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Effect of FYM and micronutrients on the productivity of seed potato (*Solanum tuberosum*) under cold desert conditions of Himachal Pradesh

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Abstract

A field experiment was conducted during the two consecutive summers of 2004 and 2005 at Lari (3200 m altitude) to study the response of FYM and micronutrients. The treatments studied were farmers' practice, recommended NPK, NPK+FYM 20t/ha, NPK+FYM+ borax 10 & 20 kg/ha, NPK + borax 10 & 20 kg/ha, NPK+FYM+ borax 10 & 20 kg/ha + micronutrient cations, NPK + borax + micronutrient cations, NPK + micronutrient cations, NPK + FYM + micronutrient cations). Results of the study revealed that all the fertility levels tested were significantly superior to farmer's practice (flat bed planting + 15 t FYM/ha) in influencing plant height, shoots/hill, tubers/hill, seed tuber yield, net return and B: C ratio. 100% NPK (120:80:60:: N:P_2O_5:K_2O, kg/ha) + FYM 20 t/ha + borax 10 kg/ha + $ZnSO_4$, Mn SO_4 and Fe SO_4 each at 2 kg/ha and 100% NPK + FYM 20 t/ha + borax 20 kg/ha + ZnSO4, Mn SO4 and Fe SO4 each at 2 kg/ha were statistically at par which resulted in significantly higher plant height, shoots/hill, tubers/hill, seed tuber yield and net return. The above fertility levels increased tuber yield and net return by 57.1 and 75.51% and 61.31 and 79.23%, respectively over the farmers practice and 26.19 and 20.54 and 29.57 and 23.09%, respectively over 100% NPK. However, 100% NPK at par with 100% NPK + $ZnSO_4$, Mn SO_4 and Fe SO_4 each at 2 kg/ha fetched significantly higher B: C ratio. Based upon yield and net return 100% NPK + FYM 20 t/ha + borax 10 kg/ha + $ZnSO_4$, Mn SO_4 and Fe SO_4 each at 2 kg/ha was recommended under Spiti valley conditions of Himachal Pradesh.

Key words: Potato, *Solanum tuberosum,* FYM, micronutrient and productivity.

Introduction

Potato (*Solanum tuberosum*) is one of the major cash crops of Himachal Pradesh in general and temperate high hills of Himachal in particular. Of the total area under potatoes, 88% lies in the higher hills. Spiti valley (3000-4200 m altitude) in the dry temperate region is known as an ideal pocket for the production for disease free potatoes. Potato is cultivated as a main crop during summer under long day conditions. The soil of the valley is shallow, has high pH, and low organic matter. Consequently, nutrient disorders in these soils are the most important limiting factor to crop production, second only to moisture stress. Major problems are deficiencies of nitrogen and phosphorus. Recent research has revealed that micronutrient problems are also hampering crop production. Zn deficiency is the most widespread problem reported by Reddy (2004) and Rashid and Ryan (2004). Fe chlorosis, the second most important micronutrient disorder, is induced by high soil $HCO3^-$, high moisture and cold temperature Rashid and Ryan (2004). Research in the recent past has revealed B also to be a widespread problem in crops. Kanwar *et. al.* (2004) have documented that 62.5% surface soil samples in cauliflower growing soils of Himachal Pradesh were low in available B. Soil micronutrient deficiencies not only reduce crop productivity, but low Zn and Fe plant food is also adversely affecting human health and well-being. Though fertilizer use for micronutrients is highly cost-effective, actual use remains rather limited. Thus, micronutrient problems are likely to be accentuated because of increased pressure on soil resources. Therefore, to increase the overall nutrient use efficiency, alleviation of deficiency of various nutrient elements is more critical than application of high doses of NPK only. Integrated nutrients application plays pivotal role in boosting the productivity of potatoes. (Sharma and Kumar, 2000 and Sasani *et al.*, 2003). Taking into consideration the above facts the present investigation was undertaken to study the

effect of fym and micronutrients on the productivity of seed potato.

