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Effect of Sources of P with Organics and Tank Silt on the Yield Parameters DMP and Yield of Bhendi

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ABSTRACT

A field experiment was also conducted with three sources of P viz. fertilizer control, SSP and RP (recommended dose of P was added through RP and SSP) which were tried with tank silt addition (control, silt 5 t ha^{-1}) and organic manures (control, FYM at 2 t ha^{-1}, Pressmud at 2 t ha^{-1} and Spent wash at 2 t ha^{-1}). The test crop was bhendi hybrid Sakthi and the treatments were replicated thrice in a factorial randomised block design. The fruit samples were drawn at 5th, 12th and 19th picking of bhendi and analysed for quality parameters. The biometrical observations were also taken and final fruit yield was recorded by totalling the fruits harvested from all the pickings. The results of field experiment had shown that among the different sources of phosphatic fertilizers, the URP blended with pressmud and tank silt had registered higher yield and dry matter production. It was observed that the URP blended with pressmud and tank silt was next to SSP, indicating its superiority over farm yard manure and spent wash. It was further noticed that this treatment had resulted in higher biometrical observations viz. plant height and number of branches per plant and yield parameters like fruit length, fruit girth and fruit weight. Application of rock phosphate with press mud and tank silt had significant influence on N, P and K uptake by bhendi fruit but plant P uptake was significantly influenced by application of SSP.

Key words: *Abelmoschus esculentus*, Organics, Phosphorous, Tank silt, Yield parameters, DMP

Bhendi [*Abelmoschus esculentus* (L.) Moench] commonly known as Lady's finger is grown popularly throughout India on commercial scale. It is a good source of carbohydrates, proteins, vitamins and minerals (Saini 1997). Bhendi being a short duration vegetable crop, its growth, yield and quality are largely influenced by application of fertilizers. The yield gap could be further reduced by adopting proper nutrient management technologies. The nutrient management is one of the most important inputs in agriculture. Phosphorus (P) is an essential macronutrient for plant growth and is generally considered to be second only to N in limiting crop production. It does not occur as abundantly in soils as N and K. In the present agriculture scenario, hike in price of water soluble phosphatic fertilizers like Single Super Phosphate (SSP), DAP and other complex phosphatic fertilizers have severely curtailed the use of these costly inputs, leading to unbalanced fertilizer use. A suitable alternate for this situation is the use of rock phosphate (RP) in agriculture. The problem with rock phosphate application is, its low solubility and slow release of P. Furthermore, it was recommended for acid soils wherein sufficient quantity of protons is available to dissolve the rock phosphate. However, in the recent times, it can also be used in neutral

soils provided its solubility is enhanced by addition of organic manures (Mahimairaja and Raniperumal 1995).

Yet another practice which had been slowly forgotten is the addition of tank silt, which not only served as a source of mineral elements but also it removal enhances the storage capacity of tanks and reservoirs. It serves as a source of nutrients to crops. Tank silt is chemically inorganic, rich in mineral elements like K, Ca, Mg and S and trace elements.

MATERIALS AND METHODS

To study the effect of P source with or without tank silt and organic manure on growth, yield and quality of bhendi a field experiment was conducted during the *Kharif* season of 2014 in field number C-7 in the farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute. The field experiment was laid in a factorial randomized block design with 24 treatment and three replications. First factor is source of P fertilizer (control, RP and SSP) second factor is silt (with and with out silt) third factor is organic manure (control, Farm Yard Manure (FYM) (2 t ha^{-1}) Pressmud (2 t ha^{-1}) Spent wash (2 t ha^{-1}). Five plants were selected at random from the sampling area and tagged for recording biometric observations at 3 stages viz. 5^{th}, 12^{th} and 19^{th} picking. The observations on fruit length, fruit girth, fruit weight and plant height were taken at all the above stages of picking and observations on number of branches per plant and number of fruits per plant and dry matter production (DMP) were also recorded in those plants. The yield of fruits per plot recorded at each harvest was summed up and converted to yield per hectare per crop.

