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Effect of Sources and Time of Phosphorus Application on Growth and Yield of Rice (*Oryza sativa* L.)

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ABSTRACT

A field trial was conducted on sandy clay loam soil of Agricultural College Farm, Bapatla, during *kharif,* 2018 with four sources of phosphorus in combination with two times of application. The results revealed that, among the four phosphorus sources, DAP gave the highest number of grains per panicle and grain yield but had no significant effect on growth parameters. Fertilizer 28:28:0 was next in performance and it was on par with DAP. Regarding the time of application, 60 kg P_2O_5 ha^{-1} as basal + 25 kg P_2O_5 ha^{-1} at MT stage recorded the highest plant growth, yield attributes, grain and straw yields (kg ha^{-1}). The study concluded that top dressing of phosphorus at maximum tillering stage by using complex fertilizers especially DAP helps for higher productivity and profitability in rice.

Keywords: *Grain yield, Plant growth, Rice, Sources, Straw yield, Time of application and Yield attributes.*

Rice (*Oryza sativa* L.) is an oldest domesticated grain all around the world. Rice has the largest growing area and it covers nearly 9% of earth's arable land. It is central to lives of billions of people. Rice is grown by almost two billion people and consumed by more than four billion people.

For the growth of a rice plant, macro nutrients like nitrogen, phosphorus, potassium and micro nutrients like iron and zinc etc. are required. To provide nutrients for the plant and for the continuous increase in rice production, fertilizer use is one of the major component. Since late sixties, green revolution increased the fertilizer usage and changed the India's situation to self-sufficiency from begging bowl. So, in increasing agricultural production fertilizers play a key role (Srinivasarao *et al.*, 2015).

Generally, in rice during early tillering and whenever the plants begins to accumulate dry matter, deficiency of phosphorus appears. Therefore, to sustain higher yields P availability from soils to the plant is the key. As phosphorus is having a great role in the energy transformations in living tissues, it is called "Mineral of life".

In crop production, right source and right time of application are one of the important factors for obtaining good yield. Now -a-days increased availability of complex fertilizers, as well as non-availability of straight fertilizers as and when required by a farmer and to reduce the cost of application of fertilizers, use of complex fertilizers is becoming popular among farmers (Pawar and chavan, 1996).

Generally, phosphorus is recommended for basal application but many of the farmers have been applying phosphorus to rice at basal and also topdressing additional dose at
maximum tillering stage through complex fertilizers and claiming that they are getting higher yields as compared to application of phosphorus as basal alone. By keeping in view of this, the present research work was carried out.

MATERIAL AND METHODS

A field trial was conducted on sandy clay loam soils of Agricultural College Farm, Bapatla during *kharif*, 2018. The soil was neutral in soil reaction pH (7.2), very low (112.89 kg ha^{-1}) in available nitrogen, medium in organic carbon (0.45) and available phosphorus (42.8 kg ha^{-1}) and very high (291.92 kg ha^{-1}) in available potassium. The trial was laid out in randomized block design with factorial concept and replicated thrice. The treatments consisted of four sources SSP (S_1), DAP (S_2), 20:20:0 (S_3) and 28:28:0 (S_4) and two times of application *viz.*, 60 kg P_2O_5 ha^{-1} as basal (T_1) and 60 kg P_2O_5 ha^{-1} as basal + 25 kg P_2O_5 ha^{-1} at MT stage (T_2) replicated thrice. A total of 356.5 mm rainfall was received during the crop growth period. 31 day old seedlings were transplanted with a spacing of 20 X 15 cm^{-2}. Recommended dose of nitrogen @ 150 kg ha^{-1} was applied through neem coated urea in three splits *i.e.*, 1/3 as basal, 1/3 at maximum tillering and 1/3 at panicle initiation stage. Potassium @ 40 kg ha^{-1} was applied uniformly to all the plots through muriate of potash in two equal splits (half as basal and half at Panicle initiation stage). Phosphorus was applied as per the treatments. While applying DAP, 20:20:0, 28:28:0 fertilizers, nitrogen content was taken into account. Five hills were selected randomly from each plot. The data on plant growth, yield attributes and yield were recorded as per standard statistical procedures. The data was analyzed by following the analysis of variance (ANOVA) for randomized block design with factorial concept as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Plant Growth

Data on plant height as influenced by sources and time of phosphorus application are presented in Table 1. The data revealed that plant height was not significantly influenced either by the sources or by the time of phosphorus application and also by their interaction.

