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Impact of improved practices in comparison with farmer's practice on the productivity of maize-wheat system in rainfed areas of sub-montane low hills of Himachal Pradesh

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Abstract

On-farm trials were conducted at Nakroh, Katohar, Bharmoti, Bhumpal, Adhwani and Channaur centers of different districts of Himachal Pradesh on cultivators' fields to compare the recommended package of practice alone and with farm yard manure as against farmers' practice in maize-wheat cropping sequence under rainfed conditions for three years (2004-05 to 2006-07). Sixteen locations were randomly selected for trials. Results of the study revealed that single intervention of applying recommended fertilizer nutrients in the existing farmer's practice increased the grain yield of maize and wheat by about 33.9, 36.4 and 26.3 percent and 26.2. 29.2 and 32.1 percent during 2004-05, 2005-06 and 2006-07, respectively. Yields further increased by adopting the full package of practices alone and with FYM at 10 t/ha. The magnitude of increase in maize and wheat yields owing to the application of recommended package of practices without FYM was 14.2, 12.7 and 16.4% and 15.2 15.7 and 12.7 per cent during 2004-05, 2005-06 and 2006-07, respectively. Recommended package of practices along with superimposition of FYM gave highest yields of both maize and wheat as well as maize equivalent yield in the maize - wheat cropping sequence. However, higher cost of FYM application could not appreciably enhance net returns owing to superimposition of recommended NPK plus FYM 10 t/ha over farmers' practice than the recommended package of practices in the first and the third years of the investigation.

Key words: Maize-wheat cropping sequence, nutrients, package of practices.

Introduction

In Himachal Pradesh, 84 percent of the net sown area is rainfed (Singh *et al.*, 1998). Maize-wheat is the predominant cropping sequence of Himachal in general and sub-montane and low hills sub-tropical Zone-I of the State in particular. In Zone -1, maize-wheat cropping sequence occupies 111.78 thousand hectares as against 21.6 thousand hectares under rice-wheat and 3.74 thousand hectares under oilseed-pulses. In spite of the significant achievements made in research and development in improving productivity of crops and cropping systems, the productivity of maize-wheat system is far below satisfactory. The majority of the farmers in Zone I of Himachal Pradesh is marginal (57% having land holding <1.0 hectare) and small (19% having land holding 1-2 hectare). They follow traditional and subsistence farming and have low risk bearing capacity. Low use of fertilizers, improper weed control and inadequate use of FYM have been identified as the major constraints in realizing potential yield of maize-wheat cropping system in the zone. In general, levels of nutrients applied in Himachal Pradesh are far below the recommended levels of major nutrients. It is evident from the fact that N, P and K use in Himachal Pradesh was 32.6, 9.2 and 7.6 kg/ha,

respectively (Anonymous. 2004). Lack of knowledge about the non-monetary inputs is another major constraint influencing the productivity level.

As the maize-wheat system is exhaustive, there is greater drain on the native soil fertility emphasizing balanced application of nutrients to sustain the productivity. The cultivation of improved varieties, timely and proper control of weeds, insect-pests and diseases are essential for sustaining the yields. It has been well established that yields can be increased considerably by adopting improved management practices (Ahlawat and Rana, 1998). It is therefore, necessary to investigate the effect of proper nutrient management and recommended package to sustain the maize-wheat productivity on farmers' fields. Keeping in view, present study was undertaken on farmers' fields to investigate the appropriate production technology for increasing the productivity of maize- wheat system under rainfed areas of sub-montane low hills Zone of Himachal Pradesh.

