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Assessment of foliar spray of DAP on nutrient uptake and efficiency of rice in a *Vertisol* of Chhattisgarh

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Abstract

A field experiment was conducted during *Kharif* season, 2022 at Instructional cum Research farm, IGKV, Raipur, (C.G.) to study the assessment of foliar spray of DAP on productivity and nutrient uptake of rice in a *Vertisol* of Chhattisgarh. The experiment was laid out in a randomized block design with twelve treatments and replicated four times. Treatments included T₁- N0-P0-K0, T₂- N100-P0-K40, T₃- N100-P60-K40, T₄- N100-P15-K40 + 2% DAP two spray (20, 35 DAT), T₅- N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT), T₆- N100-P30-K40 + 2% DAP two spray (20, 35 DAT), T₇- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T₈- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT), T₁₀- N75-P30-K40 + 2% DAP two spray (20, 35 DAT), T₁₁- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT) and T₁₂- N100-P15-K40 + Root treatment + 2% DAP three spray (20, 35, 50 DAT). The total N uptake were recorded significantly in treatments T₇- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T₈- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T₆- N100-P30-K40 + 2% DAP two spray (20, 35 DAT), T₅- N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT) which was at par with treatment T₃- N100-P60-K40. Total P uptake were recorded significantly in treatments T₈- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T₇- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T₆- N100-P30-K40 + 2% DAP two spray (20, 35 DAT) which was at par with treatment T₃- N100-P60-K40. Total K uptake were recorded significantly in treatments T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT), T₇- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T₈- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T₆- N100-P30-K40 + 2% DAP two spray (20, 35 DAT) which was at par with treatment T₃- N100-P60-K40. Nutrient use efficiency of N, P and K is observed highest in treatment T₁₁- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T₄- N100-P15-K40 + 2% DAP two spray (20, 35 DAT) and T₃- N100-P60-K40 respectively.

Keywords: Rice, foliar spray, nutrient modules, efficiency

Introduction

Rice (*Oryza sativa* L.) belongs to the *Poaceae* family and is the most important cereal crop in India because of staple food for the majority people and also feeds more than half of the world's population. It is the backbone of livelihood for millions of rural households and plays an important role in food security, so the phrase "rice is life" is in the Indian context, and Chhattisgarh is also known as "rice bowl" of India. In terms of area and output, India is a major producer of rice. The ability of rice crop to adapt may be seen in the manner in which that it is grown in a variety of climatic regions, from tropical to temperate subtropical countries. The rice crop mostly depends on the soil conditions, which provide accessible nutrients i.e. major, secondary and micronutrients to meet the crop growth requirements, development, and finally yield. For the sustainable and efficient management of crop, nutrient fertilisation of the foliage is an essential resource. It is gaining significant commercial importance world-wide due to the costly and limited availability of basic materials and the higher losses of nutrients from soil through various mechanisms. Second in importance to nitrogen as a plant nutrient, phosphorus has become a costly input since the majority of its raw materials are imported from abroad. Regardless of the brand or composition of the fertiliser, phosphorus fixation occurs when it is applied to soil. Phosphorus is fixed when it interacts with different soil minerals to produce insoluble compounds that are unavailable to crops. In most mineral soils, the maximum P use efficiency has been observed to be between 30-40% of the total P applied. The above-

mentioned limitations can be solved by foliar application of P fertiliser. One of the most common types of phosphate fertiliser used by farmers for growing crops is DAP. As an alternative to using the water-soluble P fertiliser to solve the problem mentioned above, foliar spraying of DAP may be one of the alternatives.

Materials and Methods

The field experiment was conducted at the Instructional cum Research farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, during *Kharif* season for the year 2022 for the investigation entitled "Assessment of foliar spray of DAP on productivity and nutrient uptake of rice in a *Vertisol* of Chhattisgarh". The location of experiment was at the east of Raipur, situated in the mid-eastern part of Chhattisgarh lying at $21^{\circ} 16'$ N latitude and $81^{\circ} 36'$ E longitude with an altitude of 298.56 meter above the mean sea level (MSL). The climate of the experimental area is characterized by sub-humid conditions, with an average annual rainfall of 1400-1600 mm and a major part of precipitation occurs between June and September. The months May and December are the hottest and coolest, respectively. The experimental soil falls within the category of *Vertisol*, which is a fine, hyperthermic, montmorillonitic chomustert known locally as *Kanhar* and classified as Arang II series. Due to the existence of a high concentration of lime in the lower horizon, clayey, dark brown to black in colour, and neutral to alkaline in reaction. The soil's depth was up to 1-1.5 meter. Since, it is deep in the middle plains of Chhattisgarh, therefore, it has a high water holding capacity. The structure ranged from rough angular blocky to massive and cloddy, and in some as prismatic or columnar. Surface soil samples from 0-15 cm were randomly collected and composite samples were prepared with the use of an auger for the evaluation of various physico-chemical parameters of the experimental location. The soil was clayey in texture and slightly alkaline (7.67) interaction while it was normal in salt content (0.14 dS m^{-1}). The available soil nitrogen status in soil was 218 kg ha^{-1} and organic carbon was 0.49 percent which falls under low category in soil. The available phosphorus (17.7 Kg/ha) and potassium (498 Kg/ha) were found to be medium and high category in soil, respectively. There were twelve treatment combinations as detailed below:

