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Effect of Phosphorus Biofertilizers along with Inorganic Fertilizers on Growth and Yield of Maize

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ABSTRACT

A field experiment was conducted to study the response of maize to phosphorus levels and phosphorus biofertilizers at Agricultural College Farm, Bapatla during *kharif*, 2019. The experiment was laid out in randomized block design with nine treatments replicated thrice. The results of the experiment indicated that higher drymatter, yield attributes and yield were recorded with the application of 100% RDP + VAM @ 12.5 kg ha^{-1} (T_4) which was on par with T_3(100% RDP + PSB @ 1 L ha^{-1}). The treatments that received 75% RDP along with phosphorus biofertilizers were on par with 100% RDP in maize.

Keywords: *Maize, Phosphorus, PSB and VAM*

Maize (*Zea mays* L.) is a commercial crop on which many agro-based industries depend for raw materials. For optimum plant growth, nutrients must be available in sufficient and balanced quantities. Phosphorus (P) is the most limiting nutrient after N for crop yields and is essential for maize growth and development. Large quantities of chemical fertilizers are used to replenish soil N and P resulting in high costs and environmental contamination.

Biological phosphate fertilizers containing beneficial bacteria and fungi increased soluble phosphate, which can be absorbed by plants easily. Conversion of the insoluble forms of P to an accessible form by plants (ortho-phosphate) is an important trait of phosphate-solubilizing bacteria (PSB) and arbuscular mycorrhizal fungi (AMF).

MATERIAL AND METHODS

A field experiment was conducted during *kharif*, 2019-2020 at Agricultural College Farm, Bapatla. The experiment was laid out in RBD with nine treatments replicated thrice. The experimental soil was slightly alkaline in reaction (7.63), medium in organic carbon (0.6 %), medium in available nitrogen (354 kg ha^{-1}), high in available phosphorus (55.32 kg ha^{-1}) and available potassium (402 kg ha^{-1}).The treatments comprised of T_1- Control (without P), T_2 - 100% Recommended Dose of Phosphorus (RDP), T_3 - 100% RDP + PSB @ 1 L ha^{-1}, T_4 - 100% RDP + VAM @ 12.5 kg ha^{-1}, T_5 - 75% RDP + PSB @ 1 L ha^{-1}, T_6 -75% RDP + VAM @ 12.5 kg ha^{-1}, T_7 – PSB @ 1 L ha^{-1}, T_8 –VAM @ 12.5 kg ha^{-1}, T_9 - PSB @ 1 L ha^{-1} + VAM @ 12.5 kg ha^{-1}. Well decomposed farmyard manure @ 5 t ha^{-1} was applied before sowing. A common dose of nitrogen @ 200 kg ha^{-1} was applied in the form of urea in four equal splits *i.e* 1/4 as basal, 1/4 at knee high, 1/4 at tasseling and 1/4 at 60 DAS(Days After Sowing). Recommended dose of P_2O_5 @ 60 kg and 45 kg ha^{-1} was applied as per the treatments as basal just before sowing. A common dose of 50 kg K_2O ha^{-1}was applied as muriate of potash in two equal splits as

half at basal and remaining half at tasseling stage. Farmyard manure was mixed with biofertilizers *viz.*, PSB @ 1 L ha^{-1} and VAM @ 12.5 kg ha^{-1} as per the treatments.

RESULTS AND DISCUSSION

Dry matter accumulation

The results (Table 1) indicated progressive increase in drymatter with advancement of crop growth in all the treatments. However, the magnitude of such changes varied with treatments, being the highest (10,587 kg ha^{-1}) recorded in treatment T_4 at harvest, which might be due to combined application of 100% RDP + VAM @ 12.5 kg ha^{-1}. This resulted maximum availability of nutrients as compared to their respective sole application. Further a significant increase in dry matter was observed with increase in phosphorus levels. The lowest biomass production (1048, 2889 and 9167 kg ha^{-1} during knee high, tasseling and harvest, respectively) was recorded in the treatment that received neither phosphorus fertilizer nor any biofertilizer. Similar results were recorded by Patil *et al*. (2012) in maize where application of biofertilizers in combination with 100% RDP recorded significantly higher drymatter accumulation.

Yield attributes

The data pertaining to number of kernels per cob and test weight recorded highest with the application of 100% RDP + VAM @ 12.5 kg ha^{-1} (T_4) followed by 100% RDP + PSB @ 1 L ha^{-1} (T_3) which were statistically on par and markedly superior over other treatments. This can be ascribed to improved soil conditions and continuous supply of nutrients in adequate quantities due to mineralisation and enhanced solubilisation of P from insoluble sources. The lowest number of kernels per cob (384) and test weight (24.6g) was recorded by T_1 [Control without P)] which might be due to the result of unfavourable physiological changes in plant brought about by shortage of phosphorus, that is essential for cell division, meristematic growth and differentiation. Similar findings were recorded by Dar *et al*. (2017) and Pereira and Castro (2014) where inoculation with biofertilizers gave significant influence on test weight and number of kernels per cob.