RESULTS AND DISCUSSION

Plant height

The results of height of plant measured at different stages of crop growth are presented in (Table 1). Application of P through URP and Single Super Phosphate (SSP) significantly influenced the plant height at all stages. The plant height value recorded with application of Single Super Phosphate (119.07 cm) was significantly different from rock phosphate (98.74 cm) and control (90.11 cm). Among the different organic manures used in this experiment, addition of spent wash recorded higher value (105.85 cm) and it was comparable with pressmud application (105.06 cm), but significantly higher than farm yard manure and control. Addition of tank silt had significant influence on plant height, the highest value was recorded by application of tank silt (108.49 cm) and significantly different from without silt addition treatment. As could be expected height of the plant increased with advancement of crop growth (73.71 to 126.76 cm).

Table 1 Effect of P source, organics and tank silt on plant height (cm) at different stages of crop growth

		O_0			O_1			O_2			O_3			GM
	Stages	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1`	Mean	S_0	S_1	Mean	
P_0	5^{th}	59.70	60.23	59.97	62.84	71.00	66.92	64.21	72.63	68.42	61.10	70.13	65.62	65.23
	12^{th}	82.43	97.80	90.12	81.27	106.53	93.90	83.13	102.37	92.75	108.23	115.73	111.98	97.19
	19^{th}	90.67	96.00	93.34	103.00	122.33	112.67	104.00	125.67	114.84	102.00	119.67	110.84	107.92
	Mean	77.60	84.68	81.14	82.37	99.95	91.16	83.78	100.22	92.00	90.44	101.84	96.14	90.11
P_1	5^{th}	67.11	74.13	70.62	68.47	77.63	73.05	66.50	78.33	72.42	69.50	76.49	73.00	72.27
	12^{th}	99.80	115.73	107.77	89.20	98.13	93.67	106.00	102.87	104.44	119.83	96.00	107.92	103.45
	19^{th}	109.33	126.67	118.00	110.67	131.17	120.92	107.50	133.67	120.59	117.33	127.67	122.50	120.50
	Mean	92.08	105.51	98.80	89.45	102.31	95.88	93.33	104.96	99.15	102.22	100.05	101.14	98.74
P_2	5^{th}	79.70	83.23	81.47	81.43	83.45	82.44	82.35	89.27	85.81	80.67	89.16	84.92	83.66
	12^{th}	114.17	127.50	120.84	117.06	134,81	117.06	117.40	130.53	123.97	123.43	126.61	125.02	121.72
	19^{th}	138.00	151.00	144.50	145.00	154.33	149.67	147.67	177.00	162.34	141.67	160.00	150.84	151.83
	Mean	110.62	120.58	115.60	114.50	118.89	116.39	115.81	132.27	124.04	115.26	125.26	120.26	119.07
	GM	93.43	103.59	98.51	95.44	107.05	101.14	97.64	112.48	105.06	102.64	109.05	105.85	102.64

	P	O	S	D	P × O	P × S	P × D	O × S	O × D	S × D
S.Ed	1.06	1.22	1.06	1.06	2.58	1.499	1.83	1.73	2.58	1.49
C.D (0.05)	2.09	2.42	2.09	2.09	5.13	2.964	3.63	3.42	5.13	2.96

The interaction of P sources and organics was significant, which suggested that irrespective of different organic manure viz. farm yard manure, pressmud and spent wash, the highest plant height was recorded with application of SSP followed by RP and control. When P was applied through rock phosphate, spent wash addition recorded the highest value but it was comparable with pressmud, which in turn on par with farm yard manure. The interaction of P sources with stages of crop growth was significant, which had shown that irrespective of different stages of crop growth, SSP recorded the highest plant height followed by rock phosphate and control and irrespective P of source to value height of the plant increased with advancement of crop growth. The interaction of sources of P with tank silt revealed that application of silt along with the SSP or RP had significant influence on plant height.

The interaction of organics and tank silt had shown that addition of tank silt along with organic manures recorded significant influences on plant height. The plant height was unaltered due to the addition of organic manures in without silt addition treatment or silt control treatment, if it was added with tank silt, the highest plant height was recorded by pressmud which was significantly different from spent wash and farmyard manure, which were comparable but

significantly different from control. The interaction of organic and stages of crop growth further revealed that, at initial crop growth stage i.e. at 5th picking, the organic manure addition did not show any significant variation in plant height. As the crop growth proceeds, the highest crop growth was achieved in spent wash + RP added treatment at 12th picking and at 19th picking.

