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Residual Effect of Integrated Nutrient Management on Productivity of Maize-Wheat-Mung Cropping System

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Abstract

A field experiment was carried out during 2001-2002 and 2002-2003 with the objectives of studying the direct and residual effect of application of FYM and/or fertilizers in maize-wheat-mung cropping system. The experiment was started in the *rabi* season of 2001-02 with wheat followed by mung in summer and maize in *kharif* season of 2002-03. The same cropping sequence was repeated next year in the same experimental field. The experiment was laid out in randomized block design in *rabi* season for wheat consisting of nine treatments viz. Control ($N_0P_0K_0$), FYM at 10 t/ha, N_{120} alone, P_{60} alone, $N_{60}P_{30}K_{30}$ (50% of recommended dose), $N_{90}P_{45}K_{45}$ (75% of recommended dose), $N_{100}P_{60}K_{60}$ (100% of recommended dose), $N_{90}P_{45}K_{45}$+FYM at 5 t/ha and $N_{60}P_{30}K_{30}$+FYM at 5 t/ha. In subsequent season mungbean was grown uniformly in all the plots following the normal package of practices. In *kharif* maize crop was laid out in split plot design main plot comprised residual effect of nine treatments given to wheat in *rabi* and each of the nine such plots were splitted into three sub-plots treatments given to maize consisting of $N_0P_0K_0$ (control), $N_{60}P_{30}K_{30}$ (50% of recommended dose) and $N_{90}P_{45}K_{45}$ (75% of recommended dose). The combined use of FYM and $N_{90}P_{45}K_{45}$ to wheat produced significantly higher wheat grain yield than FYM alone and was also at par with 100% recommended dose of NPK ($N_{120}P_{60}K_{60}$ kg/ha). The maximum mung grain yield of 8.6 and 8.7 q/ha recorded in 2001-02 and 2002-03, respectively, due to residual effect of $N_{90}P_{45}K_{45}$ and FYM at 5 t/ha significantly more over alone application of 10 t of FYM/ha. In maize the direct and cumulative effect were pronounced where the combined application of $N_{90}P_{45}K_{45}$ and FYM at 5 t/ha applied to wheat had the highest residual effect on maize grain yields which were 43.6 and 41.4 q/ha in first and second year of study, respectively.

Key words : Maize-wheat-mungbean, Direct effect, Residual effect, FYM, Fertilizers.

Maize-wheat is one of the predominant cropping systems of northern parts of the country. The states of Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, Rajasthan, Madhya Pradesh and Bihar have sizeable acreage under the system. It is estimated that about 60% of total area under maize during *kharif* season is planted after wheat during *rabi*. Both maize and wheat are exhaustive in nature. Beneficial effect of legumes particularly for the succeeding crop is well known. Incorporation of crop residues has an advantage of converting the usual surplus waste into useful product for increasing the crop yield. The use of FYM in agriculture for increasing crop production has been practised for ages. Application of these nutrient sources alone or in combination with inorganic sources had been found beneficial not only in enhancing the productivity of maize and wheat (1). However, it become evident in the later that crop yields can significantly be increased by the use of inorganic fertilizers (2). Direct and residual effects of inorganic fertilizers and organic materials were studied by Sharma and Gupta (3) in maize-wheat cropping system. Response to 100% NPK was 1.51 and 1.36 t/ha over control yield of 1.87 and 1.62 t/ha in maize and wheat crops, respectively. Integration of 75% N through chemical fertilizers with 25% N through organic sources gave equal yield to 100% NPK in maize. A study conducted to develop suitable integrated nutrient supply in maize-wheat cropping system in three districts of Uttar Pradesh by Singh and Gangwar (4) has shown that in two of the three districts, both wheat and maize yields were maximum with the application of 50% N through FYM and 50% through fertilizers. Fertilizer recommendations have been based on the experiments conducted to determine the nutrient requirement of the individual crop. The residual

Table 1. Direct and residual effect of organic manure and fertilizers on growth and yield of wheat. *FYM at 5 t/ha.

