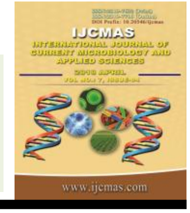
Int.J.Curr.Microbiol.App.Sci (2018) *7*(4): 3284-3295

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 04 (2018)**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2018.704.372

Influence of Crop Residue and Potassium Management on Yield, Quality, Nutrient Uptake and Nutrient Use Efficiency by Mungbean in Maize (*Zea mays* L.) -Wheat (*Triticum aestivum* L.) - Mungbean Cropping System

H.N. Meena[1], K.S. Rana[1], Ashok Kumar[2], Livleen Shukla[3], Meena Shekhar[4*], Arvind Kumar[4], Adarsh Kumar[1] and Santosh K. Meena[5]

[1]*Division of Agronomy, New Delhi, India*
[2]*P.S., NASF, ICAR, New Delhi, India*
[3]*P.S., Division of Microbiology, Meena Shekhar, P.S. ICAR-IIMR, India*
[4]*YP-II, ICAR-IIMR, India*
[5]*Department of Agronomy, BHU, Varanasi, India*

**Corresponding author*

Keywords

Consortiums, Potassium management, Agronomic K use efficiency, Physiological use efficiency, Apparent recovery, Utilization efficiency

Article Info

Accepted:
26 March 2018
Available Online:
10 April 2018

A B S T R A C T

A field experiment was conducted during 2014-15 and 2015-16 on Research Farm of Division of Agronomy, IARI at New Delhi to evaluate Influence of crop residue and potassium management on yield, quality, nutrient uptake and K use efficiencies of mungbean in maize-wheat- mungbean cropping system. The experiment consisted of 15 treatment combinations with three crop residues [no crop residue, crop residue incorporation and fungal consortium incorporation] and five potassium management practices [control, KSB, 100 % RDK, 50% RDK+ KSB and 75% RDK+ KSB]. Results revealed that considerably highest grain yields, protein content, protein yield and N P K concentration both in seed and stalk and its uptake by mungbean were noticed with treatment receiving crop residue incorporation + fungal consortium which was statistically at par with crop residue incorporation. Similar trends were also recorded for K use efficiency, physiological use efficiency, apparent recovery and utilization efficiency during both years of study. Among Potassium management, significantly highest grain yield, protein content, protein yield, N P K concentration, uptake in both seed and stalk and its total uptake were noticed with treatment receiving 75% RDK + KSB which were statistically at par with 50% RDK+ KSB. However, maximum K use efficiency, physiological use efficiency, apparent recovery, utilization efficiency were noticed with treatment receiving 50% RDK+ KSB which were statistically at par with 75% RDK+ KSB as compared to the first year, maximum attributes and efficiencies were observed in the second year of investigation.

Introduction

Maize (*Zea mays* L.) is an important staple food grain crop of the world next to wheat and rice. Grower's interest towards maize has been increasing due to its high production potential and variety of industrial uses, growing weird weather patterns and inadequate supply of water for rice cultivation. Increasing costs of nitrogenous fertilizers and growing consciousness towards safer environment have led to assess legume crops as an alternate source for N supply in crop sequences, as they fix up atmospheric N_2 and enhance the performance of succeeding crops. Ghosh *et al.,* (2007) and Sharma *et al.,* (2009) suggested that incorporation of grain legumes were beneficial for improving productivity, profitability, N economy and soil fertility in cereal-based cropping systems due to the mechanism of atmospheric N_2 fixation. Retention of legume residues on soil surface improves the N economy of the cropping system and enhances the crop productivity through many other potential benefits such as lower pest and disease incidence (Kirkegaard *et al.,* 2008). Incorporation of plant residues is a useful means of sustaining organic matter content and thereby enhances the biological activity improve physical properties and nutrient availability (Palm *et al.,* 2001). Potassium (K) is an essential plant macronutrient and plays a key role in the synthesis of cells, enzymes, protein, starch, cellulose, and vitamins, in nutrient transport and uptake, in conferring resistance to abiotic and biotic stresses, and in enhancing crop quality (Epstein and Bloom, 2005).