Table 2 Effect of P sources, organics and tank silt on number of branches plant^{-1}

		P_0	P_1	P_2	Mean
O_0	S_0	3.00	4.00	5.00	4.00
	S_1	3.00	3.67	5.00	3.89
	Mean	3.00	3.84	5.00	3.95
O_1	S_0	3.67	3.67	5.33	4.22
	S_1	3.67	5.00	5.00	4.56
	Mean	3.67	4.34	5.17	4.39
O_2	S_0	3.67	4.00	5.33	4.33
	S_1	4.00	5.33	6.33	5.22
	Mean	3.84	4.67	5.83	4.78
O_3	S_0	3.67	3.33	5.00	4.00
	S_1	3.33	4.67	5.67	4.56
	Mean	3.50	4.00	5.34	4.28
GM		3.50	4.21	5.33	4.35

	P	0	S	P × O	O × S	P × S
S.Ed	0.27	0.312	0.22	0.54	0.044	0.38
C.D (0.05)	0.55	0.629	0.44	NS	NS	0.77

Number of branches per plant

The number of branches per plant was significantly influenced by phosphorus. The highest number of branches per plant was registered by addition of SSP (5.33) followed by rock phosphate (4.21) and control (3.50). Among organic manures, pressmud registered the higher value, which was on par with farm yard manure and spent wash but significantly higher than control. The interaction of sources of P and tank silt revealed that, when P was added through rock phosphate, addition of tank silt had significant influence on number of branches per plant. Addition of tank silt did not influence the number of branches per plant if it was applied with SSP. The other interactions were insignificant.

Fruit length

The length of fruit was found to be significantly influenced by sources of phosphorus. The highest fruit length was noticed with addition of SSP (15.46 cm) followed by rock phosphate (13.18 cm) and control (12.02 cm). Among the organic manures tried, application of pressmud had registered the highest value (14.09 cm) which was significantly different from farm yard manure and spent wash which were comparable but significantly higher than control. The highest fruit length was observed in 12th picking followed by 19th and 5th picking (Table 3). The interaction of P sources and organics was significant. Irrespective of organic manures, SSP had registered the highest fruit length followed by rock phosphate and control. When P was applied through rock phosphate, there was no significant variation among the organic manures, whereas if it was through SSP, pressmud application influenced the fruit length significantly than other organic manures. The interaction of P sources with different stages of picking was significant which revealed that irrespective of P sources, 12th picking had registered significant variation in fruit length followed by 19th and 5th picking. Application of SSP had a significant influence on fruit length at all stages of picking followed by rock phosphate and control. The interaction of sources of P and tank silt revealed that silt addition along with SSP followed by rock phosphate had significant influence on fruit length. The interaction of organics and tank silt addition had shown that pressmud along with silt recorded significant influence on fruit length followed by spent wash and farm yard manure which were comparable. The interaction of organics and different stages of picking further confirmed the above results.

Table 3 Effect of P source, organics and tank silt on fruit length (cm) at different stages of crop growth

		O_0			O_1			O_2			O_3			GM
	Stages	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1`	Mean	S_0	S_1	Mean	
P_0	5th	8.83	9.57	9.20	10.17	11.30	10.74	10.53	11.43	10.98	9.73	11.30	10.52	10.36
	12th	11.43	11.67	11.55	12.87	14.43	13.65	13.10	14.77	13.94	12.23	14.30	13.27	13.10
	19th	11.52	11.73	11.63	12.28	13.53	12.91	12.69	13.84	13.27	11.97	13.33	12.65	12.61
	Mean	10.59	10.99	10.79	11.77	13.09	12.43	12.11	13.35	12.73	11.31	12.98	12.14	12.02
P_1	5th	10.97	11.53	11.25	11.10	11.90	11.50	10.87	12.07	11.47	11.17	11.70	11.44	11.41
	12th	13.97	14.87	14.42	14.10	15.13	14.62	13.77	15.67	14.72	14.17	15.07	14.62	14.59
	19th	13.02	14.01	13.52	13.20	13.32	13.26	12.84	14.60	13.72	13.29	14.08	13.69	13.55
	Mean	12.65	13.47	13.06	12.80	13.45	13.13	12.49	14.11	13.30	12.88	13.62	13.25	13.18
P_2	5th	11.83	13.37	12.60	13.10	13.47	13.29	13.33	14.40	13.87	12.30	13.97	13.14	13.22
	12th	16.03	17.17	16.60	16.43	17.80	17.12	16.97	19.00	17.99	16.10	18.27	17.19	17.22
	19th	14.92	16.00	15.46	15.12	16.16	15.64	15.28	18.39	16.84	14.99	16.67	15.83	15.94
	Mean	14.26	15.51	14.89	14.88	15.81	15.35	15.19	17.26	16.23	14.46	16.30	15.38	15.46
GM		12.50	13.32	12.91	13.15	14.12	13.63	13.26	14.91	14.09	12.88	14.30	13.59	13.56

