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Status of major nutrients in relation to soil properties of Mothbean soils of Poonch district of J&K state

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ABSTRACT

Mothbean [*Vigna aconitifolia* (Jacq.) Marechel.], a special pulse cherished by the people cultivate mostly in Poonch (Loran, Mandi, Surankote) and Kishtwar districts of Jammu province. As there was scanty information, 81 surface (0-0.20 m) soil samples were collected from farmer's fields of twenty seven mothbean cultivating villages from Poonch district. These samples were analyzed for different soil properties and available nutrients i.e. pH, electric conductivity (EC), organic carbon (OC), cation exchange capacity, soil texture and available nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) and simple correlation were undertaken. The soils of Poonch district were low to medium in available nitrogen, medium in phosphorus, medium to high in available potassium, slightly sufficient to low in sulphur content. There was a negative and non-significant relationship of soil pH with available nitrogen, phosphorus, potassium and sulphur, whereas a positive and negative relationship of soil EC with available nitrogen, phosphorus, potassium and sulphur was observed. Organic carbon indicated a positive and highly significant relationship with available nitrogen, phosphorus and sulphur but not with potassium. Nitrogen, phosphorus and potassium had positive and non-significant relationship with CEC respectively but negative and non-significant with available sulphur. The present investigation provides initial information regarding the fertility status of mothbean growing soils of district Poonch. The information may be useful for framers in developing best fertility management practices for Mothbean cultivation.

Key words: Correlation, Mothbean, Nitrogen, Phosphorus, Potassium, Soil properties, Sulphur

The macronutrients govern the fertility of the soils as well as control the yields of the crops. Soil fertility evaluation of an area or region is an important aspect in context of sustainable agricultural production, particularly moisture stress, low and erratic rainfall. The productivity of pulse crops depends on many factors such as climate, site, varieties, fertilization, irrigation, soil management practices, pests and diseases management. Among the factors, adequate supply of nutrients seems to be very crucial role in regulating cropping and quality of the pulse crops. Plant nutrition plays an important role in improving the quantity and quality of pulse crops and, thus, is essential for successful pulse growing. The pulse crops require macro elements such as nitrogen, phosphorus potassium and sulphur required in larger amounts.

In Jammu and Kashmir, presently 30,252 hectares area is under pulse cultivation with production of 17194.5 tonnes and productivity of 5.68qha^{-1}. Mothbean (*Vigna aconitifolia* (Jacq.) Marechel.) is mostly confined to Gujarat, Rajasthan, Haryana, Maharashtra and Jammu & Kashmir states of India. Mothbean, a specialty pulse cherished by the people, is cultivated mostly in Poonch (Loran, Mandi, Surankote) and Kishtwar districts of Jammu province. Poonch district has an area of 56 ha under Mothbean with a production of 29.50 tonnes only (Anonymous, 2012).

It has been observed that the farmers are adopting the same dosages of NPK for a particular crop under varying soil properties and conditions although the soil type varies greatly within a small area. Unlike in plains, the variations are up to such extent that many types of soils can be seen within a village in respect of its properties which are responsible for higher crop yield. The soil properties are essential in view of suggesting a package of agricultural practices and judicial use of inputs for increased crop production in the district.

The review of literature reveals that no study has been conducted on Mothbean growing soils of the state. Keeping the above facts in view, the present investigation was therefore undertaken to assess the status of soil properties, available macro-nutrients and the factors affecting their availability in Mothbean growing soils of Poonch district of Jammu and Kashmir state for sustainable agriculture production and soil fertility management.