Materials and Methods

The field experiment was conducted during 2014-15 and 2015-16 at research farm of the Division of Agronomy, Indian Agricultural Research Institute, New Delhi (28.40° N latitude, 77.12° E longitude and 228.6 MSL). The climate of Delhi is sub–tropical and semi-arid type with hot and dry summer, cold winter and mild to heavy rainfall. It falls under the agro-climate zone 'Trans Gangetic plains'. The mean annual rainfall of Delhi is 652 mm and more than 80% of that generally occurs during the monsoon season (July–September) with the mean annual evaporation of 850 mm. Weather conditions are attributed to have an impact on the performance of crops. Consequently, it becomes utmost important to take into consideration the conclusion from the experimental results. The minimum and maximum temperature ranged between 24.2° and 40.0°C and 23.1° and 39.6°C**,** with the rainfall of 390.8 and 633.10 mm during the growth period of mungbean in 2014-15 and 2015-16, respectively. The total rainfall received during this period was 49.20 and 40.0 mm, in the first and second year, respectively. The soil of experimental site was sandy loam with a bulk density of 1.48 and 1.46 Mg/m^3, organic carbon 0.46 and 0.52%, available N 158.4 and 164.2 kg/ha, available P 14.45 and 16.2 kg/ha and available K 257.8 and 268.5 kg/ha in the first and second year, respectively. The pH was 8.14 and 7.9 with EC of 0.28 and 0.26 dS/m during 2014-15 and 2015-16 year, respectively. The experiment consisted of 15 treatment combinations with three crop residue [no crop residue, Crop residue incorporation and Crop residue incorporation + fungal consortium] and five potassium management practices [control, KSB, 100 % RDK, 50% RDK+ KSB and 75% RDK+ KSB] was carried out in split plot design and replicated thrice. The required quantity of crop residue was incorporated in soil ten days before sowing of the crop the grain yield of crop recorded after sun drying the grains. Seed and stalk samples were digested in a di-acid mixture of HNO_3: $HClO_4$ (10:4) and phosphorus and potassium content determined by absorption spectrophotometer and flame photometer, respectively (Jackson, 1973). Nitrogen content estimated by modified

Kjeldahl method and protein content was calculated by multiplying by a factor of 6.25. Different nutrient use efficiency was calculated using following formulae as suggested by Baligar *et al.*, (2001) and Fageria *et al.*, (2001 and 2008).

Agronomic efficiency (AE) (kg kg^{-1}) = (Gf – Gu/Na)

Physiological efficiency (PE) (kg kg^{-1}) = (BYf – BYu/Nf – Nu)

Apparent recovery efficiency (ARE) (%) = (Nf − Nu/Na) X 100

Utilization efficiency (EU) (kg kg^{-1}) = PE X ARE,

Where Gf - the grain yield of the fertilized plot (kg),

Gu - the grain yield of the unfertilized plot (kg),

Na - the quantity of nutrient applied (kg).

BYf - the biological yield (grain plus straw) of the fertilized pot (kg),

BYu - the biological yield of the unfertilized plot (kg),

Nf - the nutrient uptake (grain plus straw) of the fertilized plot,

Nu - the nutrient uptake (grain plus straw) of the unfertilized plot (kg).

Results and Discussion

Yield and quality

Yield

The application of residue management practices and potassium management practices showed significant improvement in yields over control in mungbean during both the years of experimentation (Table 1). The treatment with crop residue incorporation + fungal consortium was significantly superior with respect to grain yield (1.29 and 0.78 t/ha) in mungbean compared to no crop residue and crop residue incorporation during first years. Maximum grain yield was noted with crop residue incorporation + fungal consortium but statistically at par with crop residue incorporation and significantly superior over no crop residue during the second year of investigation. Similar findings were reported by Meena *et al.*, (2015). Application of 75% RDK + KSB showed significant superiority in seed yield of mungbean (1.22 and 0.80 t/ha) over all other treatment during both year of study but at par 50% RDK + KSB. However, application of 50% RDK + KSB and 100% RDK was at par with each other and found significant over rest of the treatments during both years. These findings are also conformity with Basavesha *et al.*, (2016).

