43.3	62.16	64.95
T_3	19.8	20.6	177	178.2	17.53	17.88	44.85	45.13	64.96	67.73
T_4	20.1	21.3	181.1	186.85	18.42	19.74	57.45	59.15	85.08	88.75
S.Em. (±)	0.13	0.52	2.35	4.96	0.36	0.39	4.47	2.09	6.46	3.58
CD	0.39	1.62	7.24	15.3	1.11	1.21	13.76	6.43	19.9	11.05

In year 2022 the effect of application of Amino Sil was found greater than the previous year (2021) in all aspects of yield parameters. Yield attributes *viz*., number of panicles per plant, seeds per panicle, test weight and grain yield per panicle were significantly affected by Silicon in rice. Silicon application increased the number of spike-lets per panicle of rice particularly applied during reproductive stage. This might be due to increased synthesis of carbohydrates and that might have increased the sink size and capacity.

Silicon fertilizer, that may significantly reduce empty spikelet's number in rice and increase fertility, increased spike-lets per panicle that ultimately increased crop yield. The contribution of carbohydrates from photosynthetic activity for longer period might have resulted in efficient translocation of food material into the sink (grain) thereby increased the number of filled grains percentage. Grain yield per panicle of rice also increased by silicon than control (without silicon). Similar results were observed earlier by Jawahar *et al*., (2015). Initially, it was reported that silicon is responsible to control stomatal activity, photosynthesis and water use efficiency which ultimately results in better vegetative and reproductive growth which ultimately increased the panicle weight (Dekhane *et al*., 2022).

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