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Effect of foliar application of nutrient elements on upland rice under water stress condition in Bastar Plateau

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Abstract
An experiment was conducted during Kharif 2017 at SGCARS, Jagdalpur research farm in upland situation with the objectives of assessing the effect of foliar application of nutrient elements on upland rice under water stress condition in Bastar plateau. The experiment was conducted in randomized block design with twelve treatments namely T_1 (RDF as control), T_2 (RDF + water spray at stress condition), T_3 (RDF + P spray (KH_2PO_4, 2%) at stress condition), T_4 (RDF + P spray (KH_2PO_4, 1%) at stress condition), T_5 (RDF + N spray (Thiourea, 2000 ppm) at stress condition), T_6 (RDF + N spray (Thiourea,1000 ppm) at stress condition), T_7 (RDF + B spray (borax, 0.5%) at stress condition), T_8 (RDF + B spray (borax, 0.25%) at stress condition), T_9 (RDF + Zn spray ($ZnSO_4$, 0.5%) at stress condition), T_{10} (RDF + Zn spray ($ZnSO_4$, 0.25%) at stress condition), T_{11} (RDF + KNO_3 spray (1%) at stress condition) and T_{12} (RDF + KNO_3 spray (0.5%) at stress condition). The RDF was 80:50:30 kg NPK ha^{-1}. The stress was created for 20 days from 40 to 60 DAS and treatments were imposed at 45 and 55 DAS with 375 litres of water per hectare.

Keywords: Foliar, nutrient, elements, water, plateau

Introduction
Rice is the most important and extensively cultivated food crop, which provides half of the daily food for one of every three persons on the earth cropped in 163.2 million ha with a production of 719.7 million tons of grains (Mondal *et al.*, 2015). In India, rice occupies an area of 43.39 M ha with production and productivity of 104.32 M t and 2.4 t ha^{-1}, respectively (Ministry of agriculture & farmer's welfare, 2016). In Chhattisgarh, rice occupies an area of 3.84 mha with production and productivity of 6.09 M t and 1.5 t ha^{-1}, respectively (Ministry of agriculture & farmer's welfare, 2016). In Bastar district, the area under kharif paddy was about 137.60 thousand hectares, production was 244.70 thousand tones and productivity was 1778 kg ha^{-1} (Anonymous, 2012) [3].

Foliar application of nutrients has become an efficient way to increase yield and quality of crops (Romemheld and El-Fouly, 1999) [9]. In semiarid regions, foliar application of nutrients is a more suitable option compared with soil fertilization as it gives quick compensation of nutrient deficiency and it also helps in combating situation of water stress. Some of the compounds known for water stress management are potassium meta phosphate, thiourea, borax, zinc sulphate and potassium nitrate. Their roles and functions have been summarized in subsequent paragraphs.

Boron (B) is responsible for better pollination, seed setting and grain formation in different rice varieties (Aslam *et al.*, 2002) [4]. To crop with B deficiency, it can be delivered as soil and foliar application. Foliar applied B plants retain significant phloem mobility to flowering parts from senescing leaves. Therefore, foliar sprays of B not only provide a means to apply B at a particular growth stage, but also remove B deficiency (Rashid *et al.*, 2004) [8].

Materials and Methods
The experiment was conducted at the upland field under All India Coordinated Research Project for Dryland Agriculture, S.G. College of Agriculture and Research Station, Kumhrawand, Jagdalpur, Bastar (C.G.) during Kharif season of year, 2017.

Chhattisgarh state is located between 17˚30' and 24˚45' N latitude and 70˚30' and 84˚15' E longitude whereas Bastar lies at 19˚10' N latitude and 81˚95' E longitude with an altitude of 552 meter above mean sea level. Kumhrawand, located at Bastar district lies at 19˚05'43' N latitude and 81˚57'60'' E longitude. It has an average elevation of 552 meter above mean sea level

The region comes under sub-humid climate. The average annual rainfall of the area is 1544 mm. Major amount of precipitation occurs between June to September (about 3-4 months) which is the main rice growing seasons. Daily temperature (Maximum and Minimum) open pan evaporation and rainfall of 2016 were recorded from the meteorological observatory of Agro-meteorology Department, S.G. CARS Jagdalpur and the crop season meteorological data from 3rd week of June to 1st week of October. The investigation period received rainfall of 1305.6 mm.

