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Research Article

Influence of Phosphorus Management on Growth, Development and Yield of Sugarcane

Kranti B. Patil[1*], Sonal Tripathi[2], Rameti Jangir[3] and Lokesh Saini[4]

[1, 2 & 4]Dept. of Soil Science and Agril. Chemistry, N.M.C.A., Navsari, Navsari Agril. University Navsari; Gujarat

[3]Dept. of Agronomy, N.M.C.A., Navsari, Navsari Agril. University Navsari; Gujarat

*Corresponding Author E-mail: kpmpkv@gmail.com

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ABSTRACT

A field experiment was conducted in clayey soils at N.M. College of Agriculture, Research farm, Navsari Agril., University, Navsari, Gujarat during 2017-18 and 2018-19 with the view to evaluate an appropriate phosphorus level (100 % and 75 % of recommended dose of P_2O_5), determining the time of P_2O_5 application (basal and split) and use of biofertilizer as arbuscular mycorrhiza (AM) (with and without) on the growth, development and yield of sugarcane. The pooled data of two seasons indicated that sugarcane crop responded significantly with phosphorus management. When crop fertilized with P level of 100 percent RD of P_2O_5 responded significantly at 180 days after planting (DAP) and at harvest, at harvest cane girth, average cane weight, number of millable canes/ha (NMC/ha), periodical dry matter yield (DMY), mean crop and relative growth rate (CGR and RGR) and cane, green top yield of sugarcane. The splitting of phosphorus (50 % P_2O_5 at the time of planting and 50 % at the time of earthing up) also recorded significant results at harvest on plant height, NMC/ha, average cane weight, periodical DMY, CGR and RGR and cane, green top yield of sugarcane. Similarly an application of AM biofertilizer recorded significant results in terms of plant height, NMC/ha, cane weight, DMY at harvest, CGR and RGR and yield in sugarcane. In sugarcane crop splitting of phosphorus along with AM responded significantly in terms of plant population at harvest, DMY and growth analysis as well as yield in south Gujarat condition.

Keywords: *Phosphorus levels, arbuscular mycorrhiza, P_2O_5 split application, Crop growth rate, Relative crop growth rate*

INTRODUCTION

Sugarcane is an important cash crop of South Gujarat and as such most of the sugarcane growers depend upon it for their cash requirements. Thus, there is a need to economize sugarcane farming to improve its profitability. This crop is a heavy feeder of nutrients as compared to other crops hence adequate amount of nutrient supply is essential for optimum growth of sugarcane.

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Amongst required macronutrient phosphorus is required in small quantity. On an average the 1 tonne sugarcane crop removes 1.4 kg N, 0.6 kg P_2O_5 and 3.6 kg K_2O (Zende, 1972). Phosphorus plays the major and important role for plant growth and root development, can limit normal plant growth if not applied at the proper time with right amount (Eftkhari et al., 2010). Phosphate supply in soils has a considerable influence on germination, tillering, root growth of crop. Monophosphate ion in the water soluble phosphatic fertilizers and diphosphate ions in the citrate soluble phosphatic fertilizers undergo fixation very easily in the soil. Rate of applied phosphate in both acid and alkaline soils, maintaining adequate availability of phosphate in the soil to growing sugarcane crop during early and maturity phases is a very difficult task. The time of phosphate application has an indirect effect on growth and yield of sugarcane. Farmers apply phosphatic fertilizers to sugarcane every year without considering the existing P content of the soil. Thus it resulting in to stagnation or decline in productivity over the years (Shahi, 2002). Under these circumstances, it is necessary to ascertain the requirement of phosphorus on such a soil to crops not only to reduce the cost of chemical phosphatic fertilizer input from the current level of general recommendation but also to avoid any nutritional imbalances that might arise due to excess phosphorus availability. To overcome these problems, it is very much essential to determine the optimum level and time of application of P fertilizers considering both the existing soil P and fertilizer P on a cumulative basis for obtaining higher cane yield.

