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Effect of N & P management with and without bio organics on growth and yield parameters of *kharif* sorghum under South Gujarat conditions

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Abstract
A field experiment was conducted during 2016-17, 2017-18 and 2018-19 to study the Effect of N & P management with and without bio organics on growth and yield parameters of *kharif* sorghum under South Gujarat conditions. There were fifteen treatments comprising of three fertilizer levels of N & P [60+30kg/ha (F_1), 80+40 kg/ha (F_2) and 100+50 kg/ha (F_3)] along with five bio organics levels [Control (B_1), *Azospirillium* @ 3l/ha (B_2), AM @ 250 g/ha(B_3), *Azospirillium* & AM(B_4) and NAUROJI Novel organic liquid fertilizer (1%) at 45 and 60 DAS (B_5). The experiment was laid out in factorial RBD with three replications. The type of soil was medium black and no sever pest and disease incidence were observed on sorghum during the experiment. The plant height (187.00 cm) was recorded significantly higher under the treatment having application of F_3 (100+50 NP kg/ha) and also significantly higher under the treatment having application of B_4 (*Azospirillium* & AM). Interaction effect FxB was found significant during all the individual years as well as in pooled data. F_3B_2 interaction recorded significantly higher plant height (192.29 cm) in pooled data which was found statistically at par with F_3B_5 and F_1B_4. The length of ear head was found significantly higher (21.53 cm) with the treatment F_3 (100+50 NP kg/ha) which was found statistically at par with F_2 (80+40 NP kg/ha) in pooled data.

Keywords: Bio organics, liquid fertilizer, phosphorus, *Azospirillium*

Introduction
Sorghum is one of the important cereal crop in south Gujarat region. It is used for both grain and fodder purpose. Sorghum cultivation is gaining popularity due to its nature of extreme drought tolerance. Being a cereal crop, it is more nutrient exhaustive crop spatially nitrogen and phosphorus, as the soils of South Gujarat are low in available nitrogen and medium to high in available phosphorus and potash.

Phosphorus and Nitrogen are most needed elements for production. Phosphorus, although not required in large quantities, is critical because of its multiple effects on nutrition. It plays a key role in various physiological processes like root growth and dry matter production, nodulation and nitrogen fixation and also in metabolic activities especially in protein synthesis.

The continuous use of high grade fertilizers has generated problems like deterioration of soil fertility, soil health and nutrient imbalance and decrease the productivity. Very high cost of phosphatic fertilizer also demand the need for recycling and exploitation of fixed phosphorus to improve crop production. The availability of phosphorus to the crop can be augmented by providing appropriate strains of microbes which are known to solubilise the fixed phosphorus and mobilize the deeply placed phosphorus to root zone by their activity. Besides increasing the availability of native P in the soil also help in enhancing the use efficiency of applied phosphorus (Thenua and Kumar, 2007).

There is sufficient amount of phosphorus in the soil and phosphorus application can be avoided or reduced by the application of bio-fertilizers like *mycorrhiza* and PSB, which solubilize the native pool of phosphorus in the soil. The use of bio-organics is getting popular amongst farmers due to its low cost, eco-friendly nature and effectiveness in saving of nitrogen and phosphorus. There is enough number of studies to show that with proper use of bio-fertilizers like *Azospirillium* and PSB, use of chemical fertilizers can be minimized.

Materials and Methods
A field experiment was conducted during 2016-17, 2017-18 and 2018-19 at College farm, Navsari Agricultural University, Bharuch Campus to study the "Effect of N & P management with and without bio organics on growth and yield parameters of *kharif* sorghum under South Gujarat conditions". The soil of the experimental field was medium black having medium to

poor drainage, low in available nitrogen (195.65kg/ha) and medium in available phosphorus (38.65kg/ha). Total fifteen treatments comprising of three fertilizer levels of N & P [60+30kg/ha (F_1), 80+40 kg/ha (F_2) and 100+50 kg/ha (F_3)] along with five bio organics levels [Control (B_1), *Azospirillium* @ 3l/ha (B_2), AM @ 250 g/ha(B_3), *Azospirillium* & AM(B_4) and NAUROJI Novel organic liquid fertilizer (1%) at 45 and 60 DAS (B_5). The experiment was laid out in factorial RBD with three replications. The type of soil was medium black and no sever pest and disease incidence were observed on sorghum during the experiment. Sorghum variety GJ 42 was sown with 15-20kg/ha seed rate at a distance of 45 x 20 cm. The full dose of fertilizers was applied according to the treatments manually before sowing the seeds. All the recommended cultural practices and plant protection measures were followed throughout the experimental periods.

