POTASSIUM APPLICATION FOR RESOURCE CONSERVATION AND ENHANCED PRODUCTIVITY IN NORTH-WEST HIMALAYAN REGION

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FOREWORD

Enhancing and sustaining the productivity is a major challenge in the N-W Himalayan states, as agriculture is practiced under mildly sloppy land and outward level terraces without due care of soil and water conservation. The north-western Himalayan soils comprising of varying slopes suffer from severe land degradation with the loss of soil, water, nutrients and productivity. This degradation is much more aggravated with potassium mining by the crops. Most of the dominant cropping systems in north-west Himalayas exhibit negative potassium balance in soil and decreasing productivity, quality in long-run owing to negligible K application. Potassium is considered as a key quality elements and productivity is decreased in maize and cowpea based rotation because of extreme imbalanced fertilization. Balanced fertilization with higher canopy cover reduces soil erosion which in turn increases productivity, improves soil health and better water balance.

I am confident that potassium application technology covered in this brochure after several years of study at CSWCRTI Research Farm, Selakui, Dehradun, will not only help in getting additional revenue to the farming community but shall also help in preventing land degradation and improving soil quality.

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INTRODUCTION

- Imbalance fertilization induces scanty canopy cover which causes higher soil erosion and makes the cropping system uneconomical and unsustainable.
- Balanced fertilization reduces soil erosion which in turn increases productivity, improves soil health and better water balance.
- Hill and mountain agriculture evolved over centuries with application of farmyard manure ranging from 5 -15 tonnes ha^{-1} along with inorganic NPK application hardly exceeds 20.0 kg ha^{-1} yr^{-1} as against 115.0 kg $ha^{-1}yr^{-1}$ national average, of which potassic fertilizer application is virtually nil.
- Potassium being the quality element increases value addition and protects crops in stress conditions and from insects and pests.
- Most of the dominant cropping systems in north-west Himalayas exhibit negative potassium balance in soil and decreasing productivity and quality trend in long-run owing to negligible K application and even with recommended K application.
- Extreme imbalanced fertilization of N : P : K (15.5:5.0:1) against ideal consumption ratio of 4:2:1 exhibits lower water use efficiency of maize and cowpea based cropping system.

TECHNOLOGY DEVELOPED

The technology comprising of maize/cowpea - wheat/lentil/mustard sequences of maize–wheat (Mz-W), maize–lentil (Mz-L), maize–mustard (Mz-M) and cowpea–wheat (CP-W), cowpea–lentil (CP-L), cowpea–mustard (CP-M) with 120 kg K_2O ha^{-1} instead of 40 kg K_2O ha^{-1} application to *kharif* crops. Kanchan variety of maize, Pusa Komal of cowpea were sown in second fortnight of June, whereas winter crops, viz; HD-2353 variety of wheat, PL-4 lentil and T-59 mustard were sown during the 1st fortnight of November. Recommended doses of N and P fertilizers (kg ha^{-1}), applied to different crops were, 90 + 60 for maize, 20 + 80 for cowpea, 60 + 40 for wheat, 20 + 80 for lentil and 20 + 40 for mustard, respectively. In addition, 40 or 120 kg K_2O ha^{-1}, as per treatment was applied to *kharif* crops, whereas a uniform dose of 30 kg K_2O ha^{-1} was given to the succeeding winter crops. Full quantity of P and K to all the crops along with full N in cowpea, lentil and mustard, 1/3rd N in maize and ½ N in wheat was applied at the time of sowing. Remaining quantity of N in maize and wheat was top dressed at their recommended critical stages.