Kernel yield and stover yield

The perusal of the data presented in table 2 revealed that significantly higher kernel yield (4869 kg ha^{-1}) was recorded with application of 100% RDP + VAM @ 12.5 kg ha^{-1}(T_4) followed by 100% RDP + PSB @ 1 L ha^{-1} (T_3) (4803 kg ha^{-1}) and 100% RDP (T_2) (4748 kg ha^{-1}). At 75% RDP, the treatments of 75% RDP + PSB@ 1 L ha^{-1} (4631 kg ha^{-1}) and 75% RDP + VAM @ 12.5 kg ha^{-1} (4692 kg ha^{-1}) have also showed increased kernel yield significantly over control. Application of biofertilizers both PSB and VAM (T_9) recorded higher kernel yield when compared to their individual application (T_7 and T_8). The minimum kernel yield (3827 kg ha^{-1}) was registered in T_1 where no P and biofertilizers were applied. The application of PSB or VAM biofertilizer along with P source like SSP increased the kernal yield which could be due to increased availability of P which coincides with P requirement of crop.

Stover yield followed the same pattern as kernel yield. The highest stover yield (6343 kg ha^{-1}) was recorded with application of 100% RDP + VAM @ 12.5 kg ha^{-1} (T_4), which was on par with 100% RDP + PSB @ 1 L ha^{-1} (T_3)and 100% RDP (T_2) (6275 and 6208 kg ha^{-1} respectively). At 75% RDP, the treatments of 75% RDP + PSB@ 1 L ha^{-1} (6018 kg ha^{-1}) and 75% RDP + VAM @ 12.5 kg ha^{-1} (6139 kg ha^{-1}) stover yield increased significantly over control. The lowest stover yield (5070 kg ha^{-1}) was recorded with T_1 [Control (without P)] where no phosphorus was applied. Increased stover yield might be due to higher photosynthetic activity because of

Table 1. Effect of phosphorus biofertilizers on drymatter production in maize

Treatment	Knee high	Tasseling	Harvest
T_1: Control (without P)	1048	2889	9167
T_2: 100% Recommended Dose of Phosphorus (RDP)	1632	3895	10306
T_3: 100% RDP + PSB @ 1 L ha^{-1}	1721	3986	10431
T_4: 100% RDP + VAM @ 12.5 kg ha^{-1}	1856	4125	10587
T_5: 75% RDP + PSB@ 1 L ha^{-1}	1432	3645	10135
T_6: 75% RDP + VAM @ 12.5 kg ha^{-1}	1554	3720	10228
T_7: PSB@ 1 L ha^{-1}	1231	3129	9354
T_8: VAM@ 12.5 kg ha^{-1}	1296	3204	9446
T_9: PSB@ 1 L ha^{-1} + VAM@ 12.5 kg ha^{-1}	1354	3315	9620
S.Em (±)	77.09	206.34	320.16
CD (P = 0.05%)	231.12	618.61	959.85
C.V (%)	9.16	10.08	5.59

Table 2. Effect of phosphorus biofertilizers on yield attributes and yield of maize

Treatment	No.of kernels per cob	Test weight (g)	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1: Control (without P)	384	24.6	3827	5070
T_2: 100% Recommended Dose of Phosphorus (RDP)	455	27.3	4748	6208
T_3: 100% RDP + PSB @ 1 L ha^{-1}	476	27.7	4803	6275
T_4: 100% RDP + VAM @ 12.5 kg ha^{-1}	487	28.4	4869	6343
T_5: 75% RDP + PSB@ 1 L ha^{-1}	429	26.6	4631	6018
T_6: 75% RDP + VAM @ 12.5 kg ha^{-1}	440	26.8	4692	6139
T_7: PSB@ 1 L ha^{-1}	395	25.9	3950	5243
T_8: VAM@ 12.5 kg ha^{-1}	402	26.2	4024	5441
T_9: PSB@ 1 L ha^{-1}+VAM@ 12.5 kg ha^{-1}	411	26.4	4219	5687
S.Em (±)	9.09	0.62	250.51	272.06
CD (P = 0.05%)	27.26	1.86	751.01	815.64
C.V (%)	3.65	4.03	9.82	8.09

increased leaf area index which ultimately promoted dry matter production resulting in higher yield. Recommended dose of phosphorus fertilizer along with suitable liquid biofertilizer recorded highest stover yield in maize was reported by Sivamurugan *et al*. (2018). Similar results were also observed by Yadav *et al*. (2016) and Yosefi *et al*. (2011).

CONCLUSION

It can be concluded that the increase in phosphorus nutrition significantly influenced dry matter accumulation, number of kernels per cob, test weight, kernel and stover yield. The combined application of RDP and biofertilizer found superior than individual application of either RDP or biofertilizer alone. Addition of 75% RDP along with PSB or VAM was found to be at par with addition of only RDP. Hence the fertilizer P dose can be reduced by integrating with biofertilizer (PSB or VAM).

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