Himachal Journal of Agricultural Research 33 (2):143-146, 2007

On-farm response of maize and wheat to NPK in maize-wheat cropping system in low hills sub-tropical zone of Himachal Pradesh

S.K. Sharma*, Sanjay K. Sharma, S.S. Rana and J.J. Sharma
Department of Agronomy
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur -176 062, India.

Abstract

An on-farm experiment was carried out in sub-montane and low hills sub-tropical zone of Himachal Pradesh to study the response of nutrients in maize-wheat cropping sequence. Five treatments (control, N, NP, NK and NPK at recommended rates to the component crops) were evaluated at fourteen locations for the two consecutive cropping seasons of 2001-02 and 2002-03. Results of the study revealed that recommended dose of NPK resulted in significantly higher grain and straw yields of maize and wheat, maize equivalent yield, gross return, net return and NPK uptake over rest of the treatments. Recommended NPK resulted in 86% and 50% higher maize grain equivalent yield and Rs 22,005 ha^{-1} and Rs 17,825 ha^{-1} more net returns over control and recommended N, respectively. Recommended NP or NK were also found superior over control and N alone, NP being better than NK. The response i.e. kg grain per kg of nutrients applied was higher for P followed by K and N.

Introduction

In Himachal Pradesh, 84% of the cropped area is rainfed (Singh *et al;* 1998). Maize-wheat is one of the most important cropping sequences of Himachal in general and sub-montane and low hills sub-tropical zone-1 of the State in particular. In zone -1, this cropping sequence occupies 111.78 thousand hectares as against 21.6 thousand hectare by rice-wheat and only 3.74 thousand hectare by oilseed or pulses cropping sequence. In spite of the significant achievements made in research in improving productivity of crops and cropping systems, the productivity of the maize-wheat system is far below satisfactory. The Himachal Pradesh, Krishi Vishvavidyalaya came out with some worthwhile crop production technologies for the benefit of farmers (Anon., 1997 a & b), however, the farmers have not succeeded in taking full advantages of these technologies (Singh *et al*, 1999). The yield of each crop in a cropping system can be increased considerably by adopting improved management practices (Venkteswarlu, 1987, Ahlawat and Rana, 1998). The majority of the farmers (57%) in zone 1 of Himachal Pradesh is marginal (<1.0 hectare) and 19% are small (1-2 hectare) following traditional and subsistence farming and has low risk bearing capacity. The major constraint identified was the low use of fertilizers. In general, levels of nutrients applied are quite inadequate as the use of N, P_2O_5 and K_2O use was 32.6, 9.2 and 7.6 kg ha^{-1}, respectively (Anonymous, 2004). Hence, keeping in view the above mentioned facts, studies on response of nutrients (NPK) to maize-wheat cropping sequence was undertaken under on-farm conditions.

Material and Methods

An on-farm investigation was carried out in six villages of two main ECF centres viz. Dhaulakuan (Surajpur, Kolar, Battamandi and Nihalgarh) and Nalagarh (Rajpura and Manpura) within NARP zone 1 of Himachal Pradesh. Five treatments (Table 2) were tested at 14 locations [8 in Dhaulakuan (two experiments in each village) and 6 in Nalagarh (three experiments in each village)] during 2001-02 and 2002-03. Sowing of maize and wheat was done in the first fortnights of June and November, respectively and harvesting in second fortnights of September and April, respectively during the each year. The recommended dose of N, P_2O_5 and K_2O for maize was 90, 45 and 30 and that for wheat was 80, 40 and 40 kg/ha, respectively (Anon., 1997a & b). Recommended package of practices were followed for rest of the management practices for the individual crops in the cropping sequence.

The composite soil samples (0-15) from each location were analysed to determine the initial soil status in respect of soil pH (1:2.5)

* *Research Sub Station, Akrot (Una).*

(Jackson, 1967), available N (Subbiah and Asija, 1956), P (Watanabe and Olsen, 1965), K (Merwin and Peech, 1951) and organic C (Walkley and Black, 1934) contents. Grain and straw samples of maize and wheat were analysed for N, P and K contents following standard procedures as outlined by Jackson (1967) and Black (1965).

The soils of the zone were inceptisols having soil texture loamy sand to silty clay loam with pH 5.5 to 7.3. The average annual precipitation of the test sites is 1500 mm with mean maximum and minimum temperature ranging from 19.3 to 38.2C and 3.0 to 23.1C, respectively.