TECHNOLOGY IMPLEMENTATION

Field Preparation

Package of Practices for *Kharif* (maize and cowpea) Crops

- Field should be ploughed immediately, after harvest of previous crop with tractor drawn cultivator or bullock drawn *desi* plough followed by one planking with the onset of monsoon prior to sowing of maize, to conserve soil moisture.
- During second ploughing 45 kg N, 60 kg P_2O_5 and 120 kg K_2O ha^{-1} for maize and 20 kg N, 80 kg P_2O_5 and 120 kg K_2O ha^{-1} for cowpea should be applied followed by planking. 20 kg seed of maize variety Kanchan and 2.0 kg seed of cowpea variety Pusa Komal should be sown using a seed drill.
- For maize 90 x 20 cm plant to plant and row to row whereas for cowpea 45 x 45 cm spacing should be maintained at the time of sowing.
- Application of attrazine @1.5 kg ha^{-1} in 700 - 800 litre of water should be applied at pre-emergence (2 DAS) stage to control

weed in maize crop. Further, one hand weeding should be done after 3 - 4 weeks of sowing for maize as well as for cowpea.

- The remaining half i.e. 45 kg N ha^{-1} should be applied to maize at the time of knee-high stage.
- Generally maize and cowpea varieties are not affected by major insects and diseases in Doon valley conditions but if leaf blight (fungal diseases) is observed, it can be controlled by seed treatment with organo-mercurial @2 gm per kg seed.

Package of Practices for *Rabi* (wheat, lentil and mustard) Crops

- *Rabi* crops, viz; wheat variety of HD-2353, lentil variety of PL-4 and mustard variety of T-59 should be sown during the 1st fortnight of November.
- The doses of N, P and K fertilizers (kg ha^{-1}) should be applied to different crops are 60 + 40 + 30 for wheat, 20 + 80 + 30 for lentil and 20 + 40 + 30 for mustard, respectively. The quantity of P and K of all the crops together with full N in lentil and mustard is to be applied at the time of sowing. Half dose of N for wheat should be applied at the sowing time and remaining half should be applied at critical crown root initiation stages.
- One hand weeding is required 30 DAS in each *rabi* crop.
- To control aphid in mustard, spray Metasystsox @1 to 1.5 ml a.i. per litre of water, 2-3 times depending upon the infestation of aphid.

Production and Conservation Efficiency of Potassium with Minimum Tillage

- Higher grain yield (Photo 1) was observed in all the crops, viz; maize, cowpea green pod, wheat, lentil and mustard (Photo 2) with higher doses (120 kg K_2O ha^{-1}) of potassium than recommended K dose (40 kg K_2O ha^{-1}). Cowpea based rotation exhibited higher productivity, soil health and water balance.

Photo 1: Luxuriant crops of maize with K @120 kg K_2O ha^{-1}

Photo 2: Performances of wheat, lentil and mustard under moisture stress conditions with higher K application

- Average runoff and soil loss reduced to the tune of 18.5, 15.8% under maize and 22.8, 19.7% under cowpea cover, respectively.
- Potassium fertilization also improved the nutritional value of harvested grain by elevating the protein and oil content.
- 24.7 ± 2.8% and 56.5 ± 6.8% of the seasonal rainfall contributed to deep percolation (indirect estimate) in *kharif* and *rabi* crops, respectively (Table1 & 2).

Table 1: Average productivity of *kharif* and *rabi* crops, as affected by potassium application and crop rotations under minimum tillage

K Application ($kg\ K_2O\ ha^{-1}$)	*Kharif* Crops	Yield ($t\ ha^{-1}$)	Parameters		Yield of succeeding *rabi* crops ($t\ ha^{-1}$)		
			Runoff (% rainfall)	Soil loss ($t\ ha^{-1}$)	Wheat	Lentil	Mustard
40	Maize	2.40	45.3	9.2	1.57	0.52	0.65
	Cowpea	1.05	38.0	8.0	1.81	0.58	0.70
120	Maize	2.83	36.0	7.2	1.79	0.59	0.73
	Cowpea	1.28	32.0	6.6	21.00	0.71	0.84

Table 2: Average soil chemical health parameters and water balance as affected by potassium application and crop rotation under minimum tillage