The primary benefits of AM to the plants are the enhanced acquisition and recycling of nutrients, particularly P as well as moisture. These endomycorrhiza form external hyphal networks in the soil and grow extensively within the cells of cortex. AM fungi colonize plant roots and ramify into the surrounding bulk soil extending the root depletion zone around the root system. They transport water and mineral nutrients from the soil to the plant while the fungus is benefiting from the carbon compounds provided by the host plant. Therefore AM fungi have a pervasive effect upon plant form and function (Jamal et al., 2004).

Therefore the two year field experiments were undertaken to assess the phosphorus P_2O_5 levels, time of its application and use of biofertilizer as AM on sugarcane growth, development and yield.

MATERIAL AND METHODS

Field experiments were conducted at N.M.C.A.Navsari, Agril. University Navsari during 2017-18 and 2018-19 seasons on different block of Agronomy farm. The soil of the experimental field was *Inceptisols* comprising member of fine, montmorillonitic isohyperthermic family of *Vertic Ustrochrepts*, clayey in texture having pH slightly alkaline, normal in conductance, low in soil available nitrogen and phosphorus and medium in potash. Three main experimental factors consisting each of two levels comprising *viz*., A. Phosphorus levels; A_1- 100 percent RD of P_2O_5 and A_2- 75 percent RD of P_2O_5, B. Time of phosphorus application as; B_1- 100 percent of P_2O_5 (100 % as basal dose) application and B_2-50 percent of P_2O_5 as basal dose + 50 percent P_2O_5 at final earthing up (50-50 % splitting), C. Application of AM C_1=No application of AM and C_2=Application of AM were replicated in four replication in a randomized block design (Factorial) with gross plot size 6.3 x 6 m^2 (0.9 m row size). The variety used was CoN 05071 was planted with two eye bud setts @ 50000/ha. The experiments were planted in the month of December and harvested at peak maturity in both the seasons. The RD of chemical fertilizer was 250 N: 125 P_2O_5: 125 K_2O kg/ha and biofertilizer AM (*Glomus intraradis*) containing 3000 IP/g was applied in sugarcane @ 250g /ha at the time of planting + 200 g /ha at the time of final earthing up. Nitrogen was applied @ 250 kg/ha in the form of urea in all treatments in four splits, 15 percent at the time of planting, 30 percent at 45 DAP, 20 percent at 90 DAP, and 35 percent at 120 DAP (Before final earthing up). P_2O_5 was applied @ 125 kg/ha and 93.25 kg/ha in the form of super phosphate as per treatment and common dose of K_2O @125 kg K_2O/ha in the form of muriate of potash were applied at the time of planting. Common field management practices were followed for all the treatments.

Five plants were selected randomly from net plot for recording the bio-metric observations such as periodical plant height, average cane weight, cane girth, fresh as well as dry matter yield of sugarcane plant at 180 DAP and total dry matter (cane and trash) during both the years were recorded. The NMC /ha were counted at harvest from the net plot and recorded for each treatment. Millable cane population was converted into hectare basis. The cane girth was measured from top, middle and bottom of tagged five canes at the time of harvest. Average cane diameter was recorded by using digital vernier caliper (Mitutoyo, Japan). Cane girth is calculated using formula, Girth=D x π. The weight of five randomly selected canes from each plot were recorded individually and presented as average weight per cane.The fresh weight of green top for sugarcane was recorded from the observational plants and converted in to t/ha. The green top was air dried first and then oven dried to convert it on dry basis (t/ha).The canes were detrashed and millable canes were prepared by cutting top portion. The weight of these millable canes for each experimental plot was recorded in kilogram and then it was converted into tonnes per hectare by multiplying it with conversion factor.

The mean crop growth rate (CGR) was calculated between 180 DAP to harvesting by using the formula (Redford, 1967).

$$CGR\ (g/m^2/d\ ) = (W_2 - W_1)\ /(t_2 - t_1) \quad (1)$$

Where: W_1 and W_2= dry weight at time t_1 and t_2, respectively.

