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Short Communication

Enhancing yield and nutrient use efficiency through coated gypsic fertilizer (Sparsh gold) in irrigated rice

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Rice farmers usually apply nitrogen, phosphorus and potassium at high rates to the crop. Whenever there is an imbalance between off take and input of nutrients, it may lead to a decline in soil fertility and increase incidence of deficiencies of certain plant nutrients especially sulphur and zinc (Sachdev and Sachdev, 2002). Sulphur and calcium are essential secondary nutrients for crop growth and development. Sulphur has an important role in chlorophyll production, protein synthesis and plant function and structure and also an important constituent of straw and plant stalks. Whereas, calcium is involved in development of a good root system and combines with pectin to form calcium pectate, which is an essential constituent of the cell-wall. It also promotes the activity of soil bacteria. So, there is a need to pay attention on sulphur and calcium nutrition of rice in intensively cropped areas and imbalanced fertilized soils. Though several chemical materials are available at present in the market, there is no specific compound exclusively for sulphur and calcium that has been reported to enhance the nutrient content and yield of rice through soil application. In view of this, Sparsh gold product was manufactured by using gypsum. Along with 16% Cereal Protein hydrolysate (CPH), potassium gluconate ($C_6H_{11}O_7$ K) is also used (8%) in producing sparsh gold by coating gypsum. Sixteen different amino acids from vegetable source (maize-mostly) with plant growth substances and essential traces minerals and are coated on carrier gypsum.

The field experiment was conducted at the Indian Institute of Rice Research farm during *rabi* 2017-18. The soil was texturally clay with alkaline pH (8.19), low in salinity (0.50), medium in organic carbon (0.61), low in nitrogen (101 Kg ha^{-1}), high in phosphorus (50.3 Kg ha^{-1}) and potassium (568 Kg ha^{-1}). The experiment was carried out in a randomized complete block design with four replications with the following treatment combinations: T1 (RDF + 5 Kg sparsh gold ha^{-1} at tillering), T2 (RDF + 10 Kg sparsh gold ha^{-1} at tillering), T3 (RDF + 5 Kg sparsh gold ha^{-1} at tillering + 5 Kg sparsh gold ha^{-1} at panicle initiation), T4 (RDF+ 10 Kg sparsh gold ha^{-1} at tillering + 10 Kg sparsh gold ha^{-1} at panicle initiation) and T5 (Control)-RDF. The RDF was 120: 40: 40 NPK Kg ha^{-1}. N was applied at 3 splits *viz.,* 50% at basal, 25% at tillering and 25% at panicle intiation stage and entire quantity of phosphorus and potassium were applied at basal. Sparsh gold was applied according to the treatments. Rice variety Chandra was used in the experiment. Various crop growth and yield observations were recorded. NPK uptake at harvest and post harvest NPK soil status were analyzed by following standard procedures.

Advancement in growth stages did not alter the SPAD value and NDVI significantly, across the scheduled treatments of sparsh gold. But it has made significant changes in tillers number and panicle number over the advancement of growth stage. Tillering is the product of expanding auxiliary buds and is closely associated with nutritional condition of the mother culm during its early growth period, which gets improved by application of sulphur as it improves use efficiency of other nutrients particularly nitrogen and phosphorus (Samaraweera, 2009; Asha Ram *et al*., 2014).

Sparsh gold treated plants recorded higher number of yield parameters compared to control. There was significant increase in grain yield observed with application of sparsh gold in different doses (5 and 10 Kg ha^{-1} at two different intervals) over control plot (Table 1). Sparsh gold treated plots recorded higher grain yields ranged from 20 to 37% compared to control. Though the panicle number was non-

Table 1: Growth parameters of (*Rabi* 2017 - 2018).

Treatments	NDVI		SPAD		Yield and yield parameters					
	30 DAT	45 DAT	30 DAT	45 DAT	Tillers m^{-2}	Panicle m^{-2}	Grain number $panicle^{-1}$	1000 grain weight (g)	Grain Yield (Kg ha^{-1})	Straw Yield (Kg ha^{-1})
5 Kg ha^{-1} at tillering	0.68	0.70	38.0	36.2	346	317	88	23.1	5460	8333
10 Kg ha^{-1} at tillering	0.70	0.72	37.2	37.5	385	326	97	23.2	5568	8716
5 Kg ha^{-1} at tillering + 5 Kg ha^{-1} at panicle initiation	0.70	0.73	37.8	40.9	411	338	110	23.3	6215	10283
10 Kg ha^{-1} at tillering + 10 Kg ha^{-1} at panicle initiation)	0.69	0.76	37.9	37.9	395	332	142	23.3	6166	10083
Control	0.66	0.72	37.7	39.3	333	307	72	23.0	4546	7916
Mean	0.66	0.71	37.7	38.4	374	324	102	23.2	5591	9066
CD (5%)	NS	NS	NS	NS	52	NS	33	NS	643	1704
C.V.	11.3	5.2	4.9	9.8	7.3	19.0	16.8	1.06	6.0	9.8

Table 2: Soil properties at harvest (*Rabi* 2017 - 2018).