Result and Discussion

Plant population

The mean data pertaining to plant population of sorghum at initial and harvest as influenced by different treatments are presented in Table 1.

Fertilizer dose

Plant population at initial and harvest did not differ significantly due to fertilizer levels during all the individual years as well as in pooled data.

Bio organics levels

Plant population at initial and harvest did not differ significantly due to bio organics levels during all the individual years as well as in pooled data.

Interaction effect

Interaction effect was found not significant during all the individual years as well as in pooled data.

Plant height (cm)

The mean data pertaining to plant height in sorghum crop recorded at harvest as influenced by different treatments are presented in Table 2.

Fertilizer dose

During all the individual years as well as in pooled results of plant height (187.03, 184.36, 188.30 and 187.00 cm, respectively) was recorded significantly higher under the treatment having application of F_3 (100+50 NP kg/ha).

Bio organics levels

Plant height at harvest was recorded significantly higher under the treatment having application of B_4 (*Azospirillium* & AM) during all the individual years as well as in pooled data, which was found statistically at par with B_5 (NAUROJI Novel).

Interaction effect

Interaction effect FxB was found significant during all the individual years as well as in pooled data. F_3B_2 interaction recorded significantly higher plant height (193.11, 189.87, 193.90 and 192.29 cm, respectively) which was found statistically at par with F_3B_5 in all individual years but in pooled data being at par with F_3B_5 and F_1B_4.

Length of ear head (cm)

The mean data pertaining to length of ear head of sorghum at harvest as influenced by different treatments are presented in Table 3.

Fertilizer dose

Length of ear head of sorghum at harvest did not differ significantly due to fertilizer levels during all the individual years. However, it was found significantly higher (21.53 cm) with the treatment F_3 (100+50 NP kg/ha) which was found statistically at par with F_2 (80+40 NP kg/ha) in pooled data.

Bio organics levels

Length of ear head of sorghum at harvest did not differ significantly due to bio organics levels during all the individual years as well as in pooled data.

Interaction effect

Interaction effect was found not significant during all the individual years as well as in pooled data.

Test weight (g)

The mean data pertaining to test weight of sorghum as influenced by different treatments are presented in Table 4.

Fertilizer dose

During all the individual years as well as in pooled results test weight of sorghum was recorded significantly higher under the treatment having application of F_3 (100+50 NP kg/ha).

Bio organics levels

Test weight was recorded significantly higher under the treatment having application of AM (B_3) during second year (26.64 g) and third year (26.96 g) as well as in pooled data (26.50 g) which was found statistically at par with B_2 and B_4 during second year and B_4 during third year and pooled data.

Interaction effect

Interaction effect was found not significant during all the individual years as well as in pooled data.

Economics

The data on economics of sorghum crop as influenced by various treatments are furnished in Table 5. The gross as well as net realization, benefit cost ratio and cost of cultivation per hectare for individual treatment were worked out on the basis of grain and straw yield and prevailing local market prices.

The maximum gross realization, net realization and BCR was obtained under the treatment F_3B_5 i.e. 100-50-00 NP kg/ha + NAUROJI Novel organic liquid fertilizer 1% (152763, 117801 and 3.4, respectively) followed by F_3B_4 i.e. 100-50-00 NP kg/ha + *Azospirillium* & AM (136338, 101316 and 2.9, respectively), F_3B_3 i.e. 100-50-00 NP kg/ha + AM (133032, 98370 and 2.8, respectively) and F_2B_5 80-40-00 NP kg/ha + NAUROJI Novel organic liquid fertilizer 1% (134985, 100784 and 2.9, respectively).

Conclusion

Based on the results of three years experimentation it can be concluded that application of 80-40-00 N-P_2O_5-K_2O kg/ha (40-40-00 N-P_2O_5-K_2O kg/ha as basal and 40 N kg/ha at 30 DAS) with spraying of NAUROJI Novel organic liquid fertilizer (1%) at 45 and 60 DAS is beneficial for farmers of south Gujarat under rainfed condition.

