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Integrated nutrient management in wheat (*Triticum aestivum*) – mungbean (*Phaseolus radiatus*) cropping sequence in arid region

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ABSTRACT

The results of field experiment conducted in 1997–98 and 1998–99 revealed that application of organic manure improved yield attributes, grain and straw yields of wheat (*Triticum aestivum* L. emend. Fiori & Paol.). Application of Indian mustard [*Brassica juncea* (L.) Czernj.& Cosson] siliquae straw compost at 10 tonnes/ha yielded at par with 10 tonnes/ha FYM in wheat. Integration of compost or FYM at 10 tonnes/ha with 90 kg N/ha resulted maximum grain and straw yields of wheat. Significantly higher uptake of N and P in grain as well as straw was obtained with the application of 90 kg N + 10 tonnes mustard siliquae straw compost or FYM/ha compared to other treatments. The usages of mustard siliquae straw compost or FYM with or without fertilizer nitrogen in wheat enhanced succeeding mungbean (*Phaseolus radiatus* L.) yield and N and P uptake over the control and 90 kg N/ha. Analysis of soil after harvesting the mungbean crop showed a significant build up of organic carbon and an increase in available P in the plots treated with N and farmyard manure or mustard siliquae straw compost.

Key words : Wheat, Mungbean, Mustard siliquae straw compost, FYM

Integrating chemical fertilizers with organic manures has been found to be quite promissing not only in maintaining higher productivity but also in providing greater stability in crop production (Nambiar and Abrol, 1992). Farmyard manure (FYM) is being used as a major source of organic manure in field crops since ancient times. Limited availability of this manure is, however, an important constraint in its use as a source of nutrients. The crop wastes particularly of mustard is generally burnt in fields; however, compost prepared with various crop wastes and other material is as a good organic manure for use in integrated nutrient management practices in field crops (Gaur, 1987; Banger *et al.,* 1989; Singh *et al.,* 1992). Wheat crop responds to applied nitrogen up to 120 kg/ha, depending upon soil type and other factors in irrigated arid western plain zone. Wheat responds positively to applied nitrogen with FYM (Gill *et al.,* 1994) and vermi-compost (Ranwa and Singh, 1999). However, no work has been reported on mustard siliquae straw compost and nutrient substitution through this manure in wheat crop and their residual effect on succeeding mungbean. Keeping this in view, experiment was carried out to study the effect of integration of chemical nitrogen with compost on wheat and their residual effect on succeeding mungbean.

MATERIALS AND METHODS

The field experiment was conducted during 1997–98 and 1998–99 at Agricultural Research Station, Mandor (Jodhpur). The treatments, viz. T_1, control; T_2, 45 kg N/ha; T_3, 90 kg N/ha; T_4, mustard siliquae straw compost 10 tonnes/ha; T_5, FYM 10 tonnes/ha; T_6, 45 kg N/ha + mustard siliquae straw compost 10 tonnes/ha; T_7, 90 kg N/ha + mustard siliquae straw compost 10 tonnes/ha; T_8, 45 kg N/ha + FYM 10 tonnes/ha; T_9, 90 kg N/ha + FYM 10 tonnes/ha, were laid out in randomized block design with 3 replications. The soil was sandy loam, alkaline (pH 8.3), low in organic carbon (0.25%), medium in available phosphorus (7.6 kg/ha) and high in available potash (330 kg/ha). The FYM contained 0.92 and 0.89% N, 0.31 and 0.32% P_2O_5 and 0.82 and 0.85% K_2O (on oven-dry basis) during 1997–98 and 1998–99 respectively. The compost was prepared as per the procedure described by Banger *et al.* (1989) and Singh *et al.* (1992). The mustard siliquae straw was mixed with fresh cattle dung, well-decomposed old FYM and soil in a ratio of 8:1:0.5:0.5 (on dry-weight basis). Slurry of cattle dung, soil and FYM was made and mixed uniformly with other materials. The mixture was