MATERIALS AND METHODS

The study covers sampling of twenty seven villages *i.e*. Buflaiz, Dhraba, Surankote, Duntar, Shindra, Dalera, Kankote, Dingla, Chandak, Timbra, Sathra, Saiklu, Raj Pura, Palera, Lohil Bella, Barathrad, Loran, Band Gaidi, Tann, Biyada, Batalkote, Danna, Jabdi, Potha, Jhara Wali Ghali, Bata Dorian and Bhimber Galli of Poonch district of Jammu and Kashmir where the land has been put under Mothbean cultivation. Surface soil samples (0-0.20 m) were randomly collected from these villages. These samples were completely air dried, ground with wooden mortar and pestle and passed through 2 mm stainless steel sieve for determining different soil properties and major nutrients. Soil pH was measured in 1:2.5 soil: water ratio (w/v) with

the help of glass electrode pH meter (Jackson, 1973). Electrical conductivity was estimated in 1: 2.5 soil: water suspension with EC meter (Jackson, 1973). Organic carbon was analyzed with the help of rapid titration method as proposed by Walkley & Black (1934). Nitrogen was determined by using alkaline permanganate as per the modified Kjeldahl method proposed by Subbiah and Asija (1956). The available phosphorus was determined by the method mentioned by Olsen *et al*. (1956). 1N NH_4OAc was used as extractant and the available potassium content was determined by feeding the extract to flame photometer (Jackson, 1973). Sulphur was extracted with 0.15 per cent $CaCl_2$ (Williams and Steinberg's, 1959) and the soluble sulphur was estimated turbidimetrically using blue filter on spectrophotometer at 440 nm (Chesnin and Yien (1951).

RESULTS AND DISCUSSION

Soil properties: The properties of the soils of different mothbean growing sites of Poonch are depicted in Table1. The data reveals that the lowest pH (4.78) was recorded at Palera and the highest value was recorded at Tann (6.87). The pH values suggested that these are slightly acidic to normal in nature. This may be attributed to the nature of parent materials which form these soils and further under temperate type of climate the mineralization process is slow due to which there is organic matter accumulation which decomposes slowly and helps in lowering the pH due to acid equivalent which may have direct effect on increased soil acidity (Pathak *et al*. 2005). The electrical conductivity of the mothbean growing soils of Poonch district varied from 0.11 dS m^{-1} at Biyada and Tann which recorded lowest values, and 0.33 dSm^{-1} at Shindra having highest value. The soluble salt content in the soil were in the safe limit for growing any crop. Because of hilly terrain, the rain water removes the soluble salt from the surface soil. Besides due to organic matter build up in the soils, microbial population in rhizospheric zone enhanced microbial decomposition of organic matter which in turn affect soluble salt (Babu *et al*. 2007). These results are in conformity with the findings of Aziz *et al*. 2012. The soils under study had a textural class which ranged between clay loam to loam.

Organic carbon status of soils under study revealed that its content lie in a range of medium to high and the values varied from 5.2 - 8.4g kg^{-1} at Loran and Dingla, respectively. The organic carbon content in soil may also be the attribution of atmospheric nitrogen enhanced by the bacterial population responsible for nitrogen fixation leading to better root biomass and mineralization of nitrogen

Table 1. Village wise soil properties of mthbean growing soils of Poonch district