Persual of the data Table 1. regarding total number of tillers m^{-2} showed that the tillers were not significantly influenced by the sources tested but with the time of application. Regarding time of application, T_2 (60 kg P_2O_5 ha^{-1} as basal + 25 kg P_2O_5 ha^{-1} at MT stage) showed its supremacy over T_1 (60 kg P_2O_5 ha^{-1}) with respect to total number of tillers m^{-2}.

This increased tiller number with additional dose at maximum tillering stage was due to the adequate supply of phosphorus to roots which results in better tiller growth.

Phosphorus being the constituent of nucleic acids, phytin and phospholipids, it increased growth parameters and also active involvement of phosphorus in carbohydrate metabolism, which might have helped in increasing tiller number.

The beneficial effect of phosphorus through the availability of higher energy in the form of ATP molecules which might have favoured multiplication of cells thereby enhances the growth of the plant. This might be the reason that application of additional dose of phosphorus resulted in increased number of tillers and this increased tiller number as evidenced in this investigation corroborates with the findings of Yogeswararao *et al*. (1973), Slaton *et al*. (2002), Srujana *et al*. (2013), Murumkar *et al*. (2015).

The data (Table 1.) on number of panicles m^{-2} indicated that statistically detectable differences were found only with time of application but not with sources. With regard to time of application, significantly maximum number of panicles m^{-2} (430) were recorded with T_2 (60 kg P_2O_5 as basal+ 25 kg P_2O_5 at MT stage) compared to (399) T_1 (60 kg P_2O_5 as basal).

The significant increase in productive tillers with additional dose of phosphorus at maximum tillering might be due to adequate supply of

Table 1. Variation in plant height (cm) and total number of tillers m^{-2} , number of panicles m^{-2} at harvest as influenced by sources and time of phosphorus application

Treatments	Plant Height (cm)	Total number of tillers m^{-2}	Number of panicles m^{-2}
Sources			
S_1 – SSP	96.9	423	401
S_2 – DAP	98.6	447.3	429.3
S_3 – 20:20:0	97.3	430.2	412
S_4 – 28:28:0	98.2	436.2	417.2
SEm±	2.42	15.4	12.1
CD (P=0.05)	NS	NS	NS
Time of application			
T_1 – Basal	96.6	416.2	399.2
T_2 – Basal + MT stage	98.9	452.2	430.5
SEm±	1.71	10.89	8.53
CD (P=0.05)	NS	31.4	25.1
Interaction (S × T)			
SEm±	3.42	21.78	17.07
CD (P=0.05)	NS	NS	NS
CV%	9.1	13	10.7

Table 2. Variation in yield attributes, grain and straw yield (kg ha^{-1}) of rice as influenced by sources and time of phosphorus application

Treatments	Total grains $panicle^{-1}$	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)
Sources					
S_1 – SSP	126.1	15.08	4546	6026	42.9
S_2 – DAP	135	15.26	5106	6343	44.6
S_3 – 20:20:0	126.8	15.11	4698	6119	43.3
S_4 – 28:28:0	132.5	15.2	4910	6241	44
SEm±	2.37	0.16	135	192.8	0.9
CD (P=0.05)	7.1	NS	396	NS	NS
Time of application					
T_1 – Basal	125.4	15.06	4459	5977	42.7
T_2 – Basal + MT stage	134.8	15.28	5170	6388	44.7
SEm±	1.68	0.118	95.4	136.3	0.7
CD (P=0.05)	4.9	NS	280	400	1.9
Interaction (S × T)					
SEm±	3.36	0.24	190.9	272.7	1.3
CD (P=0.05)	NS	NS	NS	NS	NS
CV%	6.7	4.1	10.3	11.5	7.9

phosphorus for tiller production and their decreased mortality. A crop which has access to adequate phosphorus benefits many ways, among which increase in productive tillers is one. Phosphorus also induce early tillering and these early tillers were more effective in panicle bearing than late production. De datta (1981) also reported that in general, phosphorus is to be applied as basal, but later application can also be made, provided it is not later than the time of active tillering. These results were in close agreement with the findings of Srujana *et al*. (2013)

Yield Attributes

Persual of the data presented in the table 2. regarding number of grains per panicle indicated that there was a significant influence by sources and time of application on total grains per panicle, but their interaction was found non-significant.