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put into pits and allowed to decompose for 150 days from mid-May to October during both the years. The contents were mixed together after 20 and 45 days. The moisture was maintained to 70% water-holding capacity. The compost contained 0.95 and 0.92% N, 0.24 and 0.26% P_2O_5 and 1.0 and 1.2% K_2O (on oven-dry basis) in 1997–98 and 1998–99 respectively. The FYM and compost were applied about 3 weeks before the sowing of wheat. Half of the nitrogen in the form of urea as per treatments and full dose of phosphorus were applied at sowing and remaining N was top-dressed after the first irrigation. All other operations were performed as per recommendations of the crop. The crop was sown on 15 November in 1997 and 18 November in 1998 and harvested on 15 March 1998 and 24 March 1999 respectively. The data on various yield attributes, grain and straw yields were recorded under various treatments. Mungbean crop was sown during the succeeding rainy season. No fertilizer and irrigation were applied to mungbean crop.

The uptake of nutrients by wheat and mungbean was calculated by determining their concentration in grain and straw samples. The soil samples from each plot were taken after harvesting mungbean and analysed for available phosphorus and organic carbon.

RESULTS AND DISCUSSION

Yield-attributing characters

The compost prepared from mustard siliquae straw and or FYM improved the yield-attributing characters over the control (Tables 1 and 2). Height, number of ears, length of ears, grains/spike and grain weight/spike were significantly more in treatments containing organic manures than the control. However, there was no significant effect of either of organic manures on grains/spike and grain weight/spike compared with the control. No significant effect was also observed between the compost prepared and FYM for yield-attributing characters of wheat.

The integration of nitrogen with compost or FYM also improved the yield-attributing characters during both the years. Application of compost or FYM@ 10 tonnes/ha in combination with 90 kg N/ha produced significantly higher number of panicles and length of ears compared to 90 kg N/ha alone or 45 N/ha combined with compost or FYM, but height, grains/spike and grain weight/spike were statistically at par during both the years. Application of 45 kg N/ha with the combination of compost or FYM@ 10 tonnes/ha resulted in the yield attributes at par with 90 kg N/ha. The beneficial effect of organic sources on yield attributes could be attributed to the fact that after proper decomposition and mineralization of organic manure, the nutrients are readily available to the plants and also had solubilizing effects on fixed form of nutrients (Sinha *et al.*, 1981).

Grain yield

An integration of nitrogen with compost at 10 tonnes/ha also expressed its effect on grain and straw yields of wheat as noted for yield attributes. The productivity of crop in terms of grain yield was recorded minimum in no-fertilizer treatment (Table 2). Application of compost resulted in significantly higher grain yield of wheat compared to the control, but statistically at par with 45 kg N/ha or FYM @ 10 tonnes/ha in both the years and on pooled basis.

An integration of 90 kg N/ha with compost or FYM @ 10 tonnes/ha gave significantly higher grain yield of wheat compared to 90 kg N/ha alone or 45 kg N/ha combined with either of the organic manures. Combination of 45 kg N/ha with 10 tonnes/ha of compost or FYM resulted in grain yield statistically at par with 90 kg N/ha. Similar interactive effects of organic manures and fertilizer N were also visible in straw yields.

For maximum productivity of the crop, the best combination was mustard siliquae straw compost @ 10 tonnes/ha along with 90 kg N/ha. Gill *et al.* (1994) reported beneficial interactive effects of organic manures and fertilizer nitrogen in wheat due to supplementation of nitrogen and supply of other essential nutrients by organic manures. Better response of field crops to various compost materials was also reported by Bangar *et al.* (1989), Singh *et al.* (1992) and Ranwa and Singh (1999).

Nutrient uptake

Application of the compost prepared from mustard siliquae straw at 10 tonnes/ha also improved the N and P uptake of wheat compared with the control and it was statistically at par with 10 tonnes FYM/ha (Table 3). The integration of 45 kg N + 10 tonnes compost or FYM/ha was statistically at par with 90 kg N/ha in terms of N and P uptake in grain, straw as well as total uptake in wheat. However, maximum and significantly higher uptake of N and P in grains, straw and total uptake was obtained with the combination of 90 kg N + 10 tonnes compost or FYM/ha as compared to all other treatments. The variation in N and P uptake was due to variation in yield levels. Similar results on nutrients uptake were also reported by Singh *et al.* (1992).