Treatments	Dry matter production (g/m)		Effective tillers/m		No. of grains/ear		1,000 grain weight (g)		Grain yield (q/ha)	
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
Control	958.1	970.0	237.7	224.2	33.5	30.1	34.8	32.5	35.3	33.4
FYM 10 t/ha	1145.0	1175.2	275.6	284.7	40.3	45.1	39.2	39.9	47.8	50.6
N_{120}	1103.0	1143.3	268.2	264.5	41.5	40.2	37.8	36.8	45.6	45.3
P_{60}	1074.7	1064.8	264.5	261.6	40.3	38.3	37.6	37.5	44.2	44.8
$N_{60}P_{30}K_{30}$	1192.5	1210.6	270.7	278.3	44.8	44.8	39.6	40.2	49.6	49.3
$N_{90}P_{45}K_{45}$	1228.4	1279.9	294.0	301.6	45.7	46.2	41.3	41.5	52.5	54.5
$N_{120}P_{60}K_{60}$	1370.5	1390.0	312.9	335.9	48.9	49.5	43.4	43.8	57.2	59.5
$N_{90}P_{45}K_{45}$+FYM*	1318.8	1403.5	318.5	329.2	46.5	50.8	42.3	44.5	56.9	60.4
$N_{60}P_{30}K_{30}$+FYM*	1205.5	1280.2	298.1	307.5	44.9	47.2	40.2	40.7	53.2	54.5
CD (P=0.05)	92.5	99.7	21.9	20.2	4.0	4.1	2.3	2.1	2.8	3.4

effect of fertilizer applied to the previous crop on the succeeding crop has usually been ignored. The residual value may substantially affect the fertilizer need of the following crop. The beneficial effect of organic sources applied in preceding crops was recorded in succeeding wheat crop (5, 6). Several experiments have been conducted in the past to evaluate the efficiency of integrated nutrient management in maintaining the physico-chemical properties of soil and increasing the yield of crops. Investigations have also been made on nutrient availability and their uptake by crops, both when sown individually as a component in a cropping system. But little attention has been paid towards the fate of applied fertilizers and organic manures and their impact on succeeding crop. Keeping these in view a field experiment was carried out in research farm of the Indian Agricultural Research Institute, New Delhi, India during three seasons of 2001-2002 and 2002-2003 with the objectives of studying the direct and residual effect of application of FYM or fertilizers or their integrated use on the productivity of maize-wheat-mung cropping system.

Methods

The experiment was started in the *rabi* season of 2001-02 with wheat followed by mung in summer and maize in *kharif* season of 2002-03. The same cropping sequence was repeated next year in the same experimental field. The varieties used for wheat, maize and mung were HD 2285, Ganga Safed 2 and Pusa Bold, respectively. Physico-chemical analysis of the soil revealed that the soil was sandy loam, low in organic carbon (0.4%) (Walkley and Black Method), pH (1:2.5::soil:water) 7.5, electrical conductivity at 25° C, 0.33 dS/m and CEC [c.mol (p^{-1})/kg] was 10.8.

The experiment was laid out in randomized block design in *rabi* season for wheat consisting of nine treatments such as, Control ($N_0P_0K_0$), FYM at 10 t/ha, N_{120} alone, P_{60} alone, $N_{60}P_{30}K_{30}$ (50% of recommended dose), $N_{90}P_{45}K_{45}$ (75% of recommended dose), $N_{100}P_{60}K_{60}$ (100% of recommended dose), $N_{90}P_{45}K_{45}$+FYM at 5 t/ha and $N_{60}P_{30}K_{30}$+FYM at 5 t/ha. In subsequent season mung was grown uniformly in all the plots following the normal package of practices. In *kharif* maize crop was laid out in split plot design main plot comprised residual effect of nine treatments given to wheat in *rabi* and each of the nine such plots were splitted into three sub plots treatments given to maize consisting of $N_0P_0K_0$, $N_{60}P_{30}K_{30}$ (50% of recommended dose) and $N_{90}P_{45}K_{45}$ (75% of recommended dose).

Pre-sowing irrigation was given for land preparation and sowing of wheat, maize and mung. The required amount of FYM was incorporated into the wheat plots as per the treatment after the lay out was made. Urea, single super phosphate and muriate of potash were used as sources of N, P and K for wheat and maize. Wheat received half of N, full dose of P and K as basal and the rest half of N at 30 days after sowing. In maize total N dose was applied in three splits as one third at sowing and the remaining at knee height and silking stage in equal splits. However, mung crop did not receive any fertilizer which was raised only on residual fertility. Mung crop resi-

Table 2. Residual effect of FYM and fertilizers on grain and straw yield of mung bean. *FYM at 5 t/ha.