The mean relative growth rate was worked out between 180 DAP to harvesting by using the formula with the following formula (Watson *et al*., 1952).

$$RGR\ (g/m^2/d) = (LnW_2 - LnW_1)/(t_2 - t_1) \quad (2)$$

Where: W_1 and W_2= dry weight at time t_1 and t_2, $L_{n\,=}$ Natural logarithm, respectively.

The statistical analysis of data recorded for various characters studied in the investigation was followed by using statistical procedures appropriate to Factorial Block Design as described by Panse and Sukhatme (1978) and the significance was tested by "Variance ratio" i.e. “F” test. Five percent level of significance was used to test the significance of results.

RESULTS AND DISCUSSION

The pooled data in respect of sugarcane growth, development and yield of two crop seasons are reported in Tables -1, 2 and 3.

Growth attributes

The effect of phosphorus levels, time of it’s application and use of biofertilizer as AM on germination percentage, periodical plant height, at harvest number of millable canes per hectare, cane girth and average cane weight are presented in Table-1.

The germination percentage at 45 DAP was not found significant result with phosphorus management treatments. From the data, it could be seen that the mean plant height of sugarcane increased with the advancement of crop age during both the years of experimentation and reached to the maximum at harvest. Plant height at 90 DAP was not responded significantly due to different treatments. With the application of phosphorus level of 100 percent RD of P_2O_5 kg/ha the plant height responded significantly at 180 DAP (224 cm) and at harvest (321 cm) over 75 percent RD of P_2O_5 kg/ha, respectively. While with the application of AM plant height at harvest recorded significantly highest (319 cm). The NMC/ha were increased significantly with 100 percent RD of P_2O_5 level by 9 percent over 75 percent RD of P_2O_5 level, further it increased 9 percent with split application over basal P application and also increases with 14 percent with the application of AM biofertilizer in sugarcane. This might be due to phosphorus application improved shoot population because of increased tillering at

100 kg P_2O_5 level, thus resulted into more NMC/ha. The interaction effect between time of phosphorus application as split application of P_2O_5 with AM recorded significantly highest NMC /ha (90259 /ha) which was found to be at par with an application of P_2O_5 as a basal dose with AM (89399 /ha) and split application of P_2O_5 with no use of AM, (85970/ha), respectively (Table -3).

Cane girth was significantly improved (6.32 cm) with the 100 percent RD of P_2O_5 level over 75 percent of RD of phosphorus. The average cane weight was significantly responded with phosphorus management. It was found significantly highest with 100 percent RD of P_2O_5 level (1.102 kg), with split application phosphorus in sugarcane recorded 1.077 kg and with the application of AM recorded 1.099 kg, respectively. Similarly, this findings tally with that of Shukla and Singh (2011), Devi et al. (2012) and Tasdo et al. (2013), respectively. In general, application of P caused significant improvement in growth of sugarcane.

Sugarcane development and yield

The data tabulated in the Table 2 revealed that amongst the phosphorus levels an application of 100 percent RD of P_2O_5 kg/ha was responded significantly highest DMY (6544 kg/ha) at 180 DAP while with splitting of phosphorus recorded significantly highest DMY at 180 DAP (6320 kg/ha). At harvest among the phosphorus levels an application of 100 percent RD of P_2O_5 kg/ha was responded significantly highest total DMY (21870 kg/ha) and with split application of phosphorus over basal application of phosphorus and an application of AM recorded significant results (20510 and 20526 kg/ha), respectively. The data tabulated in Table 3 of significant interaction revealed that the DMY at 180 DAP and total DMY were recorded significantly superior results with splitting of phosphorus and AM (6766 and 22964 kg/ha), respectively. The results presented about mean CGR and RGR between the time period of 180 DAP to harvest in Table-2 influenced significantly with phosphorus level of an application of 100 percent RD of P_2O_5 kg/ha (12.91 and 17.11 g/m^2/day) and further it shows significantly highest with basal application of P_2O_5 (12.16 and 17.04 g/m^2/day) and with an application of AM found (12.15 and 17.03 g/m^2/day), respectively. The interaction effect between split application of phosphorus and AM presented in (Table-3) recorded significantly superior results in respect of mean CGR during time period of 180 to harvest (13.67 g/m^2/day) and similar significantly superior interaction effect in mean RGR was recorded between 180 to harvest (17.15 g/m^2/day). Sitthaphanit et al. (2010) reported that in maize the mean CGR and RGR improved significantly during crop growth with splitting of fertilizers over basal application.