Village	pH (1:2.5)		Electrical conductivity(dS m^{-1})		Organic carbon (g kg^{-1})		CEC (cmol (p+) kg^{-1})		Textural class	GPS Location
	Range	Mean	Range	Mean	Range	Mean	Range	Mean		
Bufliaz	5.36 - 5.66	5.51	0.19 - 0.24	0.21	5.9 - 6.6	6.2	12.51- 12.64	12.58	clay loam	N 33° 36'667" E 074° 21'059"
Dhraba	5.07 - 5.88	5.48	0.13 - 0.22	0.17	5.1 -5.9	5.4	11.16 - 12.51	11.84	clay loam	N 33° 36'620" E 074° 19'614"
Surankote	5.14 - 5.45	5.30	0.12 - 0.19	0.15	5.9 - 6.9	6.3	11.23 - 13.54	12.39	clay loam	N 33° 38'079" E 074° 16'225"
Duntar	4.66 - 5.83	5.25	0.17 - 0.18	0.17	6.0 - 6.6	6.2	12.58 - 13.51	13.05	clay loam	N 33° 41'506" E 074° 14'530"
Shindra	5.64 - 6.21	5.93	0.27 - 0.40	0.33	5.9 - 8.0	6.9	11.35 - 12.14	11.75	Loam	N 33° 44'313" E 074° 11'885"
Dalera	5.03 - 6.65	5.84	0.18 - 0.33	0.25	6.0 - 7.3	6.6	12.56 - 13.61	13.09	Loam	N 33° 45'406" E 074° 08'118"
Kankote	6. 25 - 6.72	6.49	0.27 - 0.32	0.29	7.3- 8.0	7.6	11.91 - 13.15	12.53	Loam	N 33° 46'115" E 074° 08'151"
Dingla	6.11 - 6.35	6.23	0.23 - 0.29	0.25	8.0 - 8.8	8.4	11.94 - 12.68	12.31	Loam	N 33° 45'487" E 074° 09'721"
Chandak	4.53 - 5.64	5.09	0.11 - 0.21	0.15	5.1 - 8.0	6.5	12.65 - 13.68	13.17	clay loam	N 33° 44'951" E 074° 11'066"
Timbra	5.45 - 6.46	5.96	0.23 - 0.39	0.31	6.1 - 6.6	6.3	12.15 - 13.41	12.78	Loam	N 33° 45'657" E 074° 12'298"
Sathra	5.21 - 6.15	5.68	0.15 - 0.45	0.29	5.9 - 6.3	6.0	13.67 - 14.61	14.14	Loam	N 33° 46'222" E 074° 13'104"
Saiklu	5.24 - 5.26	5.25	0.17 - 0.21	0.19	5.4 - 6.0	5.7	11.54 - 13.51	12.53	clay loam	N 35° 47'336" E 074° 14'656"
Raj Pura	5.15 - 5.63	5.39	0.16 - 0.23	0.19	5.1 - 6.1	5.6	11.38 - 13.16	12.27	clay loam	N 33° 48'289" E 074° 16'792"
Palera	4.51 - 5.04	4.78	0.12 - 0.13	0.12	5.1 - 6.6	5.8	12.39 - 12.51	12.45	clay loam	N 33° 48'564" E 074° 17'997"
Lohil Bella	6.10 - 6.45	6.28	0.21 - 0.29	0.24	5.7 - 6.0	5.8	12.64 - 13.41	13.03	Loam	N 33°48'902" E 074° 18'516"
Barathrad	6.35 - 6.55	6.45	0.20 - 0.32	0.26	5.1 - 5.9	5.4	11.36 - 12.67	12.02	Loam	N 33° 49'248" E 074° 18'593"
Loran	6.75 - 6.78	6.77	0.12 - 0.45	0.28	4.5 - 5.9	5.2	11.54 - 13.94	12.74	Sandy	N 33° 49'738" E 074° 19'194"
Band Gaidi	6.79 - 6.85	6.82	0.11 - 0.13	0.12	5.6 - 7.8	6.7	12.51 - 13.98	13.25	Sandy	N 33° 50'151" E 074° 19'832"
Tann	6.85 - 6.88	6.87	0.10 - 0.13	0.11	4.9 - 5.7	5.3	13.41 - 14.35	13.88	Loam	N 33° 50'127" E 074° 20'096"
Biyada	5.45 - 6.93	6.19	0.09 - 0.13	0.11	4.9 - 6.5	5.7	13.89 - 14.51	14.20	Loam	N 33° 50'070" E 074° 20'544"
Batalkote	4.51 - 6.5	5.51	0.11 - 0.16	0.13	6.4 - 7.4	6.9	13.57 - 14.51	14.04	clay loam	N 33° 49'784" E 074° 20'840"
Danna	6.45 - 6.48	6.47	0.21 - 0.35	0.28	6.4 - 6.8	6.6	13.57 - 14.26	13.92	Loam	N 33° 50'383" E 074° 20'172"
Jabdi	4.51 - 6.12	5.32	0.22 - 0.25	0.23	4.5 - 6.8	5.6	13.78 - 14.51	14.15	clay loam	N 33° 50'254" E 074° 20'350"
Potha	5.24 - 5.64	5.44	0.26 - 0.32	0.29	5.6 - 6.4	6.0	12.91 - 13.62	13.27	clay loam	N 33° 39'252" E 074° 14'743"
Jhera Gali	5.84 -6.54	6.19	0.14 - 0.21	0.17	6.7 - 8.5	7.6	13.51 - 14.35	13.93	Loam	N 33° 36'991" E 074° 15'730"
Bata Dorian	5.32 - 6.15	5.74	0.13 - 0.31	0.22	7.9 -8.1	8.0	13.59 - 14.48	14.04	Loam	N 33° 34'846" E 074° 16'425"
Bhimber Galli	5.18 - 6.12	5.65	0.12 - 0.24	0.18	6.7 -7.5	7.1	13.68 - 14.51	14.10	Loam	N 33° 33'360" E 074° 13'963"
Overall range and mean	**4.78-6.87**	**5.84**	**0.11-0.33**	**0.21**	**5.2-8.4**	**6.4**	**11.16-14.51**	**13.09**	**Clay loam-loam**	