Materials and Methods

Field experiments were conducted for three years (2004-05 to 2006-07) at Nakroh and Katohar centers of district Una, Bharmoti and Bhumpal centers of district Hamirpur and Adhwani and Channaur centers of district Kangra within NARP Zone-1 of Himachal Pradesh on cultivators' fields. Sixteen locations, 2 at each center within districts Una and Kangra, and 4 at each center in Hamirpur were randomly selected. The soils of the experimental sites were inceptisols having soil texture loamy sand to silty clay loam with pH slightly acidic to neutral and low to high in organic carbon content. The total rainfall received was 1025.3, 544.7 and 1106.5 mm during 2004-05, 2005-06 and 2006-07, respectively. The mean maximum & minimum temperature (^{O}C) ranged from 19.0 to 39.0 & 6.8 to 25.0, during 2004-05, 20.8 to 39.4 & 4.7 to 25.4 during 2005-06 and 21.2 to 37.0 & 4.6-25.7 during 2006-07, respectively.

Maize hybrid KH-101 and wheat varieties PBW-343 and HPW-184 were sown during the period of study. Sowing and harvesting of maize were done in the second fortnight of May and second fortnight of September and that of wheat in the first fortnight of November and second fortnight of April, respectively, each year. The recommended dose of N, P_2O_5 and K_2O for maize was 90, 45 and 30 kg/ha and that for wheat was 80, 40 and 40 kg/ha, respectively.

The treatments were as follows;

T_1: Farmers practice (FYM 4 t /ha + 60 kg N/ha in maize and no FYM + 60 kg N /ha in wheat), no criteria of seed rate, method of sowing, plant protection measures and inappropriate weed control measures without considering critical stages,

T_2: Farmers practice (excluding application of FYM) with recommended doses of NPK,

T_3: Recommended package of practices for both the component crops of the sequence and

T_4: Recommended package of practices with 10 t/ha of FYM for both the component crops of the sequence.

The data collected were analyzed statistically in RBD considering locations as the replications. Homogeneity of error variances was tested by using Bartlett χ^2 – test; which were found to be homogeneous. Therefore, the data were pooled and analyzed in randomized block design. Economics of the treatments were calculated as per the prevailing market prices of inputs and produce.

Results and Discussion

The data on initial soil status of the experimental sites are summarized in table 1. Soil pH at different locations varied from 5.5 to 7.6, 4.9 to 7.9 and 5.8 to 7.0 in Una, Hamirpur and Kangra districts, with mean value of 6.6, 6.1 and 6.5, respectively. Available N content was medium in Una and Kangra whereas it was low to medium in Hamirpur. Available P and K content was medium to high in Una and Kangra and low to high in Hamirpur. OC was in the range of low to high in all the farming situations. pH ranged from 5.5 to 7.6, 4.9 to 7.9 and 5.8 to 7.0 in Una, Hamirpur and Kangra, respectively. It depicts that few sites were requiring liming. The variation in the content of available P was large in all the farming situations followed by K, OC, N and pH in the order.

Table 1. Soil fertility status of the farmers' fields before sowing of the crops

Parameter	Max	Min	Mean	Sd±	CV
Una					
N (kg/ha)	465.4	225.8	299.7	79.2	0.264
P (kg/ha)	65.0	10.9	33.1	19.6	0.591
K (kg/ha)	425.6	158.5	234.5	89.9	0.383
OC (%)	0.8	0.2	0.5	0.17	0.347
pH	7.6	5.5	6.6	0.7	0.108
Hamirpur					
N (kg/ha)	502.9	215.5	307.4	68.9	0.224
P (kg/ha)	70.4	4.48	27.4	15.8	0.577
K (kg/ha)	346.6	112	203.3	68.0	0.334
OC (%)	0.77	0.29	0.5	0.12	0.231
pH	7.9	4.9	6.1	0.8	0.127
Kangra					
N (kg/ha)	443	251.4	351.0	61.38	0.175
P (kg/ha)	64.4	14.3	34.7	17.17	0.495
K (kg/ha)	396.5	128.8	237.2	91.42	0.385
OC (%)	0.91	0.36	0.54	0.15	0.272
pH	7	5.8	6.5	0.35	0.053