The data presented in Table 2 and Figure 1 of cane yield and green top yield revealed that yields were increased significantly with (10.39 and 22.45 %) with the P level of 100 percent P_2O_5 kg/ha application while with the split application of phosphorus resulted in significantly increased with (15 and 18.77 %) and an application of AM increased with (20.68 and 26.35 %), respectively. The significant interaction data presented in Table-3 shows that the splitting of phosphorus with AM recorded significantly highest cane and green top yield (95.68 and 22.74 t/ha) which was being at par with basal application of P_2O_5 with AM (91.44 and 21.40 t/ha).The experimental results are in agreement of the findings of Chen et al. (2003) reported that increased levels of phosphorus increased the shoot biomass and phosphorus content and higher total root length and more fine roots which were beneficial to phosphorus uptake by the plants which resulted into higher yield. The same results were reported by Singh (2007) and concluded that shoot dry weight increased with increase in rate of P_2O_5 application.

Table 1: Growth parameters influenced by phosphorus management in sugarcane

Treatments	Germination percentage	Periodical plant height (cm)			Number of millable cane per hectare	Cane girth (cm)	Average cane weight (kg)
		90 DAP	180 DAP	At harvest			
Phosphorus levels (A)							
A_1:100 % RD of P_2O_5	67.35	132	224	321	88052	6.32	1.102
A_2: 75 % RD of P_2O_5	65.57	129	207	300	80657	6.22	0.971
SE m ±	0.77	0.97	3.65	3.56	1554	0.02	0.019
CD at 5%	NS	NS	11	10	4434	0.05	0.054
Time of phosphorus application (B)							
B_1: 100 % P_2O_5 at planting	67.08	130	211	306	80594	6.25	0.997
B_2: 50 % P_2O_5 at planting + 50 % P_2O_5 at final earthing up	65.84	131	221	316	88115	6.29	1.077
SE m ±	0.77	0.97	3.65	3.6	1554	0.01	0.019
CD at 5%	NS	NS	NS	10	4434	NS	0.054
Application of arbuscular mycorrhiza (C)							
C_1: No AM	66.38	129	211	303	78879	6.27	0.974
C_2: AM	66.54	131	220	319	89829	6.27	1.099
SE m ±	0.77	0.97	3.65	3.6	1554	0.01	0.019
CD at 5%	NS	NS	NS	10	4434	NS	0.054
Significant interactions	--	--	--	--	B x C	--	--
C.V. %	6.6	4.2	9.6	6.5	10.4	1.4	10.3