Treatments	Grain yield (q/ha)		Straw yield (q/ha)	
	2001-02	2002-03	2001-02	2002-03
Control	6.7	6.6	26.7	25.7
FYM 10 t/ha	7.7	8.1	28.9	29.7
N_{120}	6.8	7.0	27.4	27.6
P_{60}	7.3	7.5	29.3	30.1
$N_{60}P_{30}K_{30}$	7.6	7.5	29.0	29.4
$N_{90}P_{45}K_{45}$	7.8	7.9	29.3	29.8
$N_{120}P_{60}K_{60}$	8.3	8.6	21.5	30.5
$N_{90}P_{45}K_{45}$+FYM*	8.6	8.7	31.3	31.4
$N_{60}P_{30}K_{30}$+FYM*	8.2	8.2	30.6	30.4
CD (P=0.05)	0.5	0.5	3.1	2.2

dues were incorporated into each plot before maize crop. The other practices were undertaken following the standard agronomic practices. The biometric observations on growth and yield were recorded according to the outlined programme and data were statistically analyzed applying the techniques of analysis of variance and significance was tested by F test.

Results and Discussion

Direct Effect of Organic Manure and Fertilizers on Wheat

Growth and Yield Attributes. Nutrient management practices to wheat significantly affected the growth and yield attributes of wheat in both the years (Table 1). Dry matter accumulation of wheat increased with increased doses of NPK fertilizers. The maximum dry weight of wheat was found with the application of recommended dose of fertilizers (120 N+60 P_2O_5+60 K_2O kg/ha) and 75% recommended dose with FYM ($N_{90}P_{45}K_{45}$ + FYM at 5 t/ha) significantly more than that produced by 50% recommended dose with FYM ($N_{60}P_{30}K_{30}$ + FYM at 5 t/ha) and than all other treatments. The above two treatments could increase the effective number of tillers/m^2 over the later treatment only in second year of experiment, however, their effect was significantly better in first year of experiment in influencing the number of grains/ear. The effect of FYM at 10 t/ha was significantly less than the integrated use of nutrients. 1000 grain weight responded positively to 120 N + 60 P_2O_5+60 K_2O kg/ha and integrated use of 90 N+45 P_2O_5+45 K_2O kg/ha + FYM 5 t/ha which increased significantly over all other treatments in both the years. More availability of nutrients with recommended dose of NPK might have improved growth of maize and wheat. Kumar (7) also reported the similar trend.

Yield. The combined use of FYM and $N_{90}P_{45}K_{45}$ produced significantly higher grain yield than the FYM alone and was also at par with $N_{120}P_{60}K_{60}$. Application of FYM alone improved the grain yield in 2002-03 which was 2.8 q/ha more over the previous year, however, this was significantly lower than the grain yield registered by integrated application of $N_{90}P_{45}K_{45}$ and FYM. The possible reason may be evidenced from Table 1 which explains the application of $N_{50}P_{45}K_{45}$+FYM enhanced the yield attributes, such as number of effective tillers/m^2, number of grains/ear and 1,000-grain weight. Sharma and Gupta (3) in maize-wheat cropping system repoted that, integrated use of fertilizers and organic manures could produce equivalent yield as produced by 100% NPK in maize.

Residual and Cumulative Effect of Manure and Fertilizers on Mungbean

Although no fertilizer was applied in raising mung still there exist differences among the various treatments in influencing grain yield (Table 2). This is because of the residual effect of FYM and fertilizer given to preceding wheat crop. In first year the application of FYM did not register significant influence, while in second year the effect was pronounced. The maximum grain yield of 8.6 and 8.7 q/ha recorded in 2001-02 and 2002-03, respectively, due to residual effect of $N_{90}P_{45}K_{45}$ and FYM at 5 t/ha significantly more over application of 10 t of FYM/ha alone. Superiority of $N_{120}P_{60}K_{60}$ and $N_{90}P_{45}K_{45}$ + FYM over alone FYM is due to the higher residual effect of nutrients especially phosphorus by the application of full dose of NPK or integrated use of FYM and fertilizers.

Direct Effect of Fertilizers and Cumulative Effect of Organic Manures on Maize

As regards direct effect of fertilizers, grain yield of maize responded positively to increased levels of NPK (Table 3). Application on $N_{90}P_{45}K_{45}$ i.e. 75% of recommended dose produced significantly higher grain yield than $N_{60}P_{30}K_{30}$ (50% recommended dose)

Table 3. Direct and residual effect of organic manure and fertilizers on maize.

