

Nutrient Utilization by Different Cropping Systems in Semi-Arid Conditions of North West India

MANOJ KUMAR, PAWAN KUMAR, S. K. YADAV AND NEERAJ KUMAR

*Department of Agronomy, CCS Haryana Agricultural University
 Hisar 125004, Haryana, India*

Abstract

A field experiment was conducted during 2001-02 to 2005-06 to assess the nutrients utilization and their translocation to grains in various cropping systems. The soil was sandy loam in texture and medium in soil fertility. Seven cropping systems viz. pearl millet-wheat, pearl millet-mustard, soybean-wheat-cowpea (f), sorghum (f)-wheat, pearl millet-potato-green gram, pearl millet-field pea-maize (f) and cotton-wheat were grown. In general the total nitrogen (N) uptake was higher with 3 crops in a year as compared to 2 crops in a year. The results revealed that the N uptake was highest in soybean-wheat-cowpea (f) cropping system while phosphorus (P) and potassium (K) uptake were highest in pearl millet-potato-green gram cropping system. During *khariif*, the highest per cent translocation of N and P to grains was observed in soybean and K in cotton. The translocation percentage of N and P to grains was highest in wheat in sorghum (f)-wheat and soybean-wheat-cowpea (f) cropping systems, respectively; and K in potato in *rabi*.

Key words : Cropping systems, Nutrients uptake, *Khariif*, *Rabi*, Per cent translocation.

The nutrients utilization by field crops is influenced by large number of physiological and agronomic factors viz. sowing time, water and fertilizer application, weed control as reported by Idnani & Singh (1), and (2), Singh, however, the type of crops cropping systems govern the nutrients utilization the most as has been reported (3). Pawar (4) have reported different nitrogen, phosphorus and potassium uptake in different crops / cropping systems. Sufficient information is available on nutrients utilization by individual crop, however such studies are lacking in different cropping systems. The studies of differential nutrients utilization by various cropping systems may be very helpful to the farmers in selecting suitable cropping system as per soil health and resources availability. The present study was, therefore, undertaken to study nitrogen, phosphorus and potassium uptake by different cropping systems grown in semi-arid Haryana.

Methods

Site and Soil Characteristics

Field experiments were conducted for six years (2001-02 to 2005-06) at the Research Farm of CCS

Haryana Agricultural University, Hisar, India, located at 74°27'28" east longitude, 27°30' east latitude, 215.2 m altitude and the mean annual rainfall is around 450 mm and most of it (around 80%) is received in rainy season (July to September). The area is characterized as semi-arid.

The soil has been classified as a Typic Haplustepts, loosely aggregated with sandy loam texture. The surface (0—15 cm) soil layer has 60.4% sand 16.9% silt and 22.7% clay. The slope of the study area was less than 1%. The organic carbon content of the surface layer (0—15 cm) was 0.38%. The available nitrogen, phosphorus and potash in surface layer was 126.0, 16.5 and 245.9 kg/ha, respectively. The soils had no salinity or drainage problem.

Table 1. Details of different cropping systems. * Fodder.

	<i>Khariif</i>	Season <i>Rabi</i>	Summer
T ₁	Pearlmillet	Wheat	—
T ₂	Pearlmillet	Mustard	—
T ₃	Soybean	Wheat	Cowpea (f)*
T ₄	Sorghum (f)	Wheat	
T ₅	Pearlmillet	Potato	Green gram
T ₆	Pearlmillet	Field pea	Maize (f)
T ₇	Cotton	Wheat	

Table 2. Mean grain yield in different cropping systems.

Treatments	Yield (kg/ha)		
	<i>Kharif</i>	<i>Rabi</i>	Summer
Pearlmillet-wheat	3295	4725	–
Pearlmillet-mustard	3324	1867	–
Soybean-wheat-cowpea (f)	2503	4734	20063
Sorghum (f)-wheat	36641	4978	–
Pearlmillet-potato-green gram	3606	26328	677
Pearlmillet-field pea-maize (f)	2953	1207	31272
Cotton-wheat	2208	4740	–

Treatments and Crop Husbandry

The rainy, winter and summer season crops were grown from July to October, October / November to April and April to June, respectively. The crops were sown in well moist field at their recommended sowing times. The experiment was established as a Incomplete Block Design with seven treatments and four replications. The details of the cropping systems are given in Table 1. The individual plot size was 10 m × 8.1 m with 1 m margins on both sides of the plot to curtail run off to adjunct plots. Recommended rates of fertilizers were applied to all the crops each year with nitrogen applied in two split doses, half at planting and the remaining half as top dressing as per recommendation. The full dose of phosphorus and potassium were applied as compound fertilizer in the soil at seeding. Planting was done each year at spacing as per recommendation for individual crop. The

crops were thinned as per need and a recommended space was maintained between plants. The crops were harvested at their physiological maturity. Other agronomic operations and plant protection measures followed local recommendations.