Material and Methods

The field experiment was conducted during the two consecutive summers (2004 and 2005) at the Research Sub Station, Lari in the Spiti Valley of Himachal Pradesh (3300 m msl). The soil of the experimental field was silty loam in texture, alkaline in reaction (pH 8.3), low available N (178 kg/ha) and organic matter content (0.55%). The temperature during winter (November to April) varies from -21.7° C to 8.2° C and during summer (May to October) from 0.1° C to 25.6° C. Rainfall varies from 15-20 cm and annual snowfall between 1-2 m (December – March)

Thirteen treatments (Table 1) were tested in randomized block design with three replications. Recommended dose of N, P_2O_5 and K_2O was 120, 80 and 60 kg/ha, respectively. FYM at 20 t/ha as per the treatment was applied before last ploughing. The plantings of variety 'Kufri Jyoti' was done on ridges during June first fortnight at 50 cm x 12 cm spacing. Farmer's practice involved planting potatoes on flat bed along with 15 t FYM/ha. Whole P_2O_5, K_2O and half N as per the treatment were supplied through single super phosphate, murate of potash and calcium ammonium nitrate, respectively. Remaining half of the N was applied at earthing up (45 DAP, days after planting). Borax was applied at planting. Micronutrient cations Zn, Cu and Fe were supplied through $ZnSO_4$, $CuSO_4$ and $FeSO_4$, respectively at earthing up. For weed control pre plant incorporation of fluchloralin 1.0 kg/ha was made one day before planting. Crop emergence completed by mid July. Recommended package of practices were followed for raising the crop. Harvesting of potato tubers was done at the second week of October and yield was recorded. Economics of the treatments were computed based upon prevalent market prices.

Results and Discussion

Effect on yield

The data on yield and yield attributes have been summarized in Table 1. All the fertility treatments were significantly superior to farmer's practice (Flat bed planting along with 15 t FYM/ha) in influencing tuber yield. 100% recommended NPK increased tuber yield by 24.5% over the farmer's practice. The addition of FYM along with 100% recommended NPK further increased tuber yield by 15.6%. Sharma and Kumar (2000) and Sasani *et al* (2003) also reported significant effect of FYM in boosting the productivity of potato. The percent increase in yield due to 100% NPK + FYM was 44.0% over the farmer's practice. This was owed to increase in growth and yield-contributing traits *viz*., plant height, shoots/hill, and tubers/hill, which were significantly higher over recommended NPK alone or in integration with FYM. The increase in yield owing to improved growth and yield contributing traits has also been observed by several workers like (Sharma and Kumar, 2000 and Sasani *et al*, 2003). Application of 20 kg borax along with recommended NPK as well as recommended NPK + FYM have shown significant improvement in growth, yield attributes and yield over its respective counterpart. In general micronutrient cations (Zn, Fe and Cu) also improved the yield. Khalifa *et al* (2003) have also observed significant improvement in yield attributes and yield in potato with micronutrient cations. Significantly superior yield attributes and higher yields were observed by treatments 100% NPK + FYM + Borax 20 kg/ha+ micronutrient cations and 100% NPK + FYM + Borax 10 kg/ha + micronutrient cations. The above fertility treatments increased tuber yield by 61.31 and 57.1% over the farmers' practice and 29.57 and 26.19% over 100% NPK.

In the present investigation, tuber yield was significantly and positively correlated with plant height (0.621** & 0.581**, in 2004 and 2005, respectively; ** significant at 1% level of significance), shoots/hill (0.807** & 0.617** in 2004 and 2005, respectively) and tubers/hill (0.893** & 0.825** in 2004 and 2005, respectively) showing high degree of association.

Net Return

Owing to higher yields, net returns were significantly higher due to all the fertility treatments over the farmer's practice. Recommended NPK tended to fetch 45.6% higher net return over the farmer's practice. FYM application along with 100% NPK further increased net return. Sasani *et al* (2003) reported similar findings. 100% NPK + FYM + Borax 20 kg/ha+ micronutrient cations and 100% NPK + FYM + Borax 10 kg/ha + micronutrient cations were statistically at par gave significantly higher net return over all the other treatments. These fertility treatments increased net return by 79.23 and 75.51 per cent, respectively over the farmer;s

Table 1. Effect of fertility treatments on tuber yield, plant height, and yield attributes