The data collected for various parameters were analysed statistically in RBD by considering locations as the replications. Economics of the treatments were calculated as per the prevailing market prices of inputs and the 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 5.7 to 6.7 and 5.5 to 7.3 with mean values of 6.2 and 6.3, during 2001-02 and 2002-03, respectively. The soils of the test sites, in general were medium to high in respect of available N, P and K and organic carbon content.

Table 1. Soil fertility status before sowing of the crop (14 locations)

Parameter	2001-02			2002-03		
	Max	Min	Mean	Max	Min	Mean
N (kg/ha)	639.5	363.7	536.5	576.8	168.0	387.5
P (kg/ha)	26.6	11.4	20.1	34.7	7.3	22.2
K (kg/ha)	280.6	145.9	185.3	374.0	148.2	216.0
OC (%)	0.87	0.45	0.62	1.10	0.60	0.70
pH	6.7	5.7	6.23	7.3	5.5	6.3

Grain yield

The recommended dose of NPK resulted in significantly higher maize and wheat yield during both the years of experimentations (Table 2). This was followed by the treatment where recommended dose of N and P was applied. The control treatment no fertilizer) resulted in lowest grain yields of maize and wheat during both the years. The higher yield in the treatment comprising recommended application of NPK to the individual crops tended to increase the maize equivalent yield significantly over rest of the treatments. The recommended fertility level increased maize equivalent yield by about 77 and 94 per cent over control and by about 49 and 60 percent over N only (farmers' practice) during 2001-02 and 2002-03, respectively. The increase in yield might be due to favourable influence on soil fertility and other micro-climatic conditions. Similar findings have also been reported by other workers (Chaudhary *et al.*, 2000a, 2000b)

Table 2. Effect of fertility treatments on yield (kg ha^{-1}) and economics (Rs ha^{-1}) of maize-wheat cropping sequence

Treatment	Maize		Wheat		Maize grain equivalent	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})
	Grain	Stover	Grain	Straw			
			2001-02				
Control (No fertilizer)	2203	5037	1783	1961	4342	29172	13103
Recommended N for the component crop	2716	6239	2057	2263	5184	34870	17101
Recommended NP for the component crop	3679	8452	2704	3001	6923	46631	27210
Recommended NK for the component crop	3300	7576	2463	2711	6255	42082	23817
Recommended NPK for the component crop	4176	9585	2940	3243	7704	51863	31946
LSD (P=0.05)	114	179	84	76	141	-	-
			2002-03				
Control (No fertilizer)	2088	4410	1941	2112	4418	31183	15148
Recommended N for the component crop	2522	5570	2348	2594	5339	38048	19511
Recommended NP for the component crop	3630	8521	3202	3634	7473	54133	33700
Recommended NK for the component crop	3205	7622	2879	3255	6659	48303	29246
Recommended NPK for the component crop	4136	10204	3514	4032	8554	61269	40316
LSD (P=0.05)	133	244	124	114	245	-	-

Economics

The highest maize and wheat yields following recommended dose of nutrients (NPK) fetched highest gross (Rs 51896 and Rs 61269 ha^{-1} during 2001-02 and 2002-03, respectively) and net returns (Rs 31946 and Rs 40316 ha^{-1} during 2001-02 and 2002-03, respectively) over rest of the treatments. On an average, the recommended dose of NPK increased the gross and net returns by Rs. 26388 and 22005 ha^{-1} over control and Rs.20107 and Rs. 17825 ha^{-1} over N alone, respectively. Use of NP or NK was also found superior over control and N alone; recommended NP was better than NK.

Nutrient Uptake

A perusal of the data (Table 3) revealed that highest total uptake of N, P and K by maize and wheat was observed where all the three nutrients were applied as per recommendations for the component crops. This was followed by the treatment where only recommended N and P was applied. The nutrient content is a function of dry matter and content, the trend in general was similar to grain and stover/straw yield of the crops. The lowest nutrient uptake by both the crops was recorded in the control treatment (without fertilizers).