Quality

Protein content and protein yield

Data in table 1 showed that application of crop residue slightly influences the protein content and protein yield during both the year of the experiment. However, the maximum value of protein content was observed with crop residue incorporation + fungal consortium (22.57 and 20.53%). The maximum protein yield of mungbean was recorded with crop residue incorporation + fungal consortium (292.2 and 159.1 kg ha^{-1}) during both the years. However, crop residue incorporation + fungal consortium and crop residue incorporation were at par with each other but except, protein yield in the first year and significant over no crop residue. The results are also conformity with findings of Meena *et al.*, (2015). Application of K management did not influence the protein content during both the year of the experiment, the highest protein yield (275.9 and 164.4 kg ha^{-1}) was recorded with 75% RDK + KSB during both the years. However, it was at par with 50% RDK + KSB significantly higher than rest of treatments. Protein yield with 100% RDK and KSB was also significantly higher than control during both the years. The results are also conformity with findings of Jabbar *et al.*, (2009).

Nutrient concentration and uptake

N concentration and uptake

The data presented in table 2 showed that the maximum N-concentration recorded with crop residue incorporation + fungal consortium application in seed (3.61 and 3.29%) and stalk (1.50 and 1.25%) during both the years of experimentation. However, crop residue incorporation treatment was at par with crop residue incorporation + fungal consortium during both the years of study. The uptake of N in seed, stalk and total uptake was highest with the crop residue incorporation + fungal consortium (46.75 and 25.46 kg ha^{-1}), (29.53 and 18.46 kg ha^{-1}) and (76.28 and 43.93 kg ha^{-1}), during both the years.

However, crop residue incorporation + fungal consortium were found at par with crop residue incorporation treatment but except, seed and total uptake in the first year and significantly higher than no crop residue treatment during both the year of experimentation. Thus, reduced crop-weed competition for nutrients increased the biomass accumulation which ultimately increased the grain yield of crops and nutrient uptake in grain and biomass. Similar results were also reported by Behera *et al.*, (2007).

Among the K-management, highest N concentration in seed (3.61and 3.28%) and stalk (1.45 and 1.21%) was recorded with 75% RDK + KSB during both years of study. This treatment was observed at par with 50% RDK + KSB and 100% RDK significantly higher from rest of combination. Maximum N-uptake was recorded with 75% RDK + KSB in seed, stalk uptake and total uptake (44.15 and 26.30 kg ha^{-1}) (29.31 and 18.67 kg ha^{-1}) and (73.46 and 44.98 kg ha^{-1}) during both the years. However, it was at par with 50% RDK + KSB significantly higher than rest of treatments. N-uptake in seed, stalk and their total at 100% RDK and KSB were significantly higher than control during both the years. Bacterial inoculation of potassium solubilising bacteria (KSB) could improve phosphorus availability in the soils by producing an organic acid and other chemicals by stimulating growth and mineral uptake of plants (Park *et al.*, 2003).

P concentration and uptake

The data pertaining to P concentration in seed and stalk of mungbean are presented in table 3. The maximum P concentration recorded with crop residue incorporation + fungal consortium application in seed (0.378 and 0.302%) and stalk (0.150 and 0.120%) during both the years of experimentation.

The uptake of P in seed, stalk and total uptake was highest with the crop residue incorporation + fungal consortium (4.89 and 2.35 kg ha^{-1}), (2.95 and 1.77 kg ha^{-1}) and (7.82 and 4.12 kg ha^{-1}), during both the years. However, it was found at par with crop residue incorporation treatment but significantly higher than no crop residue treatment during both years of experimentation.

It might be due to attributed to an increased rate of mineralization of the crop residue with the addition of fungal consortium in this soil, resulting in nutrient transformations and their mobility into the plant system for a longer period. Similar results have been reported by Bakht *et al.*, (2009).

Table.1 Effect of crop residue and potassium management on yield and quality of mungbean

