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Shalini Mishra
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

K Tedia
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

LK Srivastava
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

GK Jatav
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Corresponding Author:
Shalini Mishra
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Assessment of foliar spray of DAP on Yield and Yield attributes of rice in a vertisol of Chhattisgarh

Shalini Mishra, K Tedia, LK Srivastava and GK Jatav

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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 T_1- N0-P0-K0, T_2- N100-P0-K40, T_3- N100-P60-K40, T_4- N100-P15-K40 + 2% DAP two spray (20, 35 DAT), T_5- N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT), T_6- N100-P30-K40 + 2% DAP two spray (20, 35 DAT), T_7- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T_8- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T_9- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT), T_{10}- N75-P30-K40 + 2% DAP two spray (20, 35 DAT), T_{11}- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT) and T_{12}- N100-P15-K40 + Root treatment + 2% DAP three spray (20, 35, 50 DAT). Plant height, total number of effective tillers per hill and number of grains per panicle were recorded significantly in treatments T_7- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T_8- N100-P45-K40 + 2% DAP two spray (20, 35 DAT) and T_9- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT) which was at par with treatment T_3- N100-P60-K40, while test weight of grains showed a non-significant result due to different nutrient management practices. The highest grain and straw yields were recorded significantly in treatments T_7- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T_6- N100-P30-K40 + 2% DAP two spray (20, 35 DAT) was at par with treatment T_3- N100-P60-K40. The total N uptake were recorded significantly in treatments T_7- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T_8- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T_6- N100-P30-K40 + 2% DAP two spray (20, 35 DAT), T_5- N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT) which was at par with treatment T_3- N100-P60-K40. Total P uptake were recorded significantly in treatments T_8- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T_7- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T_6- N100-P30-K40 + 2% DAP two spray (20, 35 DAT) which was at par with treatment T_3- N100-P60-K40. Total K uptake were recorded significantly in treatments T_9- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT), T_7- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT),T_8- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T_6- N100-P30-K40 + 2% DAP two spray (20, 35 DAT) which was at par with treatment T_3- N100-P60-K40. Nutrient use efficiency of N, P and K is observed highest in treatment T_{11}- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T_4- N100-P15-K40 + 2% DAP two spray (20, 35 DAT) and T_3- N100-P60-K40 respectively.

Keywords: Rice, foliar spray, nutrient modules, yield

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˚ 16" N latitude and 81˚ 36" E longitude with an attitude 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' 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 physico-chemical properties of the experimental soil have been depicted in the table 3.1. 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:

T_1- N0-P0-K0, T_2- N100-P0-K40, T_3- N100-P60-K40, T_4- N100-P15-K40 + 2% DAP two spray (20, 35 DAT), T_5- N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT), T_6- N100-P30-K40 + 2% DAP two spray (20, 35 DAT), T_7- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT), T_8- N100-P45-K40 + 2% DAP two spray (20, 35 DAT), T_9- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT), T_{10}- N75-P30-K40 + 2% DAP two spray (20, 35 DAT), T_{11}- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT) and T_{12}- 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 yield attributing characters recorded at harvest stage are presented in Table.1 below. All the yield contributing character i.e. plant height (cm), number of effective tillers per hill, panicle length (cm), panicle weight (g) and total number of filled and unfilled grains per panicle were significantly influence of due to various nutrient management modules. At harvest, the highest plant height was observed under treatment T_3- N100-P60-K40 i.e. GRD (110.90 cm), and all the treatments was found significantly at par with each other except control. The lowest plant height was observed under treatment T_1- N0-P0-K0 i.e. control (78.40 cm). The treatment T_3- N100-P60-K40 i.e. GRD recorded significantly the highest plant height (110.90 cm) which was significantly superior over all other treatments. The highest plant height may be due to balanced and increased availability of nutrients to the crop due to fertilizer application. These results are in agreement with the results obtained in maize by Mohan kumar *et al*., (2015) and Ullasa *et al*., (2016) [31] where 100 per cent RDF has recorded significantly the highest plant height over foliar treatments with DAP and urea.

Number of effective tillers/ hill at harvest as indicated by foliar application of DAP was found significant. All the treatments were significantly superior over control. The highest number of effective tillers/hill was observed under treatment T_3- N100-P60-K40 i.e. GRD (6.35 tillers/hill) which was at par with treatments T_8 and T_9. The lowest number of effective tillers/hill was observed under treatment T_1- N0-P0-K0 i.e. control (3.81 tillers/hill).

The appropriate combination of organic and inorganic nutrient sources was found to enhance the efficiency of nutrients and

ultimately increased yield attributes such as number of effective tillers/hill of rice. This is in line with the findings of Maragatham *et al.* (2010) [17].

The highest panicle length was observed under treatment T_3- N100-P60-K40 i.e. GRD (22.19 cm) which was at par with treatments T_6, T_7, T_8 and T_9 are found significantly at par with each other. The lowest panicle length was observed under treatment T_1- N0-P0-K0 i.e. control (16.43 cm). The appropriate combination of organic and inorganic nutrient sources was found to enhance the efficiency of nutrients and ultimately increased yield attributes such as panicle length of rice. This is in line with the findings of Maragatham *et al.* (2010) [17].

The highest panicle weight was observed under treatment T_3- N100-P60-K40 i.e. GRD (4.55g) which was at par with treatments T_7, T_8 and T_9. The lowest panicle length was observed under treatment T_1- N0-P0-K0 i.e. control (2.40 cm). The appropriate combination of organic and inorganic nutrient sources was found to enhance the efficiency of nutrients and ultimately increased yield attributes such as panicle weight of rice. This is in line with the findings of Maragatham *et al.* (2010) [17].