Table 1: Plant population of sorghum at initial and harvest as influenced by different treatments

Treatment	Plant population/ net plot							
	Initial				At Harvest			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
Fertilizer levels (F) N + P kg/ha								
F1- 60+30	244.00	241.20	242.27	242.49	240.00	238.10	239.79	239.30
F2- 80+40	244.20	241.40	242.73	242.78	240.20	238.30	240.25	239.58
F3-100+50	245.13	242.33	243.13	243.53	241.13	239.23	240.65	240.34
SEm±	0.36	0.36	0.36	0.28	0.36	0.36	0.36	0.28
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Bio organics levels (B)								
B1- Control	244.24	241.44	242.11	242.60	240.24	238.34	239.63	239.41
B2- Azospirillium @ 3l/ha	244.58	241.78	242.78	243.04	240.58	238.68	240.30	239.85
B3- AM @ 250 g/ha	244.47	241.67	242.56	242.90	240.47	238.57	240.08	239.70
B4- Azospirillium& AM	244.24	241.44	243.11	242.93	240.24	238.34	240.63	239.74
B5- NAUROJI Novel organic liquid fertilizer (1%)	244.69	241.89	243.00	243.19	240.69	238.79	240.52	240.00
SEm±	0.47	0.47	0.46	0.36	0.47	0.47	0.46	0.36
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	0.57	0.58	0.57	0.45	0.58	0.59	0.57	0.46
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Plant height of sorghum as influenced by different treatments

Treatment	Plant height (cm)			
	2016-17	2017-18	2018-19	Pooled
Fertilizer levels (F) N + P kg/ha				
F1- 60+30	176.93	174.56	177.78	176.97
F2- 80+40	178.63	176.41	178.79	178.60
F3-100+50	187.03	184.36	188.30	187.00
SEm±	0.93	0.94	0.92	0.93
CD (P=0.05)	2.70	2.73	2.66	2.70
Bio organics levels (B)				
B1- Control	177.28	175.07	177.30	177.25
B2- Azospirillium @ 3l/ha	179.08	176.27	179.94	179.14
B3- AM @ 250 g/ha	178.34	175.75	179.71	178.29
B4- Azospirillium& AM	185.67	183.60	186.41	185.62
B5- NAUROJI Novel org. liquid fertilizer (1%)	183.95	181.53	184.76	183.96
SEm±	1.20	1.22	1.18	1.20
CD (P=0.05)	3.49	3.53	3.43	3.49
CV (%)	2.05	2.05	1.95	2.00
Interaction	FxB	FxB	FxB	FxB

Table 2.1: Interaction effect of FxB factors on plant height of sorghum (2016-17)

Treatment	Plant height (cm)					
	Biofertilizer (B)					
Fertility levels kg/ha (N)	B_1 : Control	B_2 : Azospirillium	B_3 : AM @	B_4 : Azospirillium& AM	B_5 : NAUROJI Novel	Mean (F)
F_1 : 60+30	167.97	168.40	178.69	187.96	181.64	176.93
F_2 : 80+40	178.47	175.73	175.00	182.52	181.44	178.63
F_3 : 100+50	185.40	193.11	181.32	186.51	188.78	187.03
Mean (B)	177.28	179.08	178.34	185.67	183.95	
				F	B	I
Sem				0.93	1.20	2.09
CD				2.70	3.49	6.04
CV %				2.00		

Table 2.2: Interaction effect of FxB factors on plant height of sorghum (2017-18)

Treatment	Plant height (cm)					
	Biofertilizer (B)					
Fertility levels kg/ha (N)	B_1 : Control	B_2 : Azospirillium	B_3 : AM @	B_4 : Azospirillium& AM	B_5 : NAUROJI Novel	Mean (F)
F_1 : 60+30	165.60	164.93	175.22	186.69	180.37	174.56
F_2 : 80+40	177.11	174.01	173.28	179.62	178.04	176.41
F_3 : 100+50	182.49	189.87	178.75	184.50	186.18	184.36
Mean (B)	175.07	176.27	175.75	183.60	181.53	
				F	B	I
Sem				0.94	1.19	2.11
CD				2.73	3.45	6.11
CV %				1.98		

Table 2.3: Interaction effect of FxB factors on plant height of sorghum (2018-19)

Treatment	Plant height (cm)					
	Biofertilizer (B)					
Fertility levels kg/ha (N)	B_1 : Control	B_2 : Azospirillium	B_3 : AM @	B_4 : Azospirillium& AM	B_5 : NAUROJI Novel	Mean (F)
F_1 : 60+30	168.30	170.93	181.22	187.39	181.07	177.78
F_2 : 80+40	178.07	174.97	174.25	184.12	182.54	178.79
F_3 : 100+50	185.53	193.90	183.65	187.73	190.68	188.30
Mean (B)	177.30	179.94	179.71	186.41	184.76	
				F	B	I
Sem				0.92	1.18	2.05
CD				2.66	3.43	5.95
CV %				1.95		