	P	O	S	D	P × O	P × S	P × D	O × S	O × D	S × D
S.Ed	0.12	0.11	0.08	0.12	0.20	0.14	0.49	0.16	0.20	0.14
C.D (0.05)	0.24	0.22	0.16	0.24	0.39	0.28	0.96	0.32	0.39	0.28

Fruit girth

The girth of fruit was highest in the treatment which received SSP as P source (6.33 cm), followed by rock phosphate (5.88 cm) and control (5.64 cm). The fruit girth was found to be numerically higher when the soil was applied with different organic manures. Addition of tank silt had significant influence on the girth of fruit. The higher girth of fruit was observed in 12th picking which was on par with 19th picking but significantly higher than 5th picking. The interaction of sources of P and different stages of picking revealed that when P was added with either through rock phosphate or single super phosphate (SSP), the highest girth of fruit was recorded in 12th picking and irrespective of stages of picking, single super phosphate had registered the highest value followed by rock phosphate. The interaction P sources and tank silt addition had shown that in single super phosphate treatment, tank silt showed no significant influence but with rock phosphate it recorded the highest value. The interaction of tank slit with different stages of picking revealed tank slit addition had significant influence on girth of fruit at 12th picking. In all other interactions the variation in the fruit girth was insignificant.

Table 4 Effect of P source, organics and tank silt on fruit girth (cm) at different stages of crop growth

		O_0			O_1			O_2			O_3			GM
	Stages	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1`	Mean	S_0	S_1	Mean	
P_0	5th	4.95	5.02	4.99	5.09	5.42	5.26	5.19	5.44	5.32	5.06	5.33	5.20	5.19
	12th	5.58	5.70	5.64	5.89	6.24	6.07	5.95	6.28	6.12	5.80	6.20	6.00	5.96
	19th	5.49	5.54	5.52	5.73	5.98	5.86	5.77	6.10	5.94	5.55	5.98	5.77	5.77
	Mean	5.34	5.42	5.38	5.57	5.88	5.73	5.64	5.94	5.79	5.47	5.84	5.65	5.64
P_1	5th	5.24	5.45	5.35	5.27	5.54	5.41	5.22	5.58	5.40	5.30	5.48	5.39	5.39
	12th	6.04	6.33	6.19	6.05	6.38	6.22	5.97	6.38	6.18	6.06	6.34	6.20	6.19
	19th	5.90	6.15	6.03	5.90	6.25	6.08	5.82	6.27	6.05	5.92	6.19	6.06	6.05
	Mean	5.73	5.98	5.85	5.74	6.06	5.90	5.67	6.08	5.87	5.76	6.00	5.88	5.88
P_2	5th	5.66	5.80	5.73	5.75	5.86	5.81	5.78	6.06	5.92	5.70	5.90	5.80	5.81
	12th	6.45	6.63	6.54	6.49	6.68	6.59	6.57	6.95	6.76	6.48	6.85	6.67	6.64
	19th	6.36	6.54	6.45	6.47	6.65	6.56	6.47	6.78	6.63	6.44	6.67	6.56	6.55
	Mean	6.16	6.32	6.24	6.24	6.40	6.32	6.27	6.60	6.44	6.21	6.47	6.34	6.33
	GM	5.74	5.74	5.91	5.82	5.85	6.11	5.98	5.86	6.20	6.03	5.81	6.10	5.96