There was a build up in organic carbon and P content of the soil after 2 years application of organic sources of nutrients in wheat (Table 4). Significantly higher organic carbon was obtained in the plots supplied with 10 tonnes

Table 1. Yield attributes of wheat as influenced by organic sources and fertilizer levels

Treatment	Ear/m row length			Height (cm)			Length of ear (cm)			Grains/spike		
	1997–98	1998–99	Mean	1997–98	1998–99	Mean	1997–98	1998–99	Mean	1997–98	1998–99	Mean
T_1	85.1	91.3	88.3	76.9	77.0	76.9	6.67	6.50	6.58	29.8	26.7	28.25
T_2	91.3	100.0	95.6	82.5	85.3	83.9	7.07	7.36	7.21	31.1	27.2	29.15
T_3	97.3	106.0	101.6	80.3	88.9	84.6	7.40	7.67	7.53	32.8	31.6	32.20
T_4	90.0	102.0	96.0	78.1	82.0	80.0	7.00	7.33	7.16	28.1	26.5	27.30
T_5	92.7	94.3	93.5	80.1	81.9	81.0	7.03	7.69	7.36	28.8	27.1	27.95
T_6	103.3	105.3	104.4	85.1	87.3	86.2	7.40	7.49	7.44	31.2	32.2	31.70
T_7	121.3	111.3	116.3	84.2	91.4	87.8	7.53	8.48	8.00	32.3	31.6	31.95
T_8	96.7	108.0	102.3	79.5	86.3	82.9	7.40	7.71	7.55	30.3	32.4	31.35
T_9	114.7	116.0	115.3	80.5	88.3	84.4	7.33	8.28	7.80	30.3	31.9	31.10
CD (P=0.05)	2.9	2.4	1.3	2.2	1.8	1.2	0.31	0.45	0.20	NS	3.30	1.80

T_1, Control; T_2, 45 kg N/ha; T_3, 90 kg N/ha; T_4, mustard siliquae straw compost 10 tonnes/ha; T_5, FYM 10 tonnes/ha; T_6, 45 kg N/ha + mustard siliquae straw compost 10 tonnes/ha; T_7, 90 kg N/ha + mustard straw compost 10 tonnes/ha; T_8, 45 kg N/ha + FYM 10 tonnes/ha; T_9, 90 kg N/ha+FYM 10 tonnes/ha

Table 2. Yield of wheat as influenced by organic sources and fertilizer levels

Treatment	Weight of grains/spike (g)			Seed yield (q/ha)			Straw yield (q/ha)		
	1997–98	1998-99	Mean	1997–98	1998-99	Mean	1997–98	1998-99	Mean
T_1	1.53	1.33	1.43	44.2	30.8	37.5	64.0	75.5	69.8
T_2	1.64	1.35	1.49	49.4	37.9	43.6	70.7	85.9	78.3
T_3	1.70	1.48	1.59	53.9	43.7	48.8	76.2	102.3	89.2
T_4	1.58	1.34	1.46	48.7	36.9	42.8	68.1	81.4	74.7
T_5	1.64	1.37	1.50	48.2	35.5	41.8	70.8	83.9	77.3
T_6	1.72	1.47	1.59	55.5	42.6	49.1	85.4	96.6	91.0
T_7	1.61	1.50	1.55	58.0	44.8	51.4	86.1	100.9	93.5
T_8	1.70	1.49	1.59	52.2	43.3	47.7	76.1	96.6	86.3
T_9	1.67	1.47	1.57	56.4	46.8	51.6	78.8	106.5	92.6
CD (P=0.05)	0.10	0.09	0.05	1.2	3.3	2.0	2.2	3.8	1.7

Details of treatments are given under Table 1

Table 3. Effect of organic and inorganic sources of nutrients on the nutrient uptake in wheat

