Annals of Plant and Soil Research 18(4): 333-337 (2016)

IMPACT OF ORGANIC MANURES, FERTILIZERS AND BIOFERTILIZERS ON YIELD AND ECONOMICS OF WHEAT IN *HAPLUSTEPTS*

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Received: June, 2016; Revised accepted: September, 2016

ABSTRACT

A field experiment was conducted during rabi season of 2013-14 and 2014-15 to study the impact of integrated nutrient management on yield and economics of wheat (Triticum aestivum L.) in Haplustepts at Udaipur (Rajasthan). The experiment was laid out in a split plot design with 27 treatment combinations which consisted of 3 organic manures (FYM, vermicompost and poultry manure), 3 levels of inorganic fertilizers (50%, 75% and 100% RDF) and 3 levels of biofertilizers (Azotobacter, PSB and Azotobacter + PSB)were replicated three times. The results revealed that the yield attributes, grain yield (5.04 t ha^{-1}), straw yield (9.69 t ha^{-1}), biological yield (14.73 t ha^{-1}), net return (` 78010 ha^{-1}) and benefit cost ratio (2.52) significantly increased with the application of 5 t poultry manure ha^{-1} than other organic manures. The minimum values of these barameters were recorded with FYM.Application of 75 % RDF significantly increased the yield attributes, grain yield (4.91 t ha^{-1}), straw yield (9.36 t ha^{-1}), biological yield (14.27 t ha^{-1}), net return (` 70757 ha$^{-1}$) and benefit cost ratio (2.15) over 50 % RDF but statistically at par with 100 % RDF. Dual inoculations of seed with Azotobacter + PSB significantly increased the grain yield (5.01 t ha$^{-1}$), straw yield (9.65 t ha$^{-1}$), biological yield (14.67 t ha$^{-1}$), net return (`. 74671 ha^{-1}) and benefit cost ratio (2.25) over individual inoculation. Azotobactor alone proved more beneficial in improving yield and economics of wheat than PSB.

Keywords: INM, yield attributes, yield, economics, wheat

INTRODUCTION

Fertilizer use especially N, P and K is considered as a corner stone in any drive for increasing the wheat yield. But the continuous use of micronutrient free high analysis NPK fertilizers in the intensive cropping system with diminishing use of organic manures has resulted in the depletion of micronutrients from the soil reserve. Lack of manuring and balanced fertilization is one of the most important causes of low yield. Integration of organics With inorganics has been found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production (Rather *et al*, 2009). The integrated use of organic materials and inorganic fertilizers have received considerable attention in the past with a hope of meeting the farmer's economic need as well as maintaining favorable ecological conditions on long-term basis (Kumar *et al.,*, 2007). Application of organic manures also help to check the emerging deficiency of nutrients other than N, P and K, Further, it brings economy and efficiency in fertilizers. Biofertilizers can also play an important role in meeting the nutrient requirement of crops because they can be produced at a low cost and can meet a part of nutrient requirements for increased crop production. They enhance soil fertility and crop productivity by fixing atmospheric nitrogen, mobilizing sparingly soluble P and by facilitating the release of nutrients through decomposition of crop residues (Kaushik *et al*, 2012). The INM affects the physical, chemical and biological environment of the soil and thus preserve the soil health. As such the goal of sustainable production could be achieved without any disastrous effect on soil and environment (Sharma and Sighal 2014). Considering the above facts, present investigation was carried oat to find out the impact of organic manures, fertilizers and biofertilizers on yield and economics of wheat (*Triticum aestivum* L.) in *Haplustepts*.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during *rabi* season of 2013-14 and 2014-15. The site was situated at 24^{o}.35' N latitude, 74^{o}.42' E longitude and an altitude of 579.5 m above mean sea level. The region falls