	P	O	S	D	P × O	P × S	P × D	O × S	O × D	S × D
S.Ed	0.10	0.12	0.08	0.10	0.20	0.14	0.18	0.16	0.2	0.14
C.D (0.05)	0.20	0.23	0.16	0.20	NS	0.28	0.35	NS	NS	0.28

Table 5 Effect of P source, organics and tank silt on fruit weight (g) at different stages of crop growth

		O_0			O_1			O_2			O_3			GM
	Stages	S_0	S_1	Mean	S_0	S_1	Mean	S_0	S_1`	Mean	S_0	S_1	Mean	
P_0	5th	10.07	12.42	11.25	10.96	12.79	11.88	11.22	13.34	12.28	10.97	12.20	11.59	11.75
	12th	11.23	13.89	12.56	12.24	13.95	13.10	12.57	14.68	13.63	12.23	12.93	12.58	12.97
	19th	11.27	13.57	12.42	12.22	13.93	13.08	12.44	14.53	13.49	12.30	13.70	13.00	13.00
	Mean	10.86	13.29	12.08	11.81	13.56	12.68	12.08	14.18	13.13	11.83	12.94	12.39	12.57
P_1	5th	14.26	15.95	15.11	14.52	16.13	15.33	15.02	16.45	15.74	14.97	16.94	15.96	15.53
	12th	15.52	17.23	16.38	15.81	17.42	16.62	16.30	17.74	17.02	16.25	18.23	17.24	16.81
	19th	15.81	17.97	16.89	17.60	18.19	17.90	17.71	18.50	18.11	17.60	18.18	17.89	17.70
	Mean	15.20	17.05	16.12	15.98	17.25	16.61	16.34	17.56	16.95	16.27	17.78	17.03	16.68
P_2	5th	17.28	17.97	17.63	17.60	18.19	17.90	17.71	18.50	18.11	17.60	18.18	17.89	17.88
	12th	18.57	19.26	18.92	18.89	19.33	19.11	19.00	19.64	19.32	18.88	19.32	19.10	19.11
	19th	18.18	19.09	18.64	19.03	19.59	19.31	19.14	19.74	19.44	18.60	19.11	18.86	19.06
	Mean	18.01	18.77	18.39	18.51	19.04	18.77	18.62	19.29	18.96	18.36	18.87	18.62	18.68
	GM	14.69	16.37	15.53	15.43	16.61	16.02	15.68	17.01	16.35	15.49	16.53	16.01	15.98

	P	O	S	D	P × O	P × S	P × D	O × S	O × D	S × D
S.Ed	0.12	0.14	0.10	0.12	0.25	0.17	0.21	0.20	0.25	0.17
C.D (0.05)	0.24	0.28	0.19	0.24	0.49	0.34	0.42	0.40	0.49	0.34

Fruit weight

The result of statistical analysis had shown that weight of fruit was found to be the highest in soil which received SSP treatment (18.68 g) followed by rock phosphate (16.68 g) and control (12.57 g) (Table 5). Among the organic manures used in this experiment, application of pressmud registered the highest weight of fruit (16.35 g) which was significantly higher than spent wash and farm yard manure

which were comparable but significantly higher than control. Addition of tank silt had significant influence on fruit weight. Among the different stages of picking, the highest weight of fruit was recorded in 12th picking which was comparable with 19th picking and it was significantly differ from 5th picking. The interaction of P source and organics had revealed that irrespective of organic sources, SSP application registered significant influence in weight of fruit followed by rock phosphate. With respect to P sources, the variation was only marginal. The interaction of P sources with different stages of picking had shown that, with respect to P sources the fruit weight was higher in 12th picking, which was comparable with 19th picking. At all stages of picking, SSP had significant influence in weight of fruit followed by rock phosphate addition. The interaction of sources of P and tank silt addition revealed that tank silt addition along with either SSP or rock phosphate had significant variation in weight of fruit. The interaction of organics and different stages of picking further revealed that addition of pressmud followed by spent wash and farm yard manure had significant variation in weight of fruit in 19th picking and 12th than 5th picking. The interactions of tank silt with organics and different stages of picking further confirmed the main effects.