Table 3. Nutrient uptake (kg ha^{-1}) in cropping system

Treatment	Nitrogen		Phosphorus		Potassium	
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
Control (No fertilizer)	98.6	127.6	21.1	20.1	65.5	46.7
Recommended N for the component crop	120.3	155	24.9	24.4	78.7	57.6
Recommended NP for the component crop	156.1	228.1	33.0	35.3	105.0	86.1
Recommended NK for the component crop	141.4	209.6	29.8	29.9	96.4	76.8
Recommended NPK for the component crop	177.0	263.8	36.9	38.6	117.4	97.4
LSD (P=0.05)	6.6	15.3	1.5	3.0	4.4	5.0

Response of crops to applied nutrients

Response of maize and wheat in terms of kg grain per kg of nutrients applied was worked out in respect of each nutrient for the component crops in the maize-wheat cropping sequence. The data are summarized in Table 4. In general, highest response was obtained in respect of P followed by K and N in both the crops. Such a response is expected from the soils which are generally medium in available NPK contents. The lowest response to N may be due to the fact that it is subjected to more losses as compared to P and K.

The findings of the present investigation envisaged the positive effect and impact of combined application of all the basic (NPK) nutrients at recommended rates to the component crops in enhancing their yield and thus the total productivity of rain fed maize-wheat cropping sequence in sub-montane and low hills sub-tropical zone of the State.

Table 4. Response of maize and wheat to applied nutrients

Crop		Response (kg grain per kg nutrient applied)					
		2001-02			2002-03		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
Maize	Max	10.3	26.3	27.4	7.6	28.2	23.2
	Min	2.7	15.6	11.9	2.4	15.3	15.9
	Mean	5.7	20.5	18.0	4.8	22.7	19.8
Wheat	Max	5.8	19.1	11.3	9.4	28.4	15.9
	Min	1.3	9.8	2.8	1.6	14.9	5.4
	Mean	3.4	14.0	8.0	5.1	18.6	10.5

References

Ahlawat IPS and Rana D S 1998. Agrotechniques In: *Fifty years of Agronomic Research in India.* Indian Society of Agronomy. Publ. pp. 33-50.

Anonymous 2004. *Fertilizer News* **49** (9): 122.

Anonymous 1997 a. *Package of practices for kharif crops.* Directorate of Extension Education, HPKV, Palampur.

Anonymous 1997 b. *Package of practices for rabi crops,* Directorate of Extension Education, HPKV, Palampur.

Black CA 1965. *Methods of Soil Analysis II.* American Society of Agronomy. Inc., Wisconsin, USA.

Chaudhary JB, Thakur RC, Bhargava M and Sood RD 2000a. Effect of different production components on yield of rainfed wheat (*Triticum aestivum*)

under farmers' conditions in mid-hill sub-humid agro-climate. Him J. Agric Res. **26** (1&2): 11-14.

Chaudhary JB, Thakur RC, Bhargava M and Sood RD 2000b. On-farm study on relative contribution of different production inputs in yield of rainfed maize (*Zea mays*) under mid-hill sub-humid agro-climate. Him J. Agric Res. **26** (1&2): 15-20.

Jackson ML 1958. *Soil chemical analysis*. Prentice Hall of India, Ltd. New Delhi, pp 219-221.

Mervin DH and Peech M 1951. Exchangeability of soil potassium in sand, silt and clay fractions as influenced by nature and complementary exchangeable cations. Proc. Soil Sci. Soc. Amer. 15: 125-128.

Singh V, Rana SS and Kharwara PC 1998. A study on the extent of adoption of latest agricultural technology by the farmers of Himachal Pradesh and constraints thereof. *International Symposium on Sustainable Agriculture in Hill areas,* Palampur, India, Oct, 29-31, Economic viability of Hill Agriculture: Status and Opportunities Vol IV, eds Sharma HR, Virender Kumar and Kapoor AC, pp. 217-223.

Subbiah BV and Asija GL 1956. A rapid procedure for determination of available nitrogen in soil. Current Sci. **25**: 259-266.

Venkateswarlu J 1987. Efficient resource and management systems for dry lands of India. Adv. Soil Sci.**7**: 165-221.

Walkley A and Black IA 1934. An examination of the Detjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci. **37**:29-38.

Watanabe FS and Olsen SR 1965. Test of an ascorbic acid method for determining phosphorus in water and sodium bicarbonate extract from soil. Proc. Soil Sci. Soc. Amer. **29**: 677-678.

VIR SOFTECH