(T1) RDF, (T2) RDF + water spray at stress condition, 45 and 55 DAS, (T3) RDF + P spray (KH_2PO_4, 2%) at stress condition, 45 and 55 DAS, (T4) RDF + P spray (KH_2PO_4, 1%) at stress condition, 45 and 55 DAS, (T5) RDF + N spray (Thiourea, 2000 ppm) at stress condition, 45 and 55 DAS, (T5) RDF + N spray (Thiourea, 1000 ppm) at stress condition, 45 and 55 DAS, (T6) RDF + N spray (Thiourea, 1000 ppm) at stress condition, 45 and 55 DAS, (T7) RDF + B spray (borax, 0.5%) at stress condition, 45 and 55 DAS, (T8) RDF + B spray (borax, 0.25%) at stress condition, 45 and 55 DAS, (T9) RDF + Zn spray ($ZnSO_4$, 0.5%) at stress condition, 45 and 55 DAS, (T10) RDF + Zn spray ($ZnSO_4$, 0.25%) at stress condition, 45 and 55 DAS, (T11) RDF + KNO_3 spray (1%) at stress condition, 45 and 55 DAS, (T12) RDF + KNO_3 spray (0.5%) at stress condition, 45 and 55 DAS. RDF: 80:50:30 kg NPK ha-1. The spray treatments were applied at 45 and 55 DAS with 375 liters of water. Fertilizers were applied as per treatment in each plot. The recommended doses of NPK were 80:50:30 kg ha^{-1}. The full doses of P and K and 1/3rd doses of N were applied as basal, Remaining N doses were given at 35 DAS and 60 DAS.

Results and Discursion

Yield and yield attributing parameters

Plant height

Showed the effect of foliar application of nutrients on plant height during crop growth period under water stress condition. The increment in plant height was 11.13% in T_3-RDF + P spray (KH_2PO_4, 2%) at stress condition, 45 and 55 DAS at 90 DAS (114.50 cm) followed by 10.32% in T_{11}-RDF + KNO_3 spray (1%) at stress condition, 45 and 55 DAS (10.32 cm) and 10.10% in T_5-RDF + N spray (Thiourea, 2000 ppm) at stress condition, 45 and 55 DAS (10.10 cm) which were significantly higher than T_1-RDF (103.03 cm).

Leaf area index

The effect of foliar application of nutrients on leaf area index during crop growth period under water stress condition was depicted in indicated that T_{11}-RDF + KNO_3 spray (1%) under stress condition, 45 and 55 DAS at 90 DAS (6.06) was found significantly higher over T_1-RDF (5.69).

Number of tillers

The data on effect of foliar application of nutrients on number of tillers at water stress condition are presented in Table 4.5 and depicted in Fig. 4.6.1 indicated that effective tillers were significantly higher in T_{11}-RDF + KNO_3 spray (1%) at stress condition, 45 and 55 DAS (158.67) followed by T_5-RDF + N spray (Thiourea, 2000 ppm) at stress condition, 45 and 55 DAS (151) and T_3-RDF + P spray (KH_2PO_4, 2%) at stress condition, 45 and 55 DAS (145) over T_1-RDF (50.67).

Panicle length

The effect of foliar application of nutrients on panicle length at water stress condition are presented in indicated that panicle length was significantly higher in T_3-RDF + P spray (KH_2PO_4, 2%) at stress condition, 45 and 55 DAS (21.87) followed by T_{11}-RDF + KNO_3 spray (1%) at stress condition, 45 and 55 DAS (21.67) and T_5-RDF + N spray (Thiourea, 2000 ppm) at stress condition, 45 and 55 DAS (21.60) over T_1-RDF (18.67).

Test weight

Showed the effect of foliar application of nutrients on test weight under water stress condition. The increment in test weight was 7.49% in T_{11}-RDF + KNO_3 spray (1%) at stress condition, 45 and 55 DAS (21.47 g) followed by 6.49% in T_5-RDF + N spray (Thiourea, 2000 ppm) at stress condition, 45 and 55 DAS (21.27 g) and 6.33% in T_9-RDF + Zn spray ($ZnSO_4$, 0.5%) at stress condition, 45 and 55 DAS (21.23 g) which were significantly higher than T_1-RDF (19.97 g).

Chlorophyll content (mg/g) in leaves during crop growth period

The effect of foliar application of nutrients on chlorophyll content (mg/g) in leaves during crop growth period is presented in under water stress condition. The results clearly indicated that there were significant variations in chlorophyll content. The maximum chlorophyll content (1.35 mg g^{-1}) was recorded under treatment T_3-RDF + P spray (KH_2PO_4, 2%) at stress condition, 45 and 55 DAS followed by T_6-RDF + N spray (Thiourea, 1000 ppm) at stress condition, 45 and 55 DAS (1.33 mg g^{-1}) which were significantly higher over control (T1) (1.0 mg g^{-1}).