K application ($kg\ K_2O\ ha^{-1}$)	Crop sequence	OC ($g\ kg^{-1}$)	Available nutrient status ($kg\ ha^{-1}$)			K balance (added/ removal) coefficient in soil
			N	P	K	
40	Mz-W	6.4	290	20	112	0.56
	Mz-L	6.6	305	22	134	0.61
	Mz-M	6.7	302	24	122	0.62
	CP-W	6.9	295	22	145	0.72
	CP-L	7.1	302	24	156	0.79
	CP-M	7.2	308	26	167	0.72
120	Mz-W	7.0	275	28	190	0.67
	Mz-L	7.3	298	21	255	1.06
	Mz-M	7.5	302	27	275	1.19
	CP-W	7.6	272	28	297	1.15
	CP-L	7.7	286	30	301	1.40
	CP-M	7.8	308	30	316	1.46
Water balance (% rainfall contributed to deep percolation)						
Kharif	24.7					
Rabi	56.5					

* Mz - maize, W - Wheat, L - Lentil, M - Mustard and CP - Cowpea.

- Over 5 years, the balance coefficient for the lower (recommended) rate was 0.67, indicating that considerably more K was removed than applied. At the higher rate, the average balance coefficient was 1.29; indicating soil K status improved over 5 years.
- Bulk density decreased with the application of higher doses of potassium with cowpea rotation.
- Infiltration rate increased with higher dose of potassium application with cowpea rotation which thereby decreased runoff.
- The water use efficiency (WUE) of *kharif* and *rabi* crops increased with the increase in potassium application (Table 3).

Table3: Average soil physical health parameters and WUE as affected by potassium application and cropping system under minimum tillage

K application ($kg\ K_2O\ ha^{-1}$)	Crop sequence	Bulk density ($g\ cc^{-1}$)	Infiltration rate ($cm\ ha^{-1}$)	Water use efficiency (WUE) ($kg\ ha^{-1}\ mm^{-1}$)	
				Maize	W/L/M
40	Mz-W	1.35	1.8	7.3	6.6
	Mz-L	1.34	1.9	7.0	3.0
	Mz-M	1.34	2.1	6.8	4.2
	CP-W	1.32	2.4	2.2	7.6
	CP-L	1.32	2.7	2.4	3.6
	CP-M	1.31	2.9	2.6	4.7
120	Mz-W	1.35	2.1	8.2	7.3
	Mz-L	1.34	2.4	8.4	4.1
	Mz-M	1.34	2.2	8.6	4.4
	CP-W	1.32	2.8	4.6	9.7
	CP-L	1.30	3.1	4.8	5.8
	CP-M	1.28	3.6	4.9	6.4

ECONOMICS

The net return for maize grain in treatment receiving 120 kg $K_2O\ ha^{-1}$ is ₹ 4,589 per ha whereas for cowpea green pod net return is ₹ 4,253 per ha over recommended K dose (40 kg $K_2O\ ha^{-1}$). The net returns from wheat, lentil and mustard crops were ₹ 7,709, ₹ 5,674 and ₹ 5,502 ha^{-1} after maize crop whereas

₹ 8,271, ₹ 5,871 and ₹ 6,278 after cowpea. The net return for crop sequences of maize-wheat, maize-lentil and maize-mustard were ₹ 12,298, ₹ 10,460 and ₹ 10,091 with B: C ratio of 1.50, 1.32 and 1.36, respectively whereas for cowpea-wheat, cowpea-lentil and cowpea-mustard were ₹ 13,524, ₹ 10,927 and ₹ 11,531 with B: C ratio 1.73, 1.56 and 1.55, respectively over recommended K dose (40 kg K_2O ha^{-1}).

SCOPE OF APPLICATION AND GENERAL REMARKS

Potassium application technology is applicable to the states of Uttarakhand, H.P. and J&K. This technology can be adopted by the farmers of hill and mountain agro-ecosystem specifically in medium to light textured soils to conserve natural resources particularly to check soil degradation in respect of K mining and build up of organic matter and enhance productivity.