Statistically detectable disparities were found in rice with different sources with regard to total number of grains per panicle and significantly, the highest number of grains per panicle (135) were obtained with the application of DAP (S_1) which was on par with 28:28:0 (132.5). However, lowest number of grains per panicle was obtained with the application of SSP (126.1).

With respect to time of application, 60 kg P_2O_5 as basal + 25 kg P_2O_5 at maximum tillering stage (T_2) recorded 134.8 grains per panicle which was significantly superior to 60 kg P_2O_5 as basal alone(T_1) (125.4). This increase in total number of grains with additional dose of phosphorus at maximum tillering stage might be due to the reason that P which was absorbed during the vegetative growth period was most efficiently utilized for grain production.

Data regarding test weight as indicated in the table 2. revealed that the test weight was not significantly influenced by sources, time of application and their interaction. This non-significant difference might be due to the fact that test weight is mostly a genetic character and is not much influenced due to fertilizer application. The results are in conformity with Sakhen *et al*. (2011), Srujana *et al*. (2013), Murumkar *et al*. (2015).

Yield (kg ha^{-1})

Data from the table 2. revealed that DAP source out yielded the remaining three sources and had shown its statistical supremacy in yielding maximum grain yield (5106 kg ha^{-1}) and was on par with 28:28:0 source. The lowest grain yield was recorded by SSP (4546 kg ha^{-1}). Application of 60 kg P_2O_5 ha^{-1} + 25 kg P_2O_5 ha^{-1} at MT stage resulted in maximum grain yield (5170 kg ha^{-1}) and was significantly superior to 60 kg P_2O_5 ha^{-1} (4459 kg ha^{-1}) (Table 2). As DAP is having higher amount of ammonical form of nitrogen it resulted in producing highest grain yield over other complex fertilizers. Also as phosphorus is an essential macro nutrient for plant reproduction, it may significantly impact grain yield (Tisdale *et al*., 1985).

Archana *et al*. (2016) also reported that application of phosphorus in two equal splits at basal and tillering stage gave higher yields, as the phosphorus absorbed during the early tillering stage was more efficiently used for grain production.

From the data collected it was found that straw yield was not significantly influenced by the sources but with the time of application. Regarding the time of application, the maximum straw yield was produced with the application of 60 kg P_2O_5 ha^{-1} as basal + 25 kg P_2O_5 ha^{-1} at MT stage (6388 kg ha^{-1}) which was significantly superior to 60 kg P_2O_5 ha^{-1} as basal (Table 2) . This increased straw yield might be due to increased tiller number m^{-2} and other growth parameters. These results are in accordance with Dey *et al*. (2014).

From the data presented in table 2. harvest index was found non-significant with sources of phosphorus and significantly influenced with time of application. The data revealed that significantly highest harvest index (44.7%) was recorded with the top dressing of additional dose of phosphorus at maximum tillering stage along with basal dose *i.e.*, T_2 (60kg P_2O_5 as basal + 25 kg P_20_5 at MT stage) and the significantly lowest (42.7 %) was recorded with T_1 (60kg P_2O_5 as basal). The interaction between the sources and time of application was found non-significant for all parameters studied.

CONCLUSION

Among the four sources of phosphorus tested, DAP and 28:28:0 performed better and remained on par with each other regarding yield thereby indicating their suitability for topdressing in rice during *kharif* in Bapatla region.

As there is a marginal increase in growth and yield of rice with the application of extra dose of phosphorus at maximum tillering stage, topdressing with complex fertilisers may be suggested.

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