Crop yields

The data (Table 2-4) revealed that application of recommended NPK nutrients to the farmer's practice resulted in significantly higher grain and straw yields of maize and wheat over farmer's practice alone in each farming situation during all the years of investigation. Single intervention of applying recommended fertilizer nutrients in the existing farmer's practice increased the overall grain yield of maize and wheat by about 33.9,

36.4 and 26.3 percent and 26.2. 29.2 and 32.1 per cent, respectively, during 2004-05, 2005-06 and 2006-07 (Table 5). Per ha NPK use in the state is quite low besides their highly disturbed ratio than the optimum of 4:2:1. Such a response of recommended application of nutrients clearly depicts that in states like Himachal Pradesh productivity of these crops can be substantially boosted only by going with balanced application of nutrients. Yields further increased by adopting the full package of practices in all farming situations in all the years. Based on the overall mean, the magnitude of increase in maize and wheat yields owing to the application of recommended package of practices over full NPK was 14.2, 12.7 and 16.4 percent and 15.2 15.7 and 12.7 per cent during 2004-05, 2005-06 and 2006-07, respectively. Such a response to applied nutrients and improved cultivation practices can be expected in the farmers' fields. Balanced application of nutrients and improved cultivation practices have been reported to be essential for sustained productivity (Prasad *et al.,* 2002; Rinwa *et al.,* 2003). It is interesting that yields go beyond expectation with recommended package of practices + FYM over the farmers' practice. This practice gave the highest yields of both maize and wheat in the maize - wheat cropping sequence.

Table 2. Effect of agronomic practices on maize and wheat yields, maize equivalent yield and economics in maize-wheat cropping sequence in Una (Average of 4 locations)

	Practice	Yield (kg/ha)				Maize equivalent	Gross return (Rs/ha)	Net return (Rs/ha)
		Maize		Wheat				
		Grain	Stover	Grain	Straw			
		2004-05						
T1	Farmers' practice	2409	5843	2427	3098	5467	40544	19348
T2	T1 + recommended NPK for both the crops	3332	8099	2789	3654	6846	51258	29616
T3	Recommended package of practices for both the crops	3876	9337	2908	3920	7540	56742	32761
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	4077	9821	3355	4370	8304	62046	32045
	LSD (P=0.05)	101	523	222	431	239	-	2060
		2005-06						
T1	Farmers' practice	2629	5053	2521	2299	4341	32048	10852
T2	T1 + recommended NPK for both the crops	3363	6921	3189	3023	6148	45708	24066
T3	Recommended package of practices for both the crops	3525	7146	3480	3698	7697	55800	31819
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	3872	8194	4274	4635	8711	63494	33493
	LSD (P=0.05)	298	1013	623	601	989	6290	6290
		2006-07						
T1	Farmers' practice	2765	6402	2616	3320	6034	50529	27133
T2	T1 + recommended NPK for both the crops	3310	7550	3312	4210	7451	62184	38173
T3	Recommended package of practices for both the crops	3604	7940	3267	4288	7688	64235	37854
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	3869	8502	3562	4645	8322	69423	36042
	LSD (P=0.05)	232	407	406	564	630	4819	4819

Maize equivalent yield

Owing to increased maize and wheat yields, the system productivity as expressed in terms of maize equivalent yield was significantly higher under recommended application of nutrients over the farmers' practice alone in all the farming situations during all the years. Maize grain equivalent yield further increased with the adoption of recommended package of practices at all farming situations. On an average, the recommended package of practices increased maize grain equivalent yields by 52.2, 51.3 and 47.9 per cent over farmers practice during 2004-05, 2005-06 and 2006-07, respectively. The system productivity was highest owing to the application of recommended package of practices with FYM at all the farming situations during all the years. Recommended package of practices + FYM increased system productivity by 68.4 per cent.