Nitrogen, phosphorus and potassium were determined using Nessler's reagent method by Lindner (5), Vanadomolybdophosphoric yellow color method by Koenig Johnson (6) and flame photometrically by Jackson (7), respectively. At the harvest, the uptake of nitrogen, phosphorus and potassium were computed from the concentration of these nutrients in grain and straw and their respective yields (Table 2).

Results and Discussion

Nitrogen Uptake and Per Cent Translocation to Grains

In general the N uptake was higher in *rabi* season than *kharif* in grains while the trend was reverse for straw (Tables 3, 4 and 5). The N uptake (grain and straw) was also higher in *rabi* as compared to *kharif* season. The uptake of N in almost all cropping systems was higher in grain as compared to straw. The N uptake in grain in *kharif* season among different cropping systems varied between 37.10 kg / ha (pearlmillet) and 99.72 kg/ha (soybean); however in most of the *kharif* crops the N uptake was around 40 kg/ha. The nitrogen uptake in cotton was (64.96 kg/ha). In straw the highest N uptake (149.32 kg/ha) was

Table 3. Nitrogen phosphorus and potassium uptake and their per cent translocation to grain during *kharif* (mean of 5 years).

Treatments	Nitrogen			Phosphorus (kg/ha)			Potassium		
	Grain	Straw	Per cent translocation to grains	Grain	Straw	Per cent translocation to grains	Grain	Straw	Per cent translocation to grains
T ₁	43.60	33.33	56.67	12.36	6.60	65.19	21.81	239.56	8.36
T ₂	39.58	35.26	52.89	11.34	7.04	61.70	21.22	258.10	7.60
T ₃	99.72	57.78	63.31	18.91	7.01	72.93	52.31	167.50	23.80
T ₄	–	149.32	–	–	19.91	–	–	212.78	–
T ₅	46.33	44.86	50.81	13.83	9.51	59.25	23.70	272.20	8.01
T ₆	37.10	35.80	50.89	10.28	7.05	59.32	18.46	227.28	7.51
T ₇	64.96	68.03	48.85	11.15	9.05	55.20	75.11	160.75	31.85

Table 6. Season-wise and total nitrogen, phosphorus and potassium uptake in different cropping systems (mean of 5 years).

Treat- ments	Nitrogen			Phosphorus (kg/ha)			Potassium					
	<i>Kharif</i>	<i>Rabi</i>	Sum- mer	Total	<i>Kharif</i>	<i>Rabi</i>	Sum- mer	Total	<i>Kharif</i>	<i>Rabi</i>	Sum- mer	Total
T ₁	76.93	137.81	–	214.74	18.96	22.43	–	41.39	261.40	171.32	–	432.72
T ₂	74.84	128.24	–	203.08	18.38	23.83	–	42.21	279.32	96.17	–	375.49
T ₃	157.50	135.77	151.97	445.24	25.93	20.25	18.21	64.39	219.81	162.52	160.60	542.93
T ₄	149.32	144.30	–	293.62	19.91	21.07	–	40.98	212.78	173.14	–	385.92
T ₅	91.19	232.89	81.59	405.67	23.34	39.07	11.40	73.81	295.90	291.19	106.05	693.14
T ₆	72.90	108.03	172.80	353.73	17.33	14.31	29.68	61.32	245.74	69.09	204.82	519.65
T ₇	132.99	117.54	–	250.53	20.20	21.27	–	41.47	235.86	169.32	–	405.18

ably to covering of field for more time in a year and higher yield in previous as compared to latter set of treatments. The N uptake in different cropping systems was influenced by their yield and N content. These results are in agreement with the findings of Idnani and Singh (1). The variation in translocation of nitrogen to grains was wider in *rabi* season as compared to *kharif* season. The higher translocation to grains might be due to higher concentration of nitrogen in the grain in various field crops. The per cent translocation of nitrogen to grains was comparatively lower in cotton, pearl millet, mustard and field pea due probably to higher yield of straw/stover in these crops. The total N uptake was a factor of N content and yield of the crop (Table 2). Similar results of higher translocation of nitrogen to grains have also been reported by Yadav and Singh (8).

Phosphorus Uptake and Per Cent Translocation to Grains

During *kharif* season the P uptake in different crops varied between 10.28 and 18.91 kg/ha in grains and between 6.60 and 19.91 kg/ha in straw (Table 3) while the respective figures for *rabi* season were 5.79 and 27.00 and 3.94 and 12.07 kg/ha (Table 4). Among various cropping systems, the highest total P uptake of 73.81 kg/ha was recorded in pearl millet-potato-green gram and lowest P uptake of 40.98 kg/ha in sorghum (f) - wheat cropping system (Table 6). Comparatively higher total P uptake was recorded in soybean-wheat-cowpea (f) and pearl millet-field pea-maize (f) cropping systems and lower uptake i.e. around 40 kg/ha was recorded in pearl millet-wheat, pearl millet-mustard and cotton-wheat cropping systems.