Treatments	Dry matter production (g/plant)		Number of grains cob		1000-grain weight (g)		Grain yield (q/ha)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
To Wheat								
Control	81.3	80.6	421.5	425.5	220.3	218.2	31.6	26.3
FYM 10 t/ha	110.2	109.3	498.0	501.3	236.5	234.5	40.3	38.3
N_{120}	90.2	87.8	455.0	410.2	228.6	231.0	30.8	32.5
P_{60}	83.3	81.7	439.5	446.3	227.0	229.8	31.7	30.2
$N_{60}P_{30}K_{30}$	96.4	92.4	490.5	482.0	230.2	231.7	36.2	35.1
$N_{90}P_{45}K_{45}$	98.3	97.2	507.3	512.5	232.2	235.4	37.8	35.1
$N_{120}P_{60}K_{60}$	105.8	112.5	528.3	524.2	237.8	240.4	42.3	40.2
$N_{90}P_{45}K_{45}$ + FYM*	111.2	110.1	530.4	527.3	238.2	241.1	43.6	41.4
$N_{60}P_{30}K_{30}$ + FYM*	195.8	107.3	510.8	544.2	232.4	236.2	42.0	40.5
CD (P=0.05)	3.0	3.2	32.1	23.8	5.8	6.1	3.5	3.0
To Maize								
$N_0P_0K_0$	73.2	81.6	470.7	469.5	221.7	229.0	31.0	29.6
$N_{60}P_{30}K_{30}$	103.1	102.5	499.9	487.5	232.7	233.9	37.8	36.7
$N_{90}P_{45}K_{45}$	117.9	108.8	501.6	500.8	240.0	236.6	43.3	40.9
CD (P=0.05)	2.4	4.5	28.7	16.5	6.7	4.3	5.6	3.5

which was significantly more over the control. Similar trend was observed in both the years. The residual and cumulative effect of FYM and fertilizers was observed on succeeding maize which influenced grain yield significantly. The plots receiving 10 t/ha of FYM registered significant residual effect on maize which was at par with that of $N_{120}P_{60}K_{60}$.

In contrast, combined application of $N_{90}P_{45}K_{45}$ and FYM at 5 t/ha had the highest residual effect on grain yield. It recorded highest grain yields of 43.6 and 41.4 q/ha in first and second year of experimentation, respectively. Similar findings were obtained by Rameshwar and Singh (8) where the direct effect of FYM during the first year of experimentation on maize and cumulative effect of FYM during all the crop seasons in maize and wheat crops improved the growth parameters like plant height, dry matter accumulation and leaf area index at different growth stages and ultimately reflected on grain yield of maize and wheat crops. Further, inclusion of leguminous crops after wheat proved beneficial to succeeding maize crop than keeping the land fallow (9).

References

1. Jamwal J. S. 2005. Productivity and economics of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system under integrated nutrient supply system in rainfed areas of Jammu. *Ind. J. Agron.* 50 : 110—112.
2. Mishra M. M., K. K. Kapor, K. Chander and R. D. Laura. 1991. Sustainable agriculture : The role of integrated nutrient management–A review. *Int. J. Trop. Agric.* 9 : 153—173.
3. Sharma M. P. and J. P. Gupta. 1998. Effect of organic materials on grain yield and soil properties in maize-wheat cropping system. *Ind. J. Agric. Sci.* 68 : 715—717.
4. Singh P. and B. Gangwar. 2000. Irrigated agri-ecosystem. *Proc. Int. conference on managing natural resources for sustainable agriculture production in the 21st century*. 14—18 Feb. New Delhi, India. 881—882 pp.
5. Yadav M. P., M. Aslam and S. P. Kushwaha. 2005. Effect of integrated nutrient management on rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system in Central Plains Zone of Uttar Pradesh. *Ind. J. Agron.* 50 : 89—93.
6. Yadav R. L., D. V. Yadav and S. K. Duttamajumdar. 2008. Rhizospheric environment and crop productivity : A review. *Ind. J. Agron.* 53 : 1—17.
7. Kumar A. 2008. Direct and residual effect of nutrient management in maize (*Zea mays* L.)-wheat (*Triticum aestivum* L.) cropping system. *Ind. J. Agron.* 53 : 37—41.
8. Rameshwar K. and C. M. Singh. 1998. Effect of FYM and fertilizer on the growth and development of maize and what in sequence. *Ind. J. Agric. Res.* 32 : 65—70.
9. Kolar J. S. and M. S. Gill. 1994. Production potential of cropping system and its impact on soil fertility. *Fert. News* 39 : 21—25.