Table 2: Sugarcane development and yield influenced by phosphorus management

Treatments	Dry matter yield (kg/ha)		Crop growth rate (180-harvest) ($g/m^2/day$)	Relative crop growth rate (180-harvest) ($g/m^2/day$)	Cane yield (t/ha)	Green top yield (t/ha)
	At 180 DAP	At harvest				
Phosphorus levels (A)						
A_1: 100 % RD of P_2O_5	6544	21870	12.91	17.11	89.77	21.76
A_2: 75 % RD of P_2O_5	4984	15961	9.68	16.83	81.32	17.77
SE m ±	131	536	0.33	0.02	1.85	0.45
CD at 5%	373	1529	0.94	0.06	5.27	1.27
Time of phosphorus application (B)						
B_1:100 % P_2O_5 at planting	5208	17322	10.43	16.89	79.57	18.07
B_2: 50 % P_2O_5 at planting + 50 % P_2O_5 at final earthing up	6320	20510	12.16	17.04	91.52	21.46
SE m ±	131	536	0.33	0.02	1.85	0.45
CD at 5%	373	1529	0.94	0.06	5.27	1.27
Application of arbuscular mycorrhiza (C)						
C_1: No AM	5595	17576	10.43	16.91	77.53	17.46
C_2: AM	5933	20526	12.15	17.03	93.56	22.07
SE m ±	131	536	0.33	0.02	1.85	0.45
CD at 5%	NS	1529	0.94	0.06	5.27	1.27
Significant interactions	B x C	B x C	B x C	B x C	B x C	B x C
C.V. %	12.8	16.0	16.4	0.70	12.2	12.7

Table 3: Significant interaction effects between time of phosphorus application and arbuscular mycorrhiza in sugarcane

Treatments	Number of millable cane per hectare	Dry matter yield at 180 DAP (kg/ha)	Total Dry matter yield At harvest (kg/ha)	Crop growth rate (180-harvest) ($g/m^2/day$)	Relative crop growth rate (180-harvest) ($g/m^2/day$)	Cane yield (t/ha)	Green top yield (t/ha)
Significant interaction (B x C)							
B_1C_1: 100 % P_2O_5 at planting without AM	71788	5316	17096	10.22	16.88	67.69	14.75
B_1C_2: 100 % P_2O_5 at planting with AM	89399	5100	17547	10.64	16.91	91.44	21.40
B_2C_1: 50 % P_2O_5 at planting + 50 % P_2O_5 at final earthing up without AM	85970	5873	18056	10.65	16.94	87.36	20.18
B_2C_2: 50 % P_2O_5 at planting + 50 % P_2O_5 at final earthing up with AM	90259	6766	22964	13.67	17.15	95.68	22.74
SE m ±	2197	262	758	0.46	0.03	2.61	0.89
CD at 5%	6271	747	2163	1.32	0.09	7.45	1.80

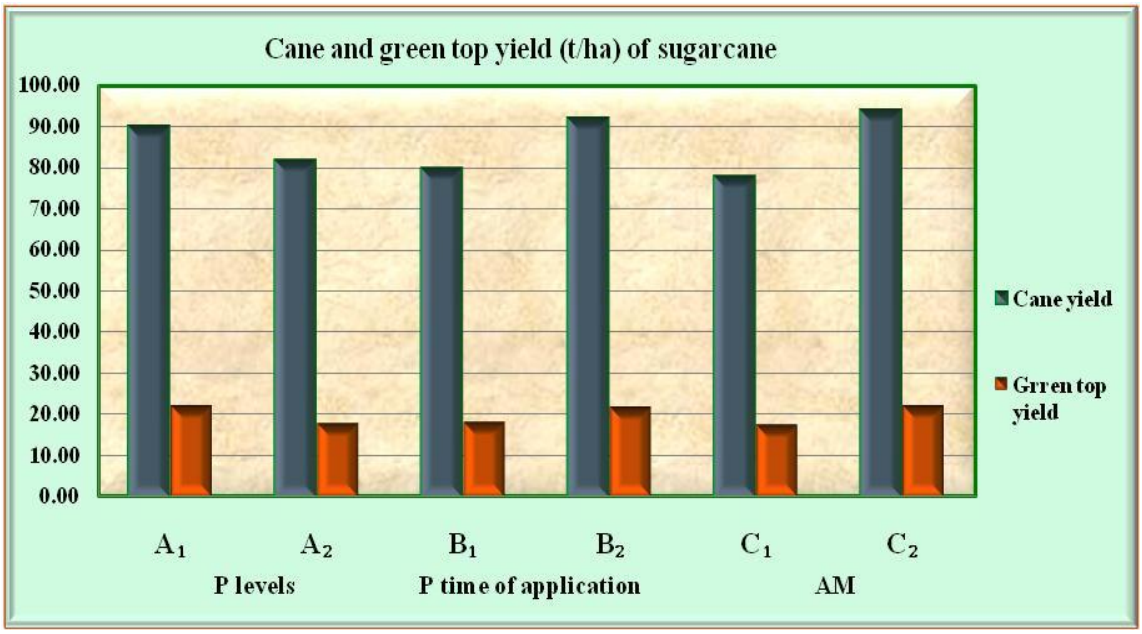

Fig. 1: Cane and green top yield as influenced by phosphorus management in sugarcane