The per cent translocation of P from grain to straw in *kharif* season was highest (72.93) in soybean and lowest (55.20) in cotton (Table 3) while during *rabi* season the translocation was around 80% in wheat and 40 per cent in field pea (Table 4).

The total uptake of phosphorus was associated with the yield in different cropping systems. Maitra, et al. (9) have also reported P uptake in sunhemp-wheat cropping system.

Potassium Uptake and Per Cent Translocation to Grains

The K uptake both by grain and straw in *kharif* season varied between 212.78 and 295.90 kg/ha while the values for *rabi* season were 69.09 and 291.19 kg/ha (Table 6). During *kharif* season the maximum uptake was in pearl millet and minimum in sorghum; while in *rabi* season the potassium uptake was lower in field pea and mustard and highest in potato. Among the various cropping systems, pearl millet-potato-green gram removed maximum total potassium of 693.14 kg/ha and was followed by soybean-wheat-cowpea (f) cropping system with 542.93 kg/ha (Table 6). Lower uptake of potassium was recorded in pearl millet-wheat, pearl millet-mustard and cotton-wheat cropping systems.

In general the per cent translocation of potassium to grains varied between 7.51 and 31.85% in *kharif* season (Table 3) among different crops. The per cent translocation to grains was lower than 10 per cent in pearl millet, however it was more than 20 and 30% in soybean and cotton, respectively. The per

cent translocation to grains in *rabi* crops (Table 4) was between 15 and 20% except potato where the translocation percentage was 64.76%. The per cent translocation of K to grain was comparatively lower than N and P and in most of the crops it was between 10 and 20%. The total uptake in different cropping systems varied between 375.49 and 693.14 kg/ ha (Table 6).

The total potassium uptake in different cropping systems was associated with crop yield (Table 2) and potassium content in the crop as reported by Kumar et al. (10). The variability in potassium uptake among different cropping systems had been due to concentration of potassium and yield of crop. The variability in translocation of potassium to grains among different crops might have been due to different potassium adsorption affinities.

On the basis of the results it can be concluded that the N uptake (grain and straw) was higher in *rabi* as compared to *kharif* season. The total N uptake was significantly highest in soybean-wheat-cowpea (f) while it was lowest in pearl millet-mustard cropping system. The percent translocation to grains during both *kharif* and *rabi* seasons was higher than stover/straw. Highest and lowest total P uptake was recorded in pearl millet-potato-green gram and sorghum (f)-wheat cropping systems, respectively. The per cent translocation of P from grain to straw in *kharif* season was highest in soybean while during *rabi* season it was around 80 per cent in wheat. During *kharif* season the maximum uptake of potassium was in pearl millet while during *rabi* it was recorded in potato. The per cent translocation to grains in *rabi*

crops was significantly higher in potato in comparison to other crops.

References

1. Idnani L. K. and R. J. Singh. 2008. Effect of irrigation regimes, planting and irrigation methods and arbuscular mycorrhizae on productivity, nutrient uptake and water use in summer green gram (*Vigna radiata* var *radiata*). *Ind. J. Agric. Sci.* 78 : 53—57.
2. Singh A. K. 2006. Exploiting water nutrient synergy—A must for evergreen revolution. *J. Ind. Soc. Soil Sci.* 54 : 396—407.
3. Anonymous. 2006. *Annual report*. Proj. Direct. for Cropping Systems Res., Modipuram, Meerut, India.
4. Pawar A. S. 2008. Effect of integrated nutrient management in maize (*Zea mays*)-mustard (*Brassica campestris* var *toria*) cropping system in mid-hills altitude. *Ind. J. Agric. Sci.* 78 : 27—31.
5. Lindner R. C. 1944. Rapid analytical method for some of the more common inorganic constituents of plant tissues. *Pl. Physiol.* 19 : 76—89.
6. Koenig R. A. and C. R. Johnson. 1942. Colorimetric determination of P in biological materials. *Ind. Eng. Chem. Anal.* 14 : 155—156.
7. Jackson M. L. 1967. *Soil chemical analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, India.
8. Yadav S. K. and D. P. Singh. 1985. Effect of irrigation and antitranspirants on nutrient concentration and uptake in barley. *Acta Agronomica Academiae Scientiarum Hungaricae* 34 : 331—336.
9. Maitra D. N., S. K. Sarkar, S. Saha, M. K. Tripathi, B. Majumdar and A. R. Saha. 2008. Effect of phosphorus and farmyard manure applied to sunhemp (*Crotalaria juncea*) on yield and nutrient uptake of sunhemp-wheat (*Triticum aestivum*) cropping system and fertility status in a Typic Ustoccept of Uttar Pradesh. *Ind. J. Agric. Sci.* 78 : 70 —74.
10. Kumar P., R. K. Nanwal and S. K. Yadav. 2004. Yield and nutrient uptake in pearl millet-wheat cropping system as influenced by various fertilizer levels applied through organic and inorganic sources. *Haryana J. Agron.* 20 : 36—38.