Treatment	N uptake (kg/ha)						P uptake (kg/ha)					
	1997–98			1998–99			1997–98			1998–99		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_1	67.5	26.7	94.2	55.7	22.7	78.4	15.8	3.3	19.1	12.3	3.0	15.3
T_2	78.9	31.0	109.9	69.0	27.8	96.8	17.6	3.8	21.4	15.2	3.2	18.4
T_3	88.8	37.0	125.8	76.5	36.1	112.6	18.8	4.4	23.2	17.4	4.6	22.0
T_4	77.0	29.0	106.1	68.2	25.6	93.8	17.8	3.6	21.4	14.5	3.4	17.9
T_5	75.6	30.2	105.8	66.0	27.2	93.2	17.8	3.9	21.7	14.4	3.5	17.9
T_6	89.8	38.0	127.8	79.2	33.8	113.0	20.6	4.5	25.1	17.7	4.3	22.0
T_7	94.6	40.8	135.4	83.0	35.9	118.9	21.3	4.7	26.0	18.2	4.7	22.9
T_8	86.8	37.1	123.9	80.3	33.3	113.6	18.8	4.4	23.2	17.3	4.4	21.7
T_9	95.2	39.6	134.8	86.7	38.9	125.6	20.3	4.6	24.9	18.8	5.2	24.0
CD (P=0.05)	4.3	2.3	5.2	4.9	3.4	5.7	0.82	0.2	0.94	0.92	0.2	1.2

Detail of treatments are given under Table 1

Table 4. Residual effect of organic and inorganic source of nutrients on seed yield, nutrient uptake by succeeding mungbean and organic carbon and available P of soil at the end of the study

Treatments	Seed yield (kg/ha)			N uptake (kg/ha)			P uptake (kg/ha)			OC (%)	Available P (kg/ha)
	1997–98	1998–99	Mean	1997–98	1998–99	Mean	1997–98	1998–99	Mean		
T_1	457	224	341	16.6	8.4	12.5	2.3	1.1	1.7	0.25	8.42
T_2	445	220	333	16.2	8.0	12.1	2.2	1.1	1.6	0.26	8.01
T_3	430	210	320	15.8	7.6	11.7	2.1	1.0	1.5	0.27	8.18
T_4	568	302	435	20.8	11.2	16.0	2.8	1.5	2.1	0.29	8.42
T_5	582	320	451	21.4	11.7	16.5	2.9	1.7	2.3	0.29	8.81
T_6	584	335	460	21.2	12.2	16.7	3.0	1.7	2.3	0.29	8.38
T_7	595	310	453	21.8	11.3	16.5	3.0	1.5	2.2	0.29	8.32
T_8	615	320	468	22.4	11.6	17.0	3.2	1.6	2.3	0.30	8.43
T_9	611	314	463	22.5	11.4	16.9	3.1	1.6	2.4	0.30	8.49
CD (P=0.05)	110	76	52	2.4	1.8		0.7	0.5		0.03	NS

Detail of treatments are given under Table 1; OC, organic carbon

FYM/ha either alone or in combination with inorganic fertilizer compared with the control and was statistically at par with 10 tonnes/ha mustard siliquae straw compost. Slow mineralization of organic matter leads to build up of organic carbon. There was also a build up of P levels in the soils as compared to initial soil status, however, the difference between the treatments was non-significant. Bangar *et al.* (1989) also reported build up of P in the soil on P fertilization.

Residual effect on succeeding mungbean

The application of 10 tonnes/ha of mustard siliquae straw compost and or FYM with or without nitrogen were significantly superior to the control, 45 and 90 kg N/ha and significantly increased seed yield of succeeding mungbean (Table 4). The usage of enriched compost along with 60 kg N/ha in wheat enhanced succeeding greengram (residual effect 33%) yield over the control with 120 kg N/ha (Gaur, 1987). The residual effect of FYM was also found significant on the grain yield of succeeding mungbean in wheat–mungbean crop sequence by Sharma (1981). The beneficial effect of organic sources of manures on seed yield of succeeding mungbean could be attributed to the fact that the population of nitrogen-fixing and phosphate-solubilizing micro-organisms were greatly stimulated and thereby increased the availability of plant nutrients to crops (Gaur, 1998).

The 2 years study indicates that application of compost prepared from mustard siliquae straw at 10 tonnes/ha yielded at par with 10 tonnes FYM/ha in wheat. Integration of 90 kg N/ha with 10 tonnes of compost resulted in maximum grain and straw yields of wheat. The application of mustard siliquae straw compost or FYM also significantly increased the succeeding mungbean seed yield.

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