Treatment	Seed yield (t/ha^{-1})		Stalk yield (t/ha^{-1})		Protein content (%)		Protein yield (Kg/ha)	
	2015	2016	2015	2016	2015	2016	2015	2016
Residue management								
No crop residue	1.01	0.66	1.75	1.34	21.84	19.90	219.7	131.4
Crop residue incorporation	1.16	0.74	1.88	1.43	22.43	20.39	259.4	150.8
Crop residue incorporation + fungal consortium	1.29	0.78	1.96	1.47	22.57	20.53	292.2	159.1
SEm±	0.02	0.03	0.04	0.03	0.14	0.13	5.9	6.0
CD (P = 0.05)	0.08	0.12	0.14	0.10	0.56	0.51	23.2	23.7
Potassium management								
Control	1.08	0.63	1.68	1.23	22.02	20.08	238.0	127.3
KSB	1.12	0.68	1.81	1.37	22.19	20.17	249.0	136.8
100 % RDK (60 kg/ha)	1.16	0.73	1.84	1.54	22.23	20.24	257.6	147.4
50 % RDK + KSB	1.18	0.78	1.94	1.42	22.40	20.36	264.9	159.7
75 % RDK + KSB	1.22	0.80	2.01	1.51	22.56	20.51	275.9	164.4
SEm±	0.02	0.02	0.03	0.02	0.12	0.12	5.3	4.1
CD (P = 0.05)	0.07	0.06	0.09	0.06	NS	NS	15.4	12.0

Table.2 Effect of crop residue and potassium management on nitrogen concentration and uptake of mungbean

Treatment	N conc. in seed (%)		N conc. in stalk (%)		N uptake in seed (kg ha^{-1})		N uptake in stalk (kg ha^{-1})		Total uptake (kg ha^{-1})	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Residue management										
No-crop residue	3.49	3.18	1.27	1.06	35.15	21.03	22.28	14.23	57.43	35.26
Crop residue incorporation	3.59	3.26	1.46	1.22	41.50	24.13	27.44	17.38	68.93	41.51
Crop residue incorporation + fungal consortium	3.61	3.29	1.50	1.25	46.75	25.46	29.53	18.46	76.28	43.93
SEm±	0.02	0.02	0.03	0.03	0.95	0.97	1.02	0.64	1.82	1.18
CD (P = 0.05)	0.09	0.08	0.12	0.10	3.71	3.80	4.01	2.51	7.15	4.61
Potassium management										
Control	3.52	3.21	1.38	1.15	38.08	20.37	23.13	14.11	61.21	34.48
KSB	3.55	3.23	1.39	1.16	39.84	21.89	25.25	15.86	65.08	37.75
100 % RDK (60 kg/ha)	3.56	3.24	1.41	1.18	41.22	23.58	26.43	16.99	67.64	40.58
50 % RDK + KSB	3.58	3.26	1.43	1.19	42.38	25.55	27.96	17.81	70.34	43.37
75 % RDK + KSB	3.61	3.28	1.45	1.21	44.15	26.30	29.31	18.67	73.46	44.98
SEm±	0.02	0.02	0.03	0.02	0.85	0.66	0.74	0.46	1.09	0.78
CD (P = 0.05)	0.06	0.06	0.08	0.07	2.47	1.91	2.16	1.36	3.17	2.26

Table.3 Effect of crop residue and potassium management on phosphorus concentration and uptake of mungbean

Treatment	P conc. in seed (%)		P conc. in stalk (%)		P uptake in seed (kg ha^{-1})		P uptake in stalk (kg ha^{-1})		Total uptake (kg ha^{-1})	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Residue management										
No crop residue	0.370	0.294	0.139	0.111	3.71	1.94	2.44	1.50	6.16	3.44
Crop residue incorporation	0.376	0.301	0.147	0.117	4.35	2.23	2.76	1.68	7.11	3.91
Crop residue incorporation + fungal consortium	0.378	0.302	0.150	0.120	4.89	2.35	2.95	1.77	7.82	4.12
SEm±	0.006	0.005	0.002	0.002	0.08	0.12	0.09	0.05	0.18	0.12
CD (P = 0.05)	NS	NS	NS	NS	0.33	0.46	0.35	0.21	0.69	0.46
Potassium management										
Control	0.368	0.292	0.140	0.112	3.97	1.85	2.36	1.38	6.30	3.23
KSB	0.372	0.297	0.142	0.113	4.15	2.02	2.57	1.55	6.73	3.57
100 % RDK (60 kg/ha)	0.375	0.300	0.146	0.117	4.35	2.19	2.68	1.66	7.02	3.84
50 % RDK + KSB	0.378	0.302	0.148	0.119	4.47	2.37	2.93	1.80	7.40	4.17
75 % RDK + KSB	0.380	0.304	0.151	0.120	4.66	2.45	3.04	1.86	7.72	4.31
SEm±	0.003	0.002	0.002	0.002	0.09	0.07	0.06	0.04	0.11	0.08
CD (P = 0.05)	NS	NS	NS	NS	0.27	0.20	0.19	0.11	0.33	0.25