CONCLUSION

An application of phosphorus to sugarcane with 100 percent RD of P_2O_5 level found significant results in terms of growth and yield of sugarcane. Thus, application of phosphorus with split (50:50) at planting and at earthing up with AM biofertilizer were found effective to increase the growth and development which resulted into highest cane and green top yield in sugarcane under south Gujarat condition.

Integration of other sources of phosphate fertilizers in this investigation *viz.*, rock phosphate, basic slag or other organic manures as well as sugarcane trash can be proposed to try individually or in combination with organic fertilizers.

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REFERENCES

Chen L., Wang S.F., Liu R., & Wang H. (2003). Changes of root morphology and rhizosphere processes of wheat under different phosphate supply levels. *Plant Nutrition and Fertilizer Science*, *18*(2), 324-331.

Devi, T. C., Bharathalakshmi, M., Kumari, M. B. G. S., & Naidu, N. V. (2012). Effect of sources and levels of phosphorus with zinc on yield and quality of sugarcane. *Sugar Tech, 14* (2), 195-198.

Eftkhari, E. T., Hurek, T., & Reinhold, H.B. (2010). Endophytic expression of nif genes of Azoarcus sp. Strain BH72 in rice roots. *Molucular Plant-Microbe International, 12*, 813-819.

Jamal, S.F., Cadet, P., Rutherford, R.S., & Straker, C.J. (2004). Effect of mycorrhiza on the nutrient uptake of sugarcane. In *Proceedings of South African Sugar Technological Association, 78*, 343-348.

Panse, V. G., & Sukhatme, P.V. (1978). *Statistical Methods for Agricultural Worker*. Indian Council of Agricultural Research, New Delhi, pp.41-44.

Redford, P.J. (1967). Growth analysis formulae. Their use and abuse. *Crop Science. 7*, 171-175.

Shahi, H. N. (2002). *Crushing prices cause concern*. The Hindu Survey of Indian Agriculture (Rani, N., Ed.) National Press, Chennai. pp. 119-124.

Shukla, S.K., & Singh, I. (2011). Tillering pattern, growth and sugarcane yield of promising genotypes under different planting seasons and fertility levels in subtropical India. *Indian Journal of Sugarcane Technology, 26* (2), 10-13.

Singh, S. (2007). Role of mycorrhizae in disturbed lands. Part II soil compaction, soil erosion, soil aggregation and volcanic eruptions. *Mycorrhizae News, 15* (2), 1-11.

Sithaphanit. S., Limpinuntana. V., Toomsan. B., Panchaban, S., & Bell, R.W. (2010). Growth and yield responses in maize to split and delayed fertilizer applications on sandy soil under high rainfall regimes. *Natural Science. 44*, 991-1003.

Tasdo, P. A., Lawal, B. A., Igwe, C. A., Adeboye, M. K. A., Odofin, A. J., & Adekambi, A. A. (2013). Effect of source and levels of phosphorus on yield and quality of sugarcane in southern guinea Savanna Zone of Nigeria. *Agriculture Science Development, 2* (3), 25-27.

Watson, D.J. (1952). The physiological basis of variation in yield. *Advances in Agronomy, 4*, 101-145.

Zende, G.K. (1984). Effect of season and management practices on the uptake of nutrients by different varieties of sugarcane. In *Proceedings of 34^th^ Annual convention of The Deccan Sugar Technologists Association Part-I*: *Addendum*: SA 50-SA53.