Dehydrogenase activity (µg TriPhenyl Formazone g^{-1} soil h^{-1}) during crop growth period

The data on dehydrogenase activities during crop growth period at water stress condition are presented in and depicted in indicated that at 60 DAS dehydrogenase activity was significantly higher in T_9-RDF + Zn spray ($ZnSO_4$, 0.5%) at stress condition, 45 and 55 DAS (13.67 µg TPF g^{-1} soil h^{-1}) followed by T_{11}-RDF + KNO_3 spray (1%) at stress condition, 45 and 55 DAS (13.67 µg TPF g^{-1} soil h^{-1}) and T_6-RDF + N spray (Thiourea, 1000 ppm) at stress condition, 45 and 55 DAS (13.50 µg TPF g^{-1} soil h^{-1}) over T_1-RDF (8.23 µg TPF g^{-1} soil h^{-1}). Although, the dehydrogenase activity in water stressed soil decreased from 40 DAS to 60 DAS due to the lower microbial activities. The increment in dehydrogenase activities were 66.06 and 64.44% in T_9 and T_{11} as compared to T_1.

Dehydrogenase activity (µg TriPhenyl Formazone g^{-1} soil h^{-1}) during crop growth period

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Table 1: Effect of foliar application of nutrient elements crop management practices on yield attributing characters

Treatment	Plant height (cm)	Leaf area index	Number of tillers	Panicle length	Test weight	Chlorophyll content (mg/g) (60 DAS)	Dehydrogenase activity (μg) (60 DAS)
T_1-RDF	103.03	5.69	131.00	18.67	19.97	1.00	8.23
T_2-RDF + water spray at stress condition, 45 and 55 DAS	109.17	5.85	141.00	20.40	20.57	1.08	11.87
T_3-RDF + P spray (KH_2PO_4, 2%)	114.50	5.94	194.33	21.87	20.80	1.35	12.73
T_4-RDF + P spray (KH_2PO_4, 1%)	111.13	5.89	150.00	20.83	20.97	1.13	12.00
T_5-RDF + N spray (Thiourea, 2000 ppm)	113.43	5.95	197.00	21.60	21.27	1.33	12.67
T_6-RDF + N spray (Thiourea, 1000 ppm)	112.20	5.89	178.00	21.17	21.17	1.12	13.50
T_7-RDF + B spray (borax, 0.5%)	111.33	5.82	175.00	21.03	21.00	1.25	13.40
T_8-RDF + B spray (borax, 0.25%)	109.33	5.93	186.00	20.77	20.60	1.20	13.10
T_9-RDF + Zn spray ($ZnSO_4$, 0.5%)	111.43	5.92	180.67	20.83	21.23	1.31	13.67
T_{10}-RDF + Zn spray ($ZnSO_4$, 0.25%)	110.67	5.85	176.33	20.23	20.87	1.17	12.90
T_{11}-RDF + KNO_3 spray (1	113.67	6.06	202.33	21.67	21.47	1.26	13.53
T_{12}-RDF + KNO_3 spray (0.5	112.67	5.94	179.00	21.10	20.73	1.13	13.30
CD 5%	8.92	0.26	30.40	2.12	0.98	0.31	5.80
CV	4.74	2.63	10.30	6.00	2.78	15.34	27.23

Table 2: Physico-chemical properties of soil

Properties	Values	Class
A. Physical properties		
Mechanical composition		
Sand (%	52	
Silt (%)	26	
Clay (%)	22	
Textural class	Silt Loam	
Bulk density (g/cm^3)	1.4	
B. Chemical properties		
pH (1:2.5 Soil:Water)	6.10	Acidic condition
EC (dSm^{-1})	0.22	Fair
CEC [c mol (p+) kg^{-1}]	16.42	
Organic carbon (%)	0.63	Medium
Available N (kg ha^{-1})	248.98	Medium
Available P_2O_5 (kg ha^{-1})	28.56	Low (Bray's P)
Available K_2O (kg ha^{-1})	233.45	Medium
Available S (kg ha^{-1})	19.88	Medium
Available B (ppm)	0.60	Sufficient
DTPA Extractable Zn (ppm)	0.96	Sufficient

Conclusion

- The increase in available nutrients in soil would be due to non-absorption of applied fertilizer's nutrients by the stressed paddy crop in upland situation which were loss as fertilizer nutrient use efficiency were very low.
- The positive response was observed in dehydrogenase activities during crop growth period under water stress condition if nutrients were sprayed particularly zinc sulphate (0.5%) and potassium nitrate (1.0%).
- All the yield attributing characters and yield of rice var. CR-40 significantly increased due to spray of nutrient fertilizers at 45 and 55 DAS along with RDF over RDF alone.
- highest gross return of Rs. 27335 was exhibited in T_{11}-RDF + KNO_3 spray (1%) at stress condition, 45 and 55 DAS followed by T_5-RDF + N spray (Thiourea,2000 ppm) at stress condition, 45 and 55 DAS (Rs.26757) and T_6-RDF + N spray (Thiourea, 1000 ppm) at stress condition, 45 and 55 DAS (Rs.25382) which were significantly higher over T_1-RDF (Rs.13447). Similar trends were observed for net return and benefit: cost ratio among different treatments.

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