along with inorganic fertilizer application. These results are in conformity with the results of Balyan *et al.* 2006. Cation exchange capacity is important for ion exchange. Cation exchange capacity (CEC) ranged between 11.75 to 14.20 cmol (p+) kg^{-1} having mean value of 13.08 cmol (p+) kg^{-1}. Based on the mean values, the highest CEC value was found in Biyada soils while the lowest was found in Shindra soils and these values are in agreement with the observations made by Gupta and Khanna (1994).

MACRONUTRIENT STATUS

Available Nitrogen: The available macronutrient contents of different Mothbean growing the soils of various villages of Poonch district are depicted in Table 2. The available nitrogen content in the soils under study varied from 243.98 kg ha^{-1} (Tann) to 395.27 kg ha^{-1} (Dingla) with a mean value of 311.61 kg ha^{-1}. Based on the mean values, the soils were categorised in low to medium range. The variation in nitrogen availability may be due to fixation of atmospheric nitrogen in soil on account of higher bacterial population, leading to better nodulation and mineralization of organic nitrogen. Similar results were also reported by Shiva Kumar and Ahlawat (2008).

Available phosphorus: The available phosphorus content in the soils ranged from 8.19 to 15.46 kg ha^{-1} at Loran and Dingla, respectively with an overall mean value of 12.59 kg ha^{-1}. Overall, the soils were in low to medium range with respect to available phosphorus. This might be because high altitude soils developed under cold and temperate climate and the low altitude soils developed under warm and subtropical climate differ in available phosphorus contents (Lyngdoh and Shukla, 1993). Sharma and Bhandari (1995) also confirmed that surface soils contain varied phosphorus contents which may be due to high organic matter content in temperate soils.

Available potassium: The available potassium content in the soils ranged from 127.00 to 318.16 kg ha^{-1} with lowest value at Band Gaidi and highest value at Lohil Bella, respectively with an overall average value of 234.63 kg ha^{-1}. This may be attributed to the potassium being positively charged ion which tends to attach itself to colloidal complex and is restricted in movement. Hence amount and type of clay and amount of organic matter present in soil invariably influence its movement and as such is retained in soil. These results are in conformity with the findings of Shivakumar and Ahlawat (2008).