Table.4 Effect of crop residue and potassium management on potassium concentration and uptake of mumgbean

Treatment	K conc. in seed (%)		K conc. in stalk (%)		K uptake in seed (kg ha^{-1})		K uptake in stalk (kg ha^{-1})		Total uptake (kg ha^{-1})	
	2015	2016	2015	2016	2015	2015	2016	2015	2016	2015
Residue management										
No crop residue	1.48	1.02	2.15	1.53	14.92	6.78	37.81	20.61	52.73	27.39
Crop residue incorporation	1.56	1.11	2.29	1.64	18.08	8.26	43.19	23.49	61.28	31.75
Crop residue incorporation + fungal consortium	1.59	1.13	2.32	1.66	20.60	8.82	45.75	24.54	66.36	33.36
SEm±	0.02	0.01	0.03	0.02	0.26	0.38	1.11	0.58	1.19	0.57
CD (P = 0.05)	0.08	0.04	0.11	0.08	1.03	1.50	4.35	2.27	4.68	2.23
Potassium management										
Control	1.41	0.99	2.00	1.41	15.30	6.30	33.59	17.39	48.89	23.68
KSB	1.49	1.04	2.14	1.53	16.77	7.11	38.81	20.91	55.58	28.02
100 % RDK (60 kg/ha)	1.65	1.17	2.44	1.74	19.17	8.52	44.96	24.80	64.13	33.31
50 % RDK + KSB	1.56	1.10	2.30	1.64	18.51	8.68	45.50	24.87	64.01	33.55
75 % RDK + KSB	1.60	1.14	2.39	1.71	19.59	9.16	48.40	26.45	67.99	35.61
SEm±	0.03	0.02	0.03	0.02	0.52	0.31	1.04	0.56	1.17	0.68
CD (P = 0.05)	0.08	0.07	0.09	0.06	1.52	0.89	3.04	1.64	3.43	1.98

Table.5 Effect of crop residue and potassium management on potassium use efficiencies of mungbean

Treatment	Agronomic use efficiency (kg kg^{-1})		Physiological use efficiency (kg kg^{-1})		Apparent recovery (%)		Utilization Efficiency (kg kg^{-1})	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Residue management								
No crop residue	1.18	2.12	3.60	8.75	20.65	14.45	3.74	3.86
Crop residue incorporation	3.38	3.03	6.24	8.17	33.36	20.76	5.26	4.94
Crop residue incorporation + fungal consortium	5.44	3.79	7.57	9.33	42.49	23.71	7.15	5.76
SEm±	0.37	0.55	0.54	1.54	2.44	1.26	0.53	0.41
CD (P = 0.05)	1.44	NS	2.13	NS	9.56	4.93	2.09	NS
Potassium management								
Control	-	-	-	-	-	-	-	-
KSB	-	-	-	-	-	-	-	-
100 % RDK (60 kg/ha)	3.33	2.63	8.18	12.57	35.23	21.30	4.22	4.25
50 % RDK + KSB	7.44	7.09	10.93	15.78	70.07	43.39	13.12	11.63
75 % RDK + KSB	5.90	5.16	9.91	15.39	55.54	33.50	9.59	8.40
SEm±	0.46	0.44	1.07	0.90	2.42	1.54	0.87	0.65
CD (P = 0.05)	1.35	1.28	3.11	2.64	7.08	4.49	2.54	1.91

Among the K-management, highest P concentration in seed (0.380 and 0.304 %) seed and stalk (0.151and 0.120 %) was recorded with 75% RDK + KSB during both years of study. However, it was at par with 50% RDK + KSB significantly higher than rest of treatments. Maximum value P-uptake was recorded with 75% RDK + KSB in seed, stalk and total uptake (4.66 and 2.45 kg ha^{-1}) (3.04 and 1.86 kg ha^{-1}) and (7.72 and 4.31 kg ha^{-1}) during both the years. However, it was at par with 50% RDK + KSB significantly higher than rest of treatments. Bacterial inoculation of potassium solubilising bacteria (KSB) could improve phosphorus availability in the soils by producing an organic acid and other chemicals by stimulating growth and mineral uptake of plants (Park *et al.*, 2003). Zhang *et al.*, (2004) also reported the effect of potassic bacteria on sorghum, which led to in increased biomass and contents of P and K in plants over the control It might be due to higher availability of nutrients to plant, which is directly correlated nutrient content in plant and which were being involved in physicochemical reaction of plant body of crops.