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under agro-climatic zone IVA (Sub-Humid Southern Plain and Aravalli Hills) of Rajasthan. The climate of the region is tropical characterized by mild winter and summer associated with high humidity particularly during July-September. The mean annual rainfall of the region ranges between 580-630 mm, most of which is contributed by South-West monsoon from July to September. In summers maximum temperature goes up to 44^0C. May and June are the hottest months. Winters are generally rainless and minimum temperature during December and January falls as low as 1^0C. The soil was Haplustepts, clay loam in texture having pH 7.6, EC 0.48 dS m^{-1}, Organic carbon 6.4g kg^{-1}, available nitrogen 320 kg ha^{-1}, available phosphorus 24 kg ha^{-1} and available potassium 310 kg ha^{-1}. The experiment was laid out in a split plot design with 27 treatment combinations which consisted of 3 organic manures (FYM, Vermicompost and Poultry manure), 3 levels of inorganic fertilizers (50%, 75% and 100% RDF) and 3 levels of biofertilizers (*Azotobacter*, PSB and *Azotobacter* + PSB). These treatments were replicated three times. Wheat (Raj 4037) was sown during second week of Novemember and harvested in the first week of April. Nitrogen, phosphorus and potassium were applied in the form of urea, diammonium phosphate, and muriate of potash, respectively. The whole amount of phosphorus and potassium and half quantity of nitrogen as per treatment was applied at the time of sowing as basal dressing and rest half of nitrogen was applied in two splits as top dressing at the CRI and tillering stages. FYM, Vermicompost and poultry manure were applied as basal dressing. *Azotobacter*, PSB and *Azotobacter* + PSB (Phosphate solubilising bacteria) were applied as seed treatment. Yield attributes (Effective tillers m^{-1} row length, grains ear^{-1} and test weight), yield (grain, straw and biological) were recorded at harvest. The economics of various treatments was computed on the basis of prevailing market price of inputs and produce.

RESULTS AND DISCUSSION

Yield attributes and yield

Data showed that the yield attributes such as effective tillers (107.2), grains ear^{-1} (42.40), test weight (43.42 g), grain yield (5.04 t ha^{-1}), straw yield (9.69 t ha^{-1}) and biological yield (14.73 t ha^{-1}) increased significantly with the application of 5t poultry manure ha^{-1} over both the treatments of 10 t FYM ha^{-1} and vermicompost @ 4 t ha^{-1} on pooled basis (Table 1 and 2). This might be due to fact that application of organic manures gave significant increase in yield attributes *viz*., effective tillers $meter^{-1}$ row length , grains ear^{-1} and test weight. The advantage of poultry manure is quite obvious, as it provides a steady supply of nutrients leading better growth of plants.

Table 1: Impact of organic manures, fertilizer levels and biofertilizers on yield attributes of wheat

Treatments	Effective Tillers m^{-1} row length			Grains ear^{-1}			Test weight (g)		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
Organic manures									
FYM(10 t ha^{-1})	98.1	100.8	99.4	38.14	40.89	39.51	39.71	40.30	40.01
VC(4 t ha^{-1})	100.9	101.8	101.4	40.19	41.17	40.68	42.07	42.72	42.40
PM(5 t ha^{-1})	106.7	107.7	107.2	41.88	42.91	42.40	43.23	43.61	43.42
SEm ±	1.63	1.71	1.18	0.41	0.51	0.33	0.53	0.51	0.37
CD (P = 0.05)	4.89	5.15	3.41	1.25	1.55	0.95	1.59	1.54	1.06
Fertilizer levels									
50% RDF	98.7	99.5	99.1	39.09	40.70	39.90	39.94	40.77	40.35
75% RDF	102.0	103.6	102.8	40.54	41.38	40.96	42.46	42.87	42.66
100% RDF	105.1	107.2	106.1	40.58	42.89	41.73	42.61	43.01	42.81
SEm ±	1.63	1.71	1.18	0.41	0.51	0.33	0.53	0.51	0.37
CD (P = 0.05)	4.89	5.15	3.41	1.25	1.55	0.95	1.59	1.54	1.06
Biofertilizers									
Azotobacter	101.9	103.0	102.4	39.00	40.96	39.98	41.07	41.80	41.43
PSB	99.1	101.3	100.2	38.80	40.52	39.66	40.98	41.57	41.27
*Azotobacte*r + PSB	104.8	106.0	105.4	42.41	43.49	42.95	42.96	43.28	43.12
SEm ±	0.97	1.03	0.71	0.41	0.48	0.31	0.42	0.44	0.30
CD (P = 0.05)	2.80	2.97	2.01	1.19	1.38	0.89	1.20	1.28	0.86