Table 3. Effect of agronomic practices on maize and wheat yields, maize equivalent yield and economics in maize-wheat cropping sequence in Hamirpur (Average of 8 locations)

	Practice	Yield (kg/ha)				Maize equivalent	Gross return (Rs/ha)	Net return (Rs/ha)
		Maize		Wheat				
		Grain	Stover	Grain	Straw			
		2004-05						
T1	Farmers' practice	2364	4933	1908	2195	4769	34157	12961
T2	T1 + recommended NPK for both the crops	3444	7474	2333	2672	6384	46232	24590
T3	Recommended package of practices for both the crops	3995	9071	2924	3425	7678	56126	32145
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	4163	9527	3161	3726	8146	59616	29615
	LSD (P=0.05)	77	602	221	294	280	-	1663
		2005-06						
T1	Farmers' practice	2199	4453	1629	2157	4317	31240	10044
T2	T1 + recommended NPK for both the crops	3110	6739	2199	3097	5969	44125	22483
T3	Recommended package of practices for both the crops	3616	8104	2736	3733	7173	53054	29073
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	4005	8884	3326	4523	8329	61351	31350
	LSD (P=0.05)	127	401	142	202	246	1473	1473
		2006-07						
T1	Farmers' practice	2406	4836	1687	2213	4514	37314	13918
T2	T1 + recommended NPK for both the crops	2978	5780	2136	2652	5648	46130	22119
T3	Recommended package of practices for both the crops	3662	7227	2730	3320	7075	57761	31380
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	3872	7733	3116	3822	7767	63524	30143
	LSD (P=0.05)	123	335	91	133	108	912	912

Returns

The higher yields following the application of recommended fertilizers to the farmers' practice and recommended package of practices fetched increased gross and net return over the farmers practice in all the farming situations during all the years. On an average, recommended technology package (T_3) recorded 104 and 18% higher net return over farmers practice and recommended application of nutrients to the farmers' practice, respectively. However, higher cost of FYM application could not appreciably enhance net returns owing to recommended package of practices plus FYM 10 t/ha over farmers' practice than the other treatments in the first and the third years of the investigation.

Table 4. Effect of agronomic practices on maize and wheat yields, maize equivalent yield and economics in maize-wheat cropping sequence in Kangra (Average of four locations)

	Practice	Yield (kg/ha)				Maize equivalent	Gross return (Rs/ha)	Net return (Rs/ha)
		Maize		Wheat				
		Grain	Stover	Grain	Straw			
		2004-05						
T1	Farmers' practice	2321	4613	2343	3154	5273	38210	17014
T2	T1 + recommended NPK for both the crops	3015	6150	3383	4844	7278	53460	31818
T3	Recommended package of practices for both the crops	3264	6706	3736	6022	7971	59945	35964
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	3879	8111	4801	6134	9928	71642	41641
	LSD (P=0.05)	448	1050	956	1577	1369	-	8766
		2005-06						
T1	Farmers' practice	1806	3274	2614	3186	5204	36321	15125
T2	T1 + recommended NPK for both the crops	2467	4653	3258	4085	6702	47264	25622
T3	Recommended package of practices for both the crops	2824	4755	3595	4582	7498	52359	28378
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	3171	5638	3961	5029	8320	58423	28422
	LSD (P=0.05)	375	1033	211	332	435	3785	3785
		2006-07						
T1	Farmers' practice	2259	3935	2449	3033	5320	42705	19309
T2	T1 + recommended NPK for both the crops	3158	5906	3558	4654	7605	62026	38015
T3	Recommended package of practices for both the crops	3525	6138	3832	5013	8316	67286	40905
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	3813	7100	4117	5419	8959	73110	39729
	LSD (P=0.05)	253	668	389	338	456	3337	3337

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To have an idea of relationship between the initial soil fertility status and yield under specific system of management, correlations were worked out (Table 6). It is clearly evident that maize and wheat grain yields under any of the treatments were not significantly associated with the initial content of any soil fertility component as well as pH and soil organic carbon in all years. It clearly depicts that it is not only soil fertility, but soil productivity factors and their interactions do play pivotal role in deciding yields of crops.