K concentration and uptake

The concentration of K in seed and stalk was significantly influenced by crop residue and level of K in both years of study (Table 4). The maximum K-concentration recorded with crop residue incorporation + fungal consortium application in seed (1.59 and 1.13%) and stalk (2.32 and 1.66 %) during both the years of experimentation, However, it was found at par with crop residue incorporation treatment but significantly higher than no crop residue treatment during both years of experimentation. The uptake of K in seed, stalk and total uptake was highest with the crop residue incorporation + fungal consortium (20.60 and 8.82 kg ha^{-1}), (45.75 and 24.54 kg ha^{-1}) and (66.36 and 33.36 kg ha^{-1}) during both the years. However, it was found at par with crop residue incorporation treatment but except, seed and total uptake in the first year and significantly higher than no crop residue treatment during both years of experimentation but except, seed and total uptake in the first year. Eldardiry *et al.*, (2010) reported that nitrogen uptake by wheat grains was higher than their corresponding treatments of straw under all the different water regimes (WR) and K treatments. These bacteria had a synergistic effect on mineral weathering increased the K availability in soils and thereby increased mineral uptake by the plant (Lin *et al.*, 2002).

Among the K-management, highest K concentration in seed (1.65 and 1.17%) and stalk (2.44 and 1.74%) was recorded with 100% RDK during both years of study. However, it was at par with 75% RDK + KSB significantly higher than rest of treatments. Maximum K-uptake was recorded with 75% RDK + KSB in seed (19.59 and 9.16 kg ha^{-1}), stalk (48.40 and 26.45 kg ha^{-1}) and (67.99 and 35.61 kg ha^{-1}), a total during both the years. However, it was at par with 100% RDK and 50% RDK + KSB significantly higher than rest of treatments. K uptake in seed, stalk and their total at KSB was significantly higher than control during both the years. Bacterial inoculation of potassium solubilising bacteria (KSB) could improve phosphorus availability in the soils by producing an organic acid and other chemicals by stimulating growth and mineral uptake of plants (Park *et al.*, 2003). Enhancement of plant growth by improving N fixer, P and K solubilizers is another beneficial effect of microorganisms with K-solubilizing potential (Maurya *et al.,* 2014).

Agronomic K use efficiency

Agronomic use efficiency of mungbean as significantly influenced by the application of residue and K management presented in table

5. The agronomic K use efficiency (5.44 and 3.79 kg kg^{-1}) of mungbean was recorded highest with crop residue incorporation + fungal consortium during both the years. However, crop residue incorporation + fungal consortium and crop residue incorporation treatment were at par with each other but an only first year and significantly higher than no crop residue treatment during both years of experimentation. Potassium management significantly influenced the agronomic K use efficiency of mungbean as compared to control. The highest agronomic K use efficiency (7.44 and 7.09 kg kg^{-1}) was recorded with 50% RDK + KSB significantly over 75% RDK + KSB and 100% RDK during both the years of experimentation. The similar results were also obtained by Meena *et al.*, (2015) for nitrogen with 100% RDN + *Azotobacter* rice-wheat cropping system. Significantly highest physiological K use efficiency of mungbean was recorded with crop residue incorporation + fungal consortium (7.57 and 9.33 kg kg^{-1}) as compared to no crop residue during 2015 and 2016. However, crop residue incorporation and crop residue incorporation + fungal consortium treatment was at par with each other during first years of experimentation. The highest physiological use efficiency (10.93 and 15.78 kg kg ha^{-1}) was recorded with 50% RDK + KSB which was closely followed by 75% RDK + KSB and 100% RDK during both the years of experimentation. Highest apparent recovery of K by mungbean was recorded with crop residue incorporation + fungal consortium (42.49 and 23.71%) significant over rest of treatments during both the years. However, crop residue incorporation and crop residue incorporation + fungal consortium treatment was at par with each other during first years of experimentation. The highest apparent recovery (70.07 and 43.39 %) was recorded with 50% RDK + KSB which was significant over rest treatment both the years of experimentation. However, 75% RDK + KSB treatment was significantly superior to 100% RDK treatment during both the year of experimentation. The utilization efficiency of mungbean was recorded highest with crop residue incorporation + fungal consortium (7.15 and 5.76 kg kg^{-1}) during both the years. However, crop residue incorporation and crop residue incorporation + fungal consortium treatment was at par with each other during first years of experimentation. The highest utilization efficiency (13.12 and 11.63 kg kg^{-1}) was recorded with 50% RDK + KSB which was significant over rest treatment both the years of experimentation. However, 75% RDK + KSB treatment was significantly superior to 100% RDK treatment during both years of experimentation. The similar results were also reported by Saad (2014) in the maize-wheat system.