T₁- N0-P0-K0, T₂- N100-P0-K40, T₃- N100-P60-K40, T₄- N100-P15-K40 + 2% DAP two spray (20, 35 DAT), T₅- N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT), T₆- N100-P30-K40 + 2% DAP two spray (20, 35 DAT), T₇- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T₈- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT), T₁₀- N75-P30-K40 + 2% DAP two spray (20, 35 DAT), T₁₁- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT) and T₁₂- N100-P15-K40 + Root treatment + 2% DAP three spray (20, 35, 50 DAT).

The parameters of growth and yield attributes were recorded from in each plots randomly at the time of harvest. The plant height was measured from five randomly selected tagged plants from the base of the plant to the tip of fully opened leaf and the average plant height was taken and expressed in centimetre. The number of effective tillers was counted at ground level for each hill. Five hills were selected from each plot at the time of harvest and then mean was worked out for each treatment. The total number of tillers was determined by summarising the number of effective tillers per m^2 and the number of ineffective tillers per m^2 . For length of panicle five panicles selected at random in each plot was recorded from base to tip of panicles and the mean was calculated and expressed in centimetre. For panicle weight,

five panicles have been weighted at random in each point using a weighing machine, and the mean was determined and expressed in gram. The total number of filled grains in the five panicles was determined after winnowing out the chaff and empty grains. Plot for each plot, the mean of those five was calculated in order to compare the effects of various treatments. The total number of unfilled grains in the five panicles was determined after winnowing out the chaff and empty grains. Plot for each plot, the mean of those five was calculated in order to compare the effects of various treatments. Thousand no of grains were counted from the randomly selected plants and weight was recorded and expressed as test weight in gram. The crop in the net plot was harvested, threshed, dried in the sun. The grains were cleaned and weight was recorded per plot for each treatment and converted into quintal per hectare. The straw from the net plot was threshing and dried in the sun, weighed and converted into quintal per hectare. Harvested bundles were threshed with help of sickle and the harvested grain was weighed. Straw yield was calculated by subtracting the weight of the grain from the total biomass weight.

Results and Discussion

The data on recorded at harvest stage are presented in Table 1 below. Result show that the effect of foliar application of DAP on nutrient uptake of N in grain, straw and total uptake of rice (Kg/ha) is found significant (Table 1) All the treatments were significantly superior over control. The N uptake in grain was found highest in treatment T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT) (65.62 kg/ha) which was at par with treatments T₃, T₇, and T₈ and lowest N uptake in grain was observed in T₁- N0-P0-K0 i.e. control plot (34.49 kg/ha). Similarly, The N uptake in straw was found highest in treatment T₃- N100-P60-K40 i.e. GRD (29.91 kg/ha) which was at par with treatments T₄, T₅, T₆, T₇, T₈, and T₉ and lowest N uptake in straw was observed in treatment T₁- N0-P0-K0 i.e. control plot (16.29 kg/ha). Similarly, The total N uptake was found highest in treatment T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT) (94.95 kg/ha) and treatments T₃, T₅, T₆, T₇ and T₈ found at par with each other and lowest total N uptake was observed in treatment T₁- N0-P0-K0 i.e. control plot (50.78 kg/ha). All the treatments were significantly superior over control.

The data on recorded at harvest stage are presented in Table 2 below. The P uptake in grain was found highest in treatment T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT) (17.77 kg/ha) which was at par with treatments T₃, T₆, T₇ and T₈ and lowest P uptake in grain was observed in T₁- N0-P0-K0 i.e. control plot (8.24 kg/ha). Similarly, P uptake in straw was found highest in treatment T₃- N100-P60-K40 i.e. GRD (2.66 kg/ha) and treatment T₉ was found at par with GRD and lowest P uptake in straw was observed in treatment T₁- N0-P0-K0 i.e. control plot (1.19 kg/ha). Similarly, The total P uptake was found highest in treatment T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT) (20.19 kg/ha) which was at par with treatments T₃, T₆, T₇ and T₈. Lowest total P uptake was observed in treatment T₁- N0-P0-K0 i.e. control plot (9.42 kg/ha).