The findings of the present investigation inferred that for feeding the growing population both of humans and animals farmers should go for recommended package of practices in maize-wheat cropping system without any compromise. For further higher yields FYM at 10 t/ha should be incorporated if available. Resource poor small and marginal farmers who can not afford to apply the full package should at least go with recommended application of nutrients to sustain yields and fetch higher returns.

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Table 5. Effect of agronomic practices on maize and wheat yields, maize equivalent yield and economics in maize-wheat cropping sequence (Overall, pooled of 16 locations)

	Practice	Yield (kg/ha)				Maize equivalent	Gross return (Rs/ha)	Net return (Rs/ha)
		Maize		Wheat				
		Grain	Stover	Grain	Straw			
		2004-05						
T1	Farmers' practice	2365	5081	2147	2661	5070	36767	15571
T2	T1 + recommended NPK for both the crops	3309	7299	2710	3461	6723	49296	27654
T3	Recommended package of practices for both the crops	3782	8546	3123	4198	7717	57235	33254
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	4071	9247	3619	4489	8631	63230	33229
	LSD (P=0.05)	132	446	290	439	390	-	2468
		2005-06						
T1	Farmers' practice	2208	4308	2098	2821	4936	35491	14295
T2	T1 + recommended NPK for both the crops	3013	6263	2711	3716	6537	47633	25991
T3	Recommended package of practices for both the crops	3395	7027	3137	4213	7473	54223	30242
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	3763	7900	3722	5001	8602	62492	32491
	LSD (P=0.05)	144	480	162	195	284	2061	2061
		2006-07						
T1	Farmers' practice	2459	5002	2109	2695	5096	41966	18570
T2	T1 + recommended NPK for both the crops	3106	6254	2786	3542	6588	54118	30107
T3	Recommended package of practices for both the crops	3614	7133	3140	3986	7538	61761	35380
T4	Recommended package of practices plus 10 t/ha FYM to both the crops	3857	7767	3478	4427	8204	67395	34014
	LSD (P=0.05)	120	308	177	231	288	2339	2339

Table 6. Correlation among the soil properties and yield of maize and wheat

	Maize grain yield (kg/ha)				Wheat grain yield (kg/ha)			
	T1	T2	T3	T4	T1	T2	T3	T4
				2004-05				
pH	0.391	-0.130	-0.166	-0.243	0.217	0.217	0.055	0.116
OC	0.079	-0.092	0.028	-0.011	-0.112	-0.072	-0.307	-0.072
N	0.016	-0.144	0.329	-0.025	-0.403	-0.251	-0.031	-0.063
P	0.156	-0.030	0.015	0.219	0.129	-0.039	-0.202	-0.133
K	0.339	0.309	0.200	0.461	-0.322	-0.385	-0.679	-0.473
				2005-06				
pH	0.232	0.194	0.008	-0.100	0.671	0.671	0.439	0.118
OC	0.011	0.123	0.228	0.114	-0.138	-0.170	-0.209	-0.511
N	-0.646	-0.617	-0.703	-0.713	0.526	0.538	0.580	0.327
P	0.342	0.418	0.394	0.274	0.171	0.130	0.109	-0.153
K	0.035	0.110	0.231	0.193	-0.283	-0.355	-0.409	-0.394
				2006-07				
pH	0.155	0.418	0.191	0.424	0.053	0.053	-0.064	0.009
OC	-0.211	0.261	0.270	0.267	-0.028	-0.078	-0.126	-0.089
N	-0.081	0.218	0.022	-0.096	0.425	0.719	0.768	0.799
P	-0.041	0.434	0.123	0.330	0.073	0.111	0.037	0.087
K	0.169	0.497	-0.070	0.061	0.573	0.612	0.400	0.483

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