Treatments	pH (1:2.5)	EC (dS m^{-1})	Org. Carbon (%)	Available N (Kg ha^{-1})	Available P (Kg ha^{-1})	Available K (Kg ha^{-1})
5 Kg ha^{-1} at tillering	8.21	0.59	0.67	91.8	57.6	496
10 Kg ha^{-1} at tillering	8.20	0.67	0.7	94.0	55.9	500
5 Kg ha^{-1} at tillering + 5 Kg ha^{-1} at panicle initiation	8.31	0.61	0.65	94.8	50.9	483
10 Kg ha^{-1} at tillering + 10 Kg ha^{-1} at panicle initiation)	8.21	0.59	0.66	94.0	60.0	469
Control	8.17	0.77	0.73	96.0	57.6	483
Initial value	**8.19**	**0.50**	**0.61**	**101.5**	**50.3**	**568**

significant across the sprash gold treated plots, the filled grain number was higher in 5 Kg sparsh gold (applied in two intervals) treated plots and this has reflected in higher grain yield (6215 Kg ha^{-1}) and this treatment was at par with the sparsh gold applied @ 10Kg at two intervals (6166 Kg ha^{-1}). The same trend was noticed in straw yield of rice. Sparh gold treated plots recorded higher straw yields ranged from 5 to 30% compared to control. Application 5 Kg sparsh gold at two intervals registered significantly higher straw yield (10283 Kg ha^{-1}) and at par with the 10 Kg at two interval (10083 Kg ha^{-1}). Sulphur plays a crucial role in diversion of photosynthate towards the shoot at every growth stages and marked variation was noticed at PI and maturity stages (Singh *et al.,* 2012). It indicates role of sulphur is much more in signaling process of photosynthate especially after onset of reproductive stages (Rahaman *et al.*, 2008). Application of Ca significantly improved water status of the plants both at the vegetative and reproductive stages. Ca treatments of seeds or plants or their combination inhibited the decline in chlorophyll and protein contents. Calcium chloride treatment increased yield components and yield of the crop in both stressed and non-stressed plants (Nayek *et al.*, 1983). Liu *et al.* (2011) reported that concentrations of K^+ and Ca^{2+} in root exudates during early or middle grain filling period (10 days or 20 days after heading stage) were significantly or very significantly and negatively correlated with chalky kernel per-centage, chalkiness and amylose content. These results indicate

Table 3: Nutrient use efficiency (Kg grain Kg^{-1} nutrient applied).

Treatments	Nitrogen use efficiency (NUE)	Phosphorus use efficiency (PUE)	Potassium use efficiency (KUE)
5 Kg ha^{-1} at tillering	55	137	137
10 Kg ha^{-1} at tillering	56	139	139
5 Kg ha^{-1} at tillering + 5 Kg ha^{-1} at panicle initiation	62	155	155
10 Kg ha^{-1} at tillering + 10 Kg ha^{-1} at panicle initiation)	62	154	154
Control	45	114	114

that root exudates are closely associated with grain quality, and K and Ca could regulate root exudates, and consequently, affect grain quality in rice.

There was no difference in soil fertility parameters after harvest between the treatments though there was a slight increase in organic carbon with sprash gold addition over the control plot (Table 2). Singh *et al.* (2012) reported that gradual build-up of organic carbon (%), N, P and K due to application of sulphur and zinc. Application of sparsh gold resulted in a slight increase in pH and EC over the control plot and decrease in soil available N and K_2O level has been noticed sparsh gold treated plots over the control due to high dry matter production. In a single season, significant differences in soil properties cannot be observed due to treatments in most of the soils.

Application of sparsh gold resulted in increased use efficiencies of nitrogen, phosphorus and potassium (Table 3). Higher nutrient use efficiencies were recorded in 5 Kg sparsh gold (applied in two intervals) and 10 Kg sparsh gold (applied in two intervals) treatments. The increased nutrient use efficiency for nitrogen ranged from 22 to 38% , for phosphorus and potash from 20 to 36%. The improvement in the Nitrogen use efficiency components of the rice crop could be due the synergistic effect of S on N uptake and utilization that facilitates the biosynthesis of proteins, a vital process that determines yield (Habtegebrial *et al.,* 2013).

The results revealed that the rice responded well to the application of sparsh gold and application of sparsh gold @ 5 Kg ha^{-1} at two intervals (tillering and panicle initiation stage) along with RDF was sufficient to achieve higher yields by 36% over RDF as well as higher nutrient use efficiency.

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