The data on recorded at harvest stage are presented in Table 3 below. The result show that the effect of foliar application of DAP on nutrient uptake of K in grain, straw and total uptake of rice (Kg/ha) is found significant. All the treatments were significantly superior over control. The K uptake in grain was found highest in treatment T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT) (30.79 kg/ha) which was at par with treatments T₃ and T₁₂ and lowest K uptake in grain was observed

in T₁- N0-P0-K0 i.e. control plot (15.87 kg/ha). Similarly, The K uptake in straw was found highest in treatment T₃- N100-P60-K40 i.e. GRD (83.63 kg/ha) which was at par with treatments T₆, T₇, T₈, and T₉ and lowest K uptake in straw was observed in treatment T₁- N0-P0-K0 i.e. control plot (39.34 kg/ha). Similarly, The total K uptake was found highest in treatment T₃- N100-P60-K40 i.e. GRD (110.75 kg/ha) which was at par with treatments T₆, T₇, T₈ and T₉ was found at par with each other and lowest total K uptake was observed in treatment T₁- N0-P0-K0 i.e. control plot (55.21 kg/ha).

The data on recorded at harvest stage for nutrient use efficiency are presented in Table 4 below. The result show that the effect of foliar application of DAP on Nitrogen use efficiency was increased by application of various combination of treatments. The maximum nitrogen use efficiency was recorded in treatment

T₁₁- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT) (44.36%) followed by treatment T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT) (44.17%) and lowest N use efficiency was recorded in treatment T₂- N100-P0-K40(19.86%). The maximum phosphorous use efficiency was recorded in treatment T₄- N100-P15-K40 + 2% DAP two spray (20, 35 DAT) (26.26%) followed by treatment T₅- N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT) (24.01%) and lowest P use efficiency was recorded in treatment T₁₁- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT) (11.11%). The maximum potassium use efficiency was recorded in treatment T₃- N100-P60-K40(138.36%) followed by treatment T₉- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT) (134.97%) and lowest P use efficiency was recorded in treatment T₂- N100-P0-K40 (61.55%).

Table 2: Effect of foliar application of DAP on nutrient uptake of N in grain, straw and total uptake of rice (Kg/ha).

Treatments	Nutrient uptake		
	Grain N uptake	Straw N uptake	Total N uptake
T ₁ - N0-P0-K0	34.49 ^d	16.29 ^d	50.78 ^d
T ₂ - N100-P0-K40	46.35 ^c	24.29 ^c	70.64 ^c
T ₃ - N100-P60-K40	60.54 ^{ab}	29.91 ^a	90.45 ^a
T ₄ - N100-P15-K40 + 2% DAP two spray (20, 35 DAT)	56.20 ^b	28.48 ^a	84.68 ^b
T ₅ - N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT)	58.28 ^b	28.43 ^{ab}	86.71 ^{ab}
T ₆ - N100-P30-K40 + 2% DAP two spray (20, 35 DAT)	57.74 ^b	29.05 ^a	86.79 ^a
T ₇ - N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	62.69 ^a	29.51 ^a	92.20 ^a
T ₈ - N100-P45-K40 + 2% DAP two spray (20, 35 DAT)	62.84 ^a	28.91 ^a	91.76 ^a
T ₉ - N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT)	65.62 ^a	29.33 ^a	94.95 ^a
T ₁₀ - N75-P30-K40 + 2% DAP two spray (20, 35 DAT)	56.40 ^b	25.23 ^b	81.63 ^b
T ₁₁ - N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	59.02 ^b	25.03 ^{bc}	84.05 ^b
T ₁₂ - N100-P15-K40 + Root treatment + 2% DAP three spray (20, 35, 50 DAT)	57.04 ^b	24.96 ^c	82.00 ^b
SEm±	2.25	1.19	2.98
CD (P = 0.05)	6.48	3.42	8.56

Table 2: Effect of foliar application of DAP on nutrient uptake of P in grain, straw and total uptake of rice (Kg/ha)