Result indicated that highest number of filled grains/panicle was observed with treatments T_3- N100-P60-K40 i.e. GRD (145.50 grains/panicle) which was at par with treatments T_7, T_8 and T_9. The lowest number of filled grains/panicle was observed under treatment T_1- N0-P0-K0 i.e. control (90.60 grains/panicle). Similarly, result indicated that highest number of unfilled grains/panicle was observed with treatments T_2- N100-P0-K40 (8.85 grains/panicle). The lowest number of unfilled grains/panicle was observed under treatment T_3- N100-P60-K40 i.e. GRD (90.60 grains/panicle). The appropriate combination of organic and inorganic nutrient sources was found to enhance the efficiency of nutrients and ultimately increased yield attributes of rice such as number of filled grains per panicle. This is in line with the findings of Maragatham *et al.* (2010) [17].

The data on grain and straw yield at harvest stage are presented in Table.2 below. Grain and straw yield of rice as influenced by foliar application of DAP was found significant. Results indicated that higher grain yield of rice crop was observed with treatments T_3- N100-P60-K40 i.e. GRD (56.87 q/ha) which was at par with treatments T_6, T_7, T_8 and T9$_9$. The lowest grain yield was observed under treatment T_1- N0-P0-K0 i.e. control (25.27 q/ha). Significantly highest straw yield was recorded under treatments T_3- N100-P60-K40 i.e. GRD (63.28 q/ha) which was at par with treatments T_6, T_7, T_8 and T9$_9$. The lowest grain yield was observed under treatment T_1- N0-P0-K0 i.e. control (27.83 q/ha). Chemical substances foliar application during panicle initiation + mid booting stages resulted in higher yield as compared with control treatment. The increase in grain yield with foliar application of 2% DAP in treatments T_3, T_6, T_7, T_8 and T_9 may be due to the considerable increase in early growth, which reflected on higher grain yield attributes in turn increased grain yield and straw yield. These results are confirmed with the findings of Ganapathy *et al.* (2008) [7], Al-Khuzai and. Al-Juthery (2020) [1].

Table 1: Effect of foliar spray of DAP on yield attributes of rice

Treatments	Plant height at harvest (cm)	Number of effective tillers per hill	Panicle length (cm)	Panicle weight (g/panicle)
T_1- N0-P0-K0	78.40	3.81	16.43	2.40
T_2- N100-P0-K4	104.12	5.65	18.99	3.85
T_3- N100-P60-K40	110.90	6.35	22.19	4.55
T_4- N100-P15-K40 + 2% DAP two spray (20, 35 DAT)	104.9	5.93	20.13	3.65
T_5- N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT)	107.62	5.92	20.15	4.03
T_6- N100-P30-K40 + 2% DAP two spray (20, 35 DAT)	107.03	5.93	20.93	4.10
T_7- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	108.81	5.82	20.87	4.20
T_8- N100-P45-K40 + 2% DAP two spray (20, 35 DAT)	107.83	6.18	21.76	4.40
T_9- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT)	109.79	6.10	21.92	4.30
T_{10}- N75-P30-K40 + 2% DAP two spray (20, 35 DAT)	105.37	5.85	20.03	3.90
T_{11}- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	106.62	5.86	19.93	3.95
T_{12}- N100-P15-K40 + Root treatment + 2% DAP three spray (20, 35, 50 DAT)	105.22	5.95	20.12	4.00
SEm±	2.70	0.14	0.68	0.14
CD (P = 0.05)	7.96	0.39	1.97	0.41

Table 2: Effect of foliar spray of DAP on grain yield and straw yield of rice

Treatments	Grain yield (q/ha)	Straw yield (q/ha)
T_1- N0-P0-K0	25.27^{d}	27.83^{e}
T_2- N100-P0-K4	42.55^{c}	45.51^{d}
T_3- N100-P60-K40	56.87^{a}	63.28^{a}
T_4- N100-P15-K40 + 2% DAP two spray (20, 35 DAT)	49.57^{b}	55.44^{b}
T_5- N100-P15-K40 + 2% DAP three spray (20, 35, 50 DAT)	50.73^{b}	56.51^{b}
T_6- N100-P30-K40 + 2% DAP two spray (20, 35 DAT)	52.40^{ab}	59.21^{ab}
T_7- N100-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	53.72^{a}	60.28^{a}
T_8- N100-P45-K40 + 2% DAP two spray (20, 35 DAT)	55.66^{a}	59.93^{a}
T_9- N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT)	55.97^{a}	61.49^{a}
T_{10}- N75-P30-K40 + 2% DAP two spray (20, 35 DAT)	49.27^{b}	54.01^{c}
T_{11}- N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT)	50.53^{b}	54.64^{bc}
T_{12}- N100-P15-K40 + Root treatment + 2% DAP three spray (20, 35, 50 DAT)	51.27^{b}	56.08^{b}
SEm±	1.57	1.62
CD (P = 0.05	4.53	4.65

Conclusion

1. The application of treatment T_9-N100-P45-K40 + 2% DAP three spray (20, 35, 50 DAT) can be recommended to the farmers as they show maximum yield in rice.
2. The N, P and K uptake was also highest by the application of treatment T_8-N100-P45-K40 + 2% DAP two spray (20, 35 DAT), which were similar to T_3- N100-P60-K40 i.e. GRD.
3. The nutrient use efficiency of N and K was highest under treatment application of T_{11}-N75-P30-K40 + 2% DAP three spray (20, 35, 50 DAT). In case of P, the highest nutrient use efficiency was observed in T_4- N100-P15-K40 + 2% DAP two spray (20, 35 DAT).
4. The application of T_8- N100-P45-K40 + 2% DAP two spray (20, 35 DAT) showed highest B: C ratio as of GRD (N100-P60-K40).

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