Table 6 Effect of P sources, organics and tank silt on number of fruits plant^{-1}

		P_0	P_1	P_2	Mean
O_0	S_0	8.66	14.09	16.05	12.93
	S_1	9.66	14.34	16.45	13.48
	Mean	9.16	14.22	16.25	13.21
O_1	S_0	10.27	14.13	16.26	13.55
	S_1	13.07	15.38	17.15	15.20
	Mean	11.67	14.76	16.71	14.38
O_2	S_0	10.67	14.41	16.33	13.80
	S_1	13.15	15.77	17.95	15.62
	Mean	11.91	15.09	17.14	14.71
O_3	S_0	10.30	14.28	16.06	13.55
	S_1	12.83	15.49	17.13	15.15
	Mean	11.57	14.89	16.60	14.35
GM		11.08	14.74	16.67	14.16

	P	0	S	P × O	O × S	P × S
S.Ed	0.33	0.38	0.26	0.67	0.55	0.47
C.D (0.05)	0.68	0.77	0.53	1.35	1.10	0.95

Number of fruits per plant

Among the P sources, the highest fruits per plant was registered in SSP received plots (16.67) followed by rock phosphate (14.74) and control (11.08) (Table 6). Addition of organic manures had marginal influence in number of fruits per plant. The interaction of P sources and organics had shown that irrespective of P sources addition of organic manures showed only, marginal variation in number of fruits per plant, whereas irrespective of organic sources addition of SSP followed by rock phosphate had significant variation in number of fruits per plant.

Table 7 Effect of P sources, organics and tank silt on dry matter production (kg ha^{-1})

		P_0	P_1	P_2	Mean
O_0	S_0	2168	3702	3917	3262
	S_1	2758	3802	4051	3537
	Mean	2463	3752	3984	3400
O_1	S_0	2991	3844	4073	3636
	S_1	3303	4026	4478	3936
	Mean	3147	3935	4275	3786
O_2	S_0	3127	4082	4225	3811
	S_1	3465	4296	4768	4176
	Mean	3296	4189	4496	3994
O_3	S_0	2775	3646	4251	3557
	S_1	3246	4191	4234	3890
	Mean	3010	3918	4242	3724
GM		2979	3949	4250	3726

	P	0	S	P × O	O × S	P × S
S.Ed	157	181	128	222	257	222
C.D (0.05)	316	365	258	448	517	448

Dry matter production (DMP)

The results of dry matter production as influenced by P sources with organic manures and tank silt at harvest stage are presented in (Table 7). Higher DMP was associated with the plot which received SSP as P sources (4250 kg ha^{-1}) which was comparable with rock phosphate (3949 kg ha^{-1}) but significantly different from control (2979 kg ha^{-1}). There were no significant differences in DMP with respect to organic manures but significantly different from control. Addition of tank silt had shown no marked variation in DMP. The interaction of P sources with organics had shown that irrespective of organic manures, SSP application registered higher DMP and was comparable with rock phosphate. When P was applied with either SSP or rock phosphate, all the organic manures viz. pressmud, farm yard manure and spent wash registered no significant variation but significantly higher than control. The interaction of sources of P and tank silt revealed that when tank silt was added either with SSP or rock phosphate had significant influence on DMP than control. The interaction of organics and tank silt had shown that the higher value of DMP was registered in tank silt added plots when it was combined with any one of the organic manures. The simple correlation studies had shown that DMP was positively related to yield ($r=0.979^{**}$), plant height ($r=0.822^{**}$), number of branches per plant ($r=0.844^{**}$), number of fruits per plants ($r=0.967^{**}$), fruit weight ($r=0.936^{**}$), fruit length ($r=0.876^{**}$) and fruit girth ($r=0.870^{**}$) (Table 9).