Available sulphur: The available sulphur content of the mothbean growing soils of Poonch district ranged from 6.99 to 13.75 mg kg^{-1} with the mean value of 10.62 mg kg^{-1}. The available sulphur was found in a narrow range of

Table 2. Village wise range and mean of available macronutrients in mothbean growing soils of Poonch district

	Available nitrogen (kg ha^{-1})		Available phosphorus (kg ha^{-1})		Available potassium (kg ha^{-1})		Available sulphur (mg kg^{-1})	
Village	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**
Bufliaz	275.34 - 387.61	331.48	11.34 - 14.41	12.88	280.20 -315.40	297.81	6.53 - 9.79	8.15
Dhraba	188.79 - 341.82	265.31	10.58 - 11.24	10.91	198.70 - 248.00	223.33	6.53 - 7.46	6.99
Surankote	305.45 - 327.40	316.42	10.01 - 14.57	12.29	214.20 - 264.20	239.16	9.79 - 10.26	10.02
Duntar	193.80 - 335.55	264.68	12.14 - 12.54	12.34	241.20 - 248.0	244.60	5.13 - 8.86	7.01
Shindra	304.19 - 398.90	351.55	13.66 - 14.57	14.11	198.60 - 214.00	206.32	9.79 – 14.45	12.11
Dalera	235.83 - 275.97	255.90	13.66 - 14.57	14.11	189.50 - 297.8	243.64	8.86 – 15.85	12.35
Kankote	323.01 - 466.64	394.82	11.45 - 18.70	15.08	214.50 – 268.50	241.51	10.08 – 13.52	11.79
Dingla	323.01 - 467.54	395.27	14.51 - 16.41	15.46	198.20 – 315.40	256.81	6.99 – 9.79	8.39
Chandak	324.89 - 339.94	332.42	12.74 - 14.57	13.66	214.10 – 219.40	216.75	8.86 -14.45	11.65
Timbra	296.67 - 366.91	331.79	11.83 - 13.66	12.74	217.50 – 230.20	223.83	6.99 - 11.19	9.08
Sathra	320.50 - 326.14	323.32	11.83 - 12.74	12.29	196.50 – 301.20	248.86	7.46 - 11.19	9.32
Saiklu	264.05 - 282.24	273.15	10.92 - 11.83	11.38	214.10 – 288.00	251.05	11.65 - 15.85	13.75
Raj Pura	271.50 - 284.12	277.81	9.10 - 12.74	10.92	241.21 - 260.96	251.09	8.86 – 15.85	12.35
Palera	264.05 - 345.61	304.83	10.92 - 11.83	11.38	198.42 - 228.48	213.45	11.19 - 14.45	12.81
Lohil Bella	253.39 - 333.67	293.53	9.10 - 14.57	11.83	311.36 – 324.96	318.16	12.12 – 13.05	12.58
Barathrad	264.80 - 280.61	272.71	9.10 - 11.45	10.28	189.51 - 230.61	210.06	11.19 - 13.70	12.44
Loran	250.25 - 264.68	257.47	7.28 - 9.10	8.19	187.00 - 217.28	202.14	8.86 -12.51	10.68
Band Gaidi	289.45 - 341.12	315.29	10.58 - 17.45	14.02	127.00 - 211.54	127.00	9.54 - 16.54	13.04
Tann	217.64 - 270.32	243.98	9.10 - 10.92	10.01	193.54 -264.51	229.03	8.54 - 13.64	11.09
Biyada	248.51 - 347.24	297.88	11.83 - 12.74	12.29	214.51 - 258.51	236.51	8.64 - 14.31	11.47
Batalkote	297.92 - 336.18	317.05	12.35 - 14.57	13.46	184.51 - 196.51	190.51	9.47 - 10.21	9.84
Danna	296.67 - 366.91	331.79	11.25 - 15.45	13.35	298.41 - 314.25	306.33	7.81 - 9.41	8.61
Jabdi	297.92 - 336.18	317.05	10.24 - 10.25	10.25	185.00 - 214.51	199.76	10.45 - 12.51	11.48
Potha	327.40 - 339.94	333.67	10.01 - 12.74	11.38	198.41 - 275.41	236.91	7.54 - 9.48	8.51
Jhera Gali	289.54 - 394.54	342.04	14.57 - 15.48	15.02	214.51 - 280.20	247.36	8.52 - 12.51	10.51
Bata Dorian	268.51 - 345.23	306.87	12.01 - 18.54	15.28	198.40 - 301.20	249.78	9.75 - 11.24	10.49
Bhimber Galli	346.50 - 384.50	365.50	11.24 - 18.70	14.97	214.50 - 248.00	231.26	9.54 - 10.45	9.99
Over all range and mean	**243.98-395.27**	**311.61**	**8.19-15.46**	**12.59**	**127.00-318.16**	**234.63**	**6.99-13.75**	**10.62**