Treatments	Nutrient uptake		
	Grain P uptake	Straw P uptake	Total P uptake
T ₁ - N0-P0-K0	8.24 ^f	1.19 ^e	9.42 ^f
T ₂ - N100-P0-K40	11.26 ^e	1.76 ^d	13.02 ^e
T ₃ - N100-P60-K40	16.44 ^{ab}	2.44 ^a	18.87 ^a
T ₄ - N100-P15-K40 + 2% DAP two spray (20, 35 DAT)	14.06 ^{cd}	1.88 ^{cd}	15.94 ^{cd}
T ₅ - N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT)	14.74 ^{bc}	1.83 ^{cd}	16.57 ^{bc}
T ₆ - N100-P30-K40 + 2% DAP two spray (20, 35 DAT)	15.63 ^{abc}	2.07 ^{bcd}	17.69 ^{abc}
T ₇ - N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	15.98 ^{abc}	2.12 ^{abc}	18.1 ^{ab}
T ₈ - N100-P45-K40 + 2% DAP two spray (20, 35 DAT)	16.88 ^a	2.32 ^{ab}	19.2 ^a
T ₉ - N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT)	16.93 ^a	2.41 ^{ab}	19.34 ^a
T ₁₀ - N75-P30-K40 + 2% DAP two spray (20, 35 DAT)	12.64 ^{de}	1.76 ^d	14.39 ^{de}
T ₁₁ - N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	12.32 ^{de}	2.08 ^{bcd}	14.39 ^{de}
T ₁₂ - N100-P15-K40 + Root treatment + 2% DAP three spray (20, 35, 50 DAT)	13.94 ^{cd}	1.77 ^{cd}	15.71 ^{cd}
SEm±	0.651	0.108	0.66
CD (P = 0.05)	1.872	0.312	1.899

Table 3: Effect of foliar application of DAP on nutrient uptake of K in grain, straw and total uptake of rice (Kg/ha)

Treatments	Nutrient uptake		
	Grain K uptake	Straw K uptake	Total K uptake
T ₁ - N0-P0-K0	15.87 ^e	39.34 ^f	55.21 ^e
T ₂ - N100-P0-K40	21.73 ^d	58.11 ^e	79.83 ^d
T ₃ - N100-P60-K40	27.12 ^b	83.63 ^a	110.75 ^a
T ₄ - N100-P15-K40 + 2% DAP two spray (20, 35 DAT)	22.74 ^{cd}	72.05 ^{cd}	94.8 ^c
T ₅ - N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT)	25.37 ^{bc}	71.87 ^{cd}	97.23 ^{bc}
T ₆ - N100-P30-K40 + 2% DAP two spray (20, 35 DAT)	25.41 ^{bc}	78.53 ^{abc}	103.95 ^{abc}
T ₇ - N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	25.76 ^{bc}	82.8 ^{ab}	108.56 ^a
T ₈ - N100-P45-K40 + 2% DAP two spray (20, 35 DAT)	25.01 ^{bc}	79.44 ^{abc}	104.45 ^{ab}
T ₉ - N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT)	30.79 ^a	78.41 ^{abc}	109.2 ^a
T ₁₀ - N75-P30-K40 + 2% DAP two spray (20, 35 DAT)	25.76 ^{bc}	68.87 ^d	94.62 ^c

T ₁₁ - N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	22.65 ^{cd}	72.33 ^{cd}	94.98 ^c
T ₁₂ - N100-P15-K40 + Root treatment + 2% DAP three spray (20, 35, 50 DAT)	27.11 ^b	74.32 ^{bcd}	101.43 ^{abc}
S.Em \pm	1.003	2.66	2.904
CD (P = 0.05)	2.886	7.654	8.355

Table 4: Effect of foliar application of DAP on the nutrient use efficiency (NUE) of rice (%)

Treatments	NUE (%)		
	N	P	K
T ₁ - N0-P0-K0			
T ₂ - N100-P0-K40	100		68.97
T ₃ - N100-P60-K40	100	60	149.89
T ₄ - N100-P15-K40 + 2% DAP two spray (20, 35 DAT)	103.84	24.84	106.39
T ₅ - N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT)	105.76	29.76	115.46
T ₆ - N100-P30-K40 + 2% DAP two spray (20, 35 DAT)	103.84	39.84	110.64
T ₇ - N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	105.76	44.76	144.03
T ₈ - N100-P45-K40 + 2% DAP two spray (20, 35 DAT)	103.84	54.84	130.52
T ₉ - N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT)	105.76	59.76	149.37
T ₁₀ - N75-P30-K40 + 2% DAP two spray (20, 35 DAT)	78.84	39.84	105.96
T ₁₁ - N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	80.76	44.76	93.91
T ₁₂ - N100-P15-K40 + Root treatment + 2% DAP three spray (20, 35, 50 DAT)	105.76	29.76	129.63

Conclusion

1. The N, P and K uptake was also highest by the application of treatment T₈-N100-P45-K40 + 2% DAP two spray (20, 35 DAT), which were similar to T₃- N100-P60-K40 i.e. GRD.
2. The nutrient use efficiency of N and K was highest under treatment application of T₁₁-N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT). In case of P, the highest nutrient use efficiency was observed in T₄- N100-P15-K40 + 2% DAP two spray (20, 35 DAT).

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