Yield

The highest fruit yield was recorded in the plots which received SSP (17.87 t ha^{-1}) followed by rock phosphate (16.87 t ha^{-1}) and control (12.44 t ha^{-1}) (Table 8). Among the organic manures tried, the higher yield was registered with pressmud application (16.68 t ha^{-1}) and it was on par with application of farm yard manure (15.93 t ha^{-1}) which in turn comparable with spent wash (15.66 t ha^{-1}), but significantly

higher than control (14.65 t ha^{-1}). Addition of tank silt had shown significant variation in yield. The interaction of sources of P and organics had shown that irrespective of P sources, higher yield was recorded with addition of pressmud which was on par with farm yard manure and significantly higher than control. Irrespective of all the organic manures tried in this experiment, higher yield was recorded with SSP addition which was comparable with rock phosphate. The interaction of sources of P and tank silt addition revealed that, the highest yield was recorded with tank silt addition along with SSP followed by rock phosphate and control. The interaction of organics and silt had further revealed that, all the organic manures registered the highest yield with tank silt addition. Among the organic manures, pressmud addition recorded higher yield which was comparable with farm yard manure and spent wash.

Table 8 Effect of P sources, organics and tank silt on fruit yield (t ha^{-1}) (fresh weight)

		P_0	P_1	P_2	Mean
O_0	S_0	9.12	15.67	16.47	13.75
	S_1	11.60	17.99	17.03	15.54
	Mean	10.36	16.83	16.75	14.65
O_1	S_0	12.57	16.17	17.13	15.29
	S_1	13.89	16.93	18.87	16.56
	Mean	13.23	16.55	18.00	15.93
O_2	S_0	13.15	17.17	17.77	16.03
	S_1	13.89	18.07	20.05	17.34
	Mean	13.52	17.62	18.91	16.68
O_3	S_0	11.67	15.33	17.87	14.96
	S_1	13.65	17.62	17.80	16.36
	Mean	12.66	16.475	17.84	15.66
GM		12.44	16.87	17.87	15.73

	P	0	S	P × O	O × S	P × S
S.Ed	0.39	0.45	0.32	0.78	0.63	0.55
C.D (0.05)	0.78	0.90	0.64	1.56	0.18	1.10

A close scrutiny of the effect of treatments on the various yield parameters had shown that application of SSP followed by RP with pressmud / spent wash with tank silt had resulted in favourable yield parameters like plant height, number of branches per plant, fruit length, girth and fruit weight. The favorable effect of P application on the above yield parameters could be attributed to the role of P on root proliferation and plant metabolism. Furthermore, addition of P could result in the increase in available P status of soil which ultimately enhanced the P uptake and thereby the yield parameters. This is in line with Balachander (2002), Abarna (2012) in rice. The significant influence of SSP on yield parameters is quite expected that it contains the entire P as soluble form, which enhanced the root proliferation and crop growth. On the other hand, addition of rock phosphate along with tank silt with pressmud or spent wash was also resulted in significant influence in yield parameters of Bhendi. It might be due to the influence of organic manures, which stimulate better plant and root growth by providing hormones, vitamins and other organic acids produced during decomposition. Similar trend of beneficial effect of organic sources was reported by Kuppusamy (2008). The organic acids produced during decomposition of organic manures could solubilize the P present in the rock phosphate, and also mineral P present in tank slit (tank slit contain 0.140 per cent total P) which increased the yield parameters of bhendi. Similar trend of result was reported by Binitha (2006), Rajakumar (2014), Sreenadha Reddy (2014) in bendhi.

A close scrutiny on other yield parameters had suggested that in general application of tank silt along with the organic manures like farm yard manure, pressmud and spent wash could favourably influence the plant height, number of branches, fruit length, fruit girth, weight and number of fruits. It could be inferred that chemical nature of tank silt had indicated that it is a good source of inorganic elements like K, Ca, Mg and S and blending this tank silt with organic manures which were good source of organically bound elements like N, P, S and trace elements might have resulted in the increase in the available nutrient status of almost all essential nutrient elements thereby resulting in better growth and yield parameters. Similar observation with tank silt application was reported by Shankaranarayana (2001), Annadurai *et al.* (2005) in Bhendi.

Further increased in yield parameters with crop stages might be due to the growth regulators produced by the beneficial microorganisms leading to activation of cell division and cell elongation and formation of more tissues resulting in luxuriant vegetative growth and other yield parameters like fruit length, girth and weight. The increased microbial activity may be due to the addition of organic manures. The foregoing discussion had clearly brought out the influence of addition of RP with organic manures and tank silt next to SSP on the yield parameters. However, the ultimate objective of any management strategy should be to enhance the economic yield, in the present experiment, the fruit yield of Bhendi. Increased dry matter accumulation is considered to be the prerequisite for obtaining better economic yield, provided the accumulated photosynthates are transported from the source to sink.