Moreover, the increased availability of P and K in addition to other plant nutrients released by the poultry manure might have contributed in enhancing the yield-attributes. The positive impact of availability of individual plant nutrients and humic substances from manure and balanced supplement of nitrogen through inorganic fertilizers might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and regulation of water intake into the cells, resulting in the enhancement of yield parameters (Sharma *et al.,* 2013). The poultry manure was reported the best sources among all the organic sources because of higher concentration of N and P that is readily available to crop. It was observed that approximately 40 % of total N and 74 % of total P in poultry manure would be in available form (Kumar and Pannu, 2012). The higher yield may be due to fact that poultry manure might have supplies more direct available nutrients such as nitrogen and phosphorus to the plants and improving the proportion of water stable aggregates of the soil (Dhaka *et al.,* 2012). Furthermore this may also be due to the fact that the presence of uric acids in poultry manure which hastens the release of nutrients from poultry manure as compared to compost and cow dung so easy and readily available nutrients to plant and it increased the yield attributes and yield of crop (Islam *et al.,* 2014).

An assessment of data (Table 1 and 2) revealed that application of 75% RDF significantly increased the mean effective tillers (102.8), grains ear^{-1} (40.96), test weight (42.66 g), grain yield (4.84 t ha^{-1}), straw yield (9.24 t ha^{-1}) and biological yield (14.07 t ha^{-1}) over 50 % RDF but statistically at par with 100 % RDF. This might be due to the fact that the grain yield of wheat is chiefly a product of yield attributing characters *viz*, effective tillers m^{-1} row length grain ear^{-1} and test weight which significantly increased up to 75 % level of fertilizer. Application of fertilizers might have supplied adequate amount of nutrients that helped in expansion of leaf area which might have accelerated the photosynthesis rate and ultimately increased the supply of carbohydrates to the plants. Similar results have also reported by (Jat *et al.,* 2014 and Chauhan, 2014). The optimum use of fertilizers can be achieved only by maintaining balanced fertilizer management for the crop and thereby better yield. Similarly results were reported by Bandyopdhyay *et al.,* (2009) and Khare and Dixit, (2011).

Table 2: Impact of organic manures, fertilizer levels and biofertilizers on yields and harvest index of wheat

Treatments	Grain yield (t ha^{-1})			Straw yield (t ha^{-1})			Biological yield (t ha^{-1})		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
Organic manures									
FYM(10 t ha^{-1})	4.15	4.64	4.40	8.32	8.14	8.23	12.47	12.79	12.63
VC(4 t ha^{-1})	4.40	4.94	4.67	8.49	9.31	8.90	12.88	14.25	13.57
PM(5 t ha^{-1})	4.63	5.44	5.04	9.50	9.88	9.69	14.14	15.33	14.73
SEm ±	0.08	0.11	0.07	0.17	0.18	0.12	0.22	0.23	0.16
CD (P = 0.05)	0.25	0.33	0.20	0.51	0.55	0.36	0.66	0.69	0.46
Fertilizer levels									
50% RDF	4.04	4.68	4.36	8.14	8.30	8.22	12.18	12.98	12.58
75% RDF	4.54	5.13	4.84	8.98	9.49	9.24	13.53	14.62	14.07
100% RDF	4.60	5.22	4.91	9.18	9.54	9.36	13.78	14.76	14.27
SEm ±	0.08	0.11	0.07	0.17	0.18	0.12	0.22	0.23	0.16
CD (P = 0.05)	0.25	0.33	0.20	0.51	0.55	0.36	0.66	0.69	0.46
Biofertilizers									
Azotobacter	4.28	5.01	4.65	8.42	8.91	8.67	12.70	13.92	13.31
PSB	4.16	4.72	4.44	8.19	8.82	8.50	12.35	13.55	12.95
*Azotobacte*r + PSB	4.74	5.29	5.01	9.70	9.61	9.65	14.44	14.89	14.67
SEm ±	0.08	0.08	0.05	0.15	0.12	0.09	0.19	0.14	0.12
CD (P = 0.05)	0.23	0.24	0.16	0.44	0.35	0.27	0.55	0.42	0.34