Table 3. Correlation coefficients (r) between soil properties and macro nutrients

Soil properties	Macronutrients			
	N	P	K	S
pH	-0.049	-0.278**	-0.110	-0.246
EC	0.267	-0.076	0.015	-0.069
OC	0.451**	0.095	0.135	0.259*
CEC	0.123	0.028	0.031	-0.157

*Significant at the 5% level.
**Significant at the 1% level.

medium to low. The highest content of available sulphur i.e. 13.75 mg kg^{-1} was recorded at Saiklu and the lowest of 6.99 mg kg^{-1} was recorded at Dhraba. Organic matter plays an important role not only as a source of nutrients but also effect the availability of the nutrients through production of chelating agents forming soluble complexes (Kumar *et al*. 2009). Gupta *et al*. (2005) also reported that sulphur availability is attributed to cation exchange capacity having significant correlation with organic carbon and clay content of soil.

Correlation studies: Correlation studies of soil properties with available nutrients in different mothbean growing sites of Poonch are depicted in Table 3. There was a negative and non-significant relationship of soil pH with available nitrogen (r = -0.049), phosphorus (r = -0.278**) potassium (r = -0.110) and sulphur (r = -0.246), whereas a positive and negative relationship of soil EC with available nitrogen (r = 0.267), phosphorus (r= - 0.076) potassium (r = 0.015) and sulphur (r = -0.069) was observed. Organic carbon indicated a positive and highly significant relationship with available nitrogen (r = 0.451**) phosphorus (r= 0.095) and sulphur (r = 0.259*), however it did not exist with potassium having the correlation value (r = 0.135). Available nitrogen, phosphorus and potassium had positive and non-significant relationship with CEC (r = 0.004, r = 0.028 r = 0.031, respectively) but negative and non-significant with available sulphur (r = -0.157). The available nitrogen had a positive and highly significant relationship with soil organic carbon (r = 0.451**) indicating that an increase in organic matter in the soil, the amount of available nitrogen also increased. A negative correlation was obtained between pH (r = -0.049) and nitrogen which might be due to higher NH_4^+ fixation and slow N mineralization because of stable fractions of organic matter in small pores (Walia *et al.* 1998). Similar relation was also reported by Sharma *et al.* (2009). The available potassium revealed a positive correlation with the electrical conductivity and organic carbon [(EC (r = 0.015) and OC (r = 0.135)] which might be due to the reason that potassium being positively charged ion tends to attach itself to colloidal complex which restrict its movement. Hence amount and type of clay and amount of organic matter present in soil invariably influence its movement and as such is reported to be retained in soil for longer periods (Shivakumar and Ahlawat, 2008). A positive correlation data is presented as for available sulphur, it bears positive and significant relationship with the electrical conductivity and organic carbon [EC (r = 0.069) and OC (r = 0.259*)]. Also organic matter plays an important role not only as a source of nutrients but also effect the availability of nutrients through production of chelating agents forming soluble complexes (Kumar *et al*. 2009). Gupta *et al*. (2005) also reported that sulphur availability was attributed to cation exchange capacity and further a significant correlation with organic carbon and clay content of soil was recorded.

CONCLUSION

It might be concluded from this study that the soil samples of the mothbean growing areas of Poonch were low to medium in available nitrogen, medium in phosphorus, medium to high in available potassium, slightly sufficient to low in sulphur content. The present investigation gives first-hand information regarding the fertility status of mothbean growing soils in district Poonch, which will give insight for a better fertilizer scheduling in general and phosphorus fertilizers in particular to get the better productivity of mothbean as well as sustainable soil health.

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