The perusal of data on the fruit yield of bhendi had brought out that the addition of SSP had registered the highest fruit yield followed by RP. The yield increase due to SSP application was 42.96 per cent and it was 32.80 percent in RP treatment when compared to control. The highest yield might be due to the increased P availability resulted from readily soluble nature of SSP and the increased dissolution of RP by organic acids released during the decomposition of organic manures. Similar trend of result was reported by Bagavathi Ammal (1999), Malarkodi and Singaram (2002), Abarna (2012) in rice.

When RP was combined with organic manures viz. pressmud, spent wash and farm yard manure there was no significant variation in yield between SSP and RP. Similarly, when the RP was combined with tank silt and organic manures, there was significant increase in yield observed. In the case of super single phosphate (SSP), the initial supply is substantially higher than that of the crop

requirement which leads to P fixation there by decrease in the release at the later period time. However, the RP treatment might have lower dissolution rate at the earlier stage of crop growth, which was observed in incubation experiment i.e. it was only 18.88 per cent at 30th day of incubation, its rate of dissolution could have increased as the crop advanced to maturity, i.e. 51.41 per cent at 120th day of incubation in RP + spent wash + tank silt treatment. A similar trend of result obtained by Mahimairaja and Raniperumal (1995) with RP and organic manures confirms the present finding.

It was also observed that addition of tank silt with SSP and pressmud had recorded the highest yield (20.05 t ha^{-1}) followed by tank silt + RP + pressmud (18.07 t ha^{-1}) which could be attributed to the content of nutrients in tank silt, particularly K, Ca, Mg, and S and P content in pressmud (2.57%). It could also be attributed to the release of N, P and micro nutrients which might have linked with the organic manures. Similar results of higher yield of Bhendi with addition of tank silt with organic manures were reported by Jeyamangalam *et al*. (2012), Rajakumar (2014), Sreenadha Reddy (2014). It was reported by many authors that the tank silt addition could result in increased availability of nutrients, particularly N (Binitha 2006), P (Mohan Kumar and Gowda 2010) and other nutrients (Sankarnarayana 2001, Annadurai *et al*. 2005).

It is quite interesting to notice that the spent wash which is not containing the nutrients as that of other organic manures could produce comparable yield levels. It could be attributed to the acid pH of spent wash (3.52) which might have resulted in solubilisation of RP and some of the native nutrients. In support of the above inferences, it was found from the correlation analysis that the fruit yield is a function of various yield parameters which are positively and significantly related. It was seen from the results that the fruit yield was positively related to plant height (r=0.822**), number of branches per plant (r=0.844**), number of fruits per plant (r=0.967**), dry matter production (r=0.979**), fruit weight (r=0.936**), fruit length (r=0.876**) and fruit girth (r=0.871**) (Table 9).

Table 9 Correlation analysis between yield and various biometric characters (n = 24)

Variables	Yield	Plant height	No. of branches per plant	No. of fruits per plant	DMP	Fruit weight	Fruit length	Fruit girth
Yield	1							
Plant height	0.822**	1						
No. of branches plant^{-1}	0.844**	0.844**	1					
No. of fruits plant^{-1}	0.966**	0.898**	0.859**	1				
DMP	0.979**	0.822**	0.844**	0.966**	1			
Fruit weight	0.935**	0.887**	0.858**	0.967**	0.935**	1		
Fruit length	0.875**	0.968**	0.906**	0.926**	0.875**	0.899**	1	
Fruit girth	0.870**	0.967**	0.907**	0.928**	0.870**	0.907**	0.991**	1

*Significant at 5 % level **Significant at 1% level NS - Non significant

Application of SSP recorded the highest value of yield, DMP, and other yield parameters followed by rock phosphate with organic manures and tank silt. Among the organic manures tried, the higher yield was registered with pressmud and it was comparable with application of farm yard manure which was comparable with spentwash. All the biometric parameters were positively correlated with yield and DMP of bhendi fruit.

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