Treatments	Yield (t/ha)			Plant height (cm)			Shoots/hill			Tubers/hill		
	2004	2005	Mean	2004	2005	Mean	2004	2005	Mean	2004	2005	Mean
Farmer's practice (T1)	12.95	12.68	12.82	36.2	36.4	36.3	3.80	3.84	3.82	7.68	7.59	7.63
100% NPK (T2)	16.05	15.86	15.96	39.7	38.2	39.0	3.97	3.88	3.92	8.06	8.20	8.13
100% NPK + FYM 20 t/ha (T3)	18.78	18.15	18.46	38.2	40.3	39.3	4.10	3.94	4.02	10.22	9.52	9.87
T3 + Borax 10 kg/ha (T4)	18.98	18.34	18.66	39.7	40.9	40.3	4.11	4.02	4.06	10.33	9.93	10.13
T3 + Borax 20 kg/ha (T5)	19.31	19.05	19.18	41.6	40.0	40.8	4.19	4.06	4.13	10.65	10.60	10.63
T2 + Borax 10 kg/ha (T6)	16.67	15.78	16.23	40.5	40.6	40.6	4.10	4.11	4.10	9.18	9.28	9.23
T2 + Borax 20 kg/ha (T7)	17.28	15.93	16.61	40.3	41.8	41.1	4.10	3.99	4.04	9.75	9.34	9.54
T4 + Micronutrient cations* (T8)	20.73	19.55	20.14	43.4	42.9	43.2	4.25	4.14	4.20	12.21	11.83	12.02
T5 + Micronutrient cations* (T9)	21.08	20.28	20.68	44.1	42.8	43.4	4.36	4.26	4.31	12.90	12.22	12.56
T6 + Micronutrient cations* (T10)	16.87	16.95	16.91	39.4	38.3	38.9	4.18	4.11	4.15	9.50	10.10	9.80
T7 + Micronutrient cations* (T11)	17.14	17.22	17.18	39.3	36.9	38.1	4.05	4.06	4.06	9.63	10.08	9.86
T2 + Micronutrient cations* (T12)	16.48	16.07	16.27	41.2	38.0	39.6	4.08	4.06	4.07	9.27	8.25	8.76
T3 + Micronutrient cations* (T13)	18.20	17.31	17.76	41.5	40.6	41.1	4.10	4.17	4.13	10.37	11.55	10.96
LSD (P=0.05)	1.01	0.70	0.58	2.6	3.0	2.1	0.09	0.11	0.07	0.86	0.71	0.61

*$ZnSO_4$, $CuSO_4$ and $FeSO_4$ each at 2 kg/ha

Table 2. Economics of fertility treatments

Treatment	Net return (Rs/ha)			B:C ratio		
	2004	2005	Mean	2004	2005	Mean
Farmer' practice (T1)	89658	86892	88275	2.25	2.18	2.21
100% NPK (T2)	129470	127603	128537	4.17	4.11	4.14
100% NPK + FYM 20 t/ha (T3)	144770	138437	141603	3.36	3.22	3.29
T3 + Borax 10 kg/ha (T4)	144617	138250	141433	3.20	3.06	3.13
T3 + Borax 20 kg/ha (T5)	145797	143197	144497	3.08	3.03	3.06
T2 + Borax 10 kg/ha (T6)	133583	124617	129100	4.03	3.76	3.89
T2 + Borax 20 kg/ha (T7)	137563	124063	130813	3.90	3.52	3.71
T4 + Micronutrient cations* (T8)	160833	149033	154933	3.46	3.21	3.34
T5 + Micronutrient cations* (T9)	162213	154213	158213	3.34	3.18	3.26
T6 + Micronutrient cations* (T10)	134233	135066	134649	3.90	3.92	3.91
T7 + Micronutrient cations* (T11)	134879	135613	135246	3.69	3.71	3.70
T2 + Micronutrient cations* (T12)	132453	128353	130403	4.10	3.97	4.04
T3 + Micronutrient cations* (T13)	137686	128819	133253	3.11	2.91	3.01
LSD (P=0.05)	10054	7001	5831	0.26	0.18	0.16

practice and 23.09 and 20.54 per cent over recommended NPK. None of the other treatments involving borax and other micronutrient application surpassed the recommended NPK + FYM in influencing net return.

B: C Ratio

All the treatments were significantly superior to farmer's practice in influencing B: C ratio. 100% NPK being statistically at par with 100% NPK + micro nutrient cations resulted in significantly higher B: C ratio.

The findings of the investigation conclusively inferred that for higher productivity and remunerative return under Spiti valley conditions of Himachal Pradesh, recommended NPK application should be supplemented with FYM (20 t/ha) and micronutrients such as boron (10-20 kg borax/ha), Zn, Fe and Cu (each at 2 kg/ha as sulphate of the respective micronutrient cations).

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