Table 2.4: Interaction effect of FxB factors on plant height of sorghum (Pooled)

Treatment	Plant height (cm)					
	Biofertilizer (B)					
Fertility levels kg/ha (N)	B_1 : Control	B_2 : Azospirillium	B_3 : AM @	B_4 : Azospirillium& AM	B_5 : NAUROJI Novel	Mean (F)
F_1 : 60+30	167.29	168.09	178.38	187.35	181.03	176.43
F_2 : 80+40	177.88	174.90	174.18	182.09	180.67	177.94
F_3 : 100+50	184.47	192.29	181.24	186.25	188.55	186.56
Mean (B)	176.55	178.43	177.93	185.23	183.42	
				F	B	I
Sem				0.92	1.19	2.06
CD				2.67	3.45	5.97
CV %				1.98		

Table 3: Length of ear head of sorghum as influenced by different treatments

Treatment	Length of ear head (cm)			
	2016-17	2017-18	2018-19	Pooled
Fertilizer levels (F) N + P kg/ha				
F1- 60+30	22.00	19.20	20.27	20.49
F2- 80+40	22.20	19.40	20.73	20.78
F3-100+50	23.13	20.33	21.13	21.53
SEm±	0.36	0.36	0.36	0.28
CD (P=0.05)	NS	NS	NS	0.82
Bio organics levels (B)				
B1- Control	22.24	19.44	20.11	20.60
B2- Azospirillium @ 3l/ha	22.58	19.78	20.78	21.04
B3- AM @ 250 g/ha	22.47	19.67	20.56	20.90
B4- Azospirillium& AM	22.24	19.44	21.11	20.93
B5- NAUROJI Novel organic liquid fertilizer (1%)	22.69	19.89	21.00	21.19
SEm±	0.47	0.47	0.46	0.36
CD (P=0.05)	NS	NS	NS	NS
CV (%)	6.2	7.1	6.67	5.21
Interaction	NS	NS	NS	NS

Table 4: Test weight of sorghum as influenced by different treatments

Treatment	Test wt. (g)			
	2016-17	2017-18	2018-19	Pooled
Fertilizer levels (F) N + P kg/ha				
F1- 60+30	24.73	24.81	24.75	24.76
F2- 80+40	25.40	24.45	23.37	24.41
F3-100+50	26.27	26.32	25.83	26.14
SEm±	0.34	0.40	0.63	0.41
CD (P=0.05)	0.98	1.15	1.83	1.19
Bio organics levels (B)				
B1- Control	24.89	24.17	23.44	24.17
B2- Azospirillium @ 3l/ha	25.22	25.30	24.36	24.96
B3- AM @ 250 g/ha	25.89	26.64	26.96	26.50
B4- Azospirillium& AM	25.67	25.37	25.07	25.37
B5- NAUROJI Novel organic liquid fertilizer (1%)	25.67	24.49	23.42	24.53
SEm±	0.43	0.51	0.82	0.53
CD (P=0.05)	NS	1.49	2.36	1.53
CV (%)	5.12	6.13	9.92	6.32
Interaction	NS	NS	NS	NS

Table 5: Economics of sorghum as influenced by different treatments

Treatment	Cost of cultivation (Rs/ha)			Gross realization (Rs/ha)	Net realization (Rs/ha)	BCR
	Fixed cost	Variable cost	Total			
F1B1	29865	2278	32143	76822	44679	1.4
F1B2	29865	2638	32503	106944	74441	2.3
F1B3	29865	3278	33143	112008	78865	2.4
F1B4	29865	3638	33503	121153	87650	2.6
F1B5	29865	3578	33443	122450	89007	2.7
F2B1	29865	3036	32901	114334	81433	2.5
F2B2	29865	3396	33261	121785	88524	2.7
F2B3	29865	4036	33901	119591	85690	2.5
F2B4	29865	4396	34261	126543	92282	2.7
F2B5	29865	4336	34201	134985	100784	2.9
F3B1	29865	3797	33662	122644	88982	2.6
F3B2	29865	4157	34022	124093	90071	2.6
F3B3	29865	4797	34662	133032	98370	2.8
F3B4	29865	5157	35022	136338	101316	2.9
F3B5	29865	5097	34962	152763	117801	3.4

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