Combined application of *Azotobacter* + PSB significantly increased the effective tillers (105.4), grains ear^{-1} (42.95), test weight (43.12), grain yield (5.01 t ha^{-1}), straw yield (9.65 t ha^{-1}) and biological yield (14.67 t ha^{-1}) over both the single inoculation. The biofertlizer application

significantly improved grain and straw yield of wheat. (Malik *et al*, 2009). Biofertilizers can play an important role in meeting the nutrient requirement of crops and enhance soil fertility and crop productivity by fixing atmospheric nitrogen, mobilizing sparingly soluble P and by facilitating the release of nutrients through decomposition of crop residues. *Azotobacter* and *phosphobacteria* produce growth hormones *viz.*, Indole acetic acid and Gibberellins. These hormones stimulate root growth and development. The use of growth stimulating seed inoculants helps to accelerate uptake of plant nutrients from applied chemical fertilizers by increasing the root growth. The significant increase in straw yield under dual inoculation of *Azotobacter* +PSB seems to be due to their direct effect in improving biomass plant^{-1}, while indirect effect might be on account of increase in morphological parameters.(Kaushik *et al.,,* 2012). Single inoculation treatments, *A. Chroococcum* significantly increased the grain and straw yield of wheat over control while dual inoculation with *A. Chroococcum* in association with *Pseudomonas strita* further enhanced grain and straw yields over Azotobactor or PSB alone (Zaidi and Khan 2005). Inoculation with PSB proved less effective in increasing the yields of wheat.

Economics

The results revealed showed that application of 5 t poultry manure ha^{-1}, 75 % RDF and dual inoculation of *Azotobacter* + PSB gave significantly higher mean net returns and benefit cost ratio (`` 78010 ha$^{-1}$, 2.52), (`` 70757 ha^{-1}, 2.15) and (`` 74671, 2.25) (Table 3). This trend of the net returns for crop depends upon the cost of input and treatment effect on the grain and straw yield. Similar results were reported by Jat *et al.,* (2014), Chauhan, (2014) and Baishya *et al.,* (2015).

Table 3: Effect of organic manures, fertilizer levels and biofertilizers on net returns and benefit cost ratio of wheat

Treatments	Net Return (` ha^{-1})			Benefit cost ratio		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Organic manures						
FYM(10 t ha^{-1})	57586	67463	62525	1.81	2.09	1.95
VC(4 t ha^{-1})	56045	69409	62727	1.48	1.81	1.65
PM(5 t ha^{-1})	69520	86500	78010	2.27	2.77	2.52
SEm ±	1604	2028	1293	0.051	0.052	0.037
CD (P = 0.05)	4810	6081	3725	0.153	0.157	0.105
Fertilizer levels						
50% RDF	54930	68141	61536	1.74	2.12	1.93
75% RDF	64077	77438	70757	1.96	2.34	2.15
100% RDF	64144	77793	70969	1.86	2.21	2.04
SEm ±	1604	2028	1293	0.051	0.052	0.037
CD (P = 0.05)	4810	6081	3725	0.153	0.157	0.105
Biofertilizers						
Azotobacter	58392	74105	66248	1.77	2.22	2.00
PSB	55780	68905	62343	1.69	2.05	1.87
*Azotobacte*r + PSB	68980	80362	74671	2.10	2.40	2.25
SEm ±	1484	1446	1036	0.044	0.038	0.029
CD (P = 0.05)	4257	4149	2921	0.127	0.108	0.082

Results showed that application of 5 t poultry manure ha^{-1}, 75 % RDF and *Azotobacter* + PSB gave higher yield, net return and benefit cost ratio than other treatments. So it is concluded that wheat crop should be grown with 5 t poultry manure ha^{-1} along with soil enrichment with 75% RDF and seeds should be dual inoculated with *Azotobacter* + PSB for batter yield and economics.

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