On the basis of the results illustrated from the present investigation, it can be concluded that significantly highest grain yield, protein content, protein yield and N P K uptake of mungbean were noticed with treatment receiving fungal consortium incorporation. Similar results were also recorded for agronomic K use efficiency, physiological use efficiency, apparent recovery (%), utilization efficiency during both the years. Significantly highest grain yield, protein content, protein yield, N P K content and its uptake both in seed and stalk of the crop were noticed with treatment receiving 75% RDK+ KSB. However, noticeably highest agronomic K use efficiency, physiological use efficiency, apparent recovery and utilization efficiency of mungbean were noticed with 50% RDK+ KSB.

References

Bakht, J., Shafi, M., Jan, M.T. and Shah, Z. 2009. Influence of crop residue management, cropping system and N fertilizer on soil N and C dynamics and sustainable wheat (*Triticum* *aestivum* L.) production. *Soil and Tillage Research* 104: 233-240.

Basavesha, K.N., Savalgi, V.P., Sreenivasa, M.N. and Manjunatha, H. 2016. Impact of bacteria solubilizing both potassium and phosphorus on growth and yield of maize (*Zea mays* L.). *Research in Environment and Life Sciences* 9(4):464-465. *Agronomy* 45 (4):707-710.

Behera, U.K., Sharma, A.R. and Pandy, H.N. 2007. Sustaining productivity of wheat-soybean cropping system through integrated nutrient management practices on the Vertisols of central India. *Plant and Soil* 297: 185-199.

Eldardiry, I.E., El Hady, M.A. and El Ashry, S. M. 2010. Effect of water regime and potassium application on water relations and nutrients uptake of wheat plant. *International Journal Academic Research* 2(2): 75-82.

Epstein, E. and Bloom, A.J. 2005. Mineral Nutrition of Plants: Principles and Perspectives, 2nd edition Sunderland, MA: Sinauer Associates. pp. 1-380.

Ghosh, P.K., Bandypadhyay, K.K., Wanjari, R.H., Manna, M.C., Mishra, A.K and Mohanty, M. 2007. Legume effect for enhancing productivity and nutrient use efficiency in major cropping systems - an Indian perspective: a review. *Journal of Sustainable Agriculture*. 30(1):61–86.

Jabbar, A., Aziz, T., Bhatti, I.H., Virk, Z.A., Khan, M.M. and Wasi, D. 2009. Effect of potassium application on yield and protein content of late sown wheat (*Triticum aestivum*) under the field. *Soil and Environment* 28(2): 193-196.

Lin, Q., Rao, Z., Sun, Y., Yao, J. and Xing, L. 2002. Identification and practical application of silicate dissolving bacteria. *Agricultural Science in China* 1: 81-85.

Maurya, B.R., Meena, V.S. and Meena, O.P. 2014. Influence of inceptisol and alfisol's potassium solubilizing bacteria (KSB) isolates on release of K from waste mica. *Vegetos* 27: 181-187.

Meena, J.R., Behera, U.K., Chakraborty, D. and Sharma, A.R. 2015. Tillage and residue management effect on soil properties, crop performance and energy relations in greengram (*Vigna radiata* L.) under maize-based cropping systems. *International Soil and Water Conservation Research* 3(4): 261-272.

Palm C A, Giller K E, Mafongoya P L and Shift M J 2001 Management of organic matter in the tropics: translating theory into practice. Nutrient Cycle Agroecosystem 61: 63-75.

Park, M., Singvilay, D., Seok, Y., Chung, J., Ahn, K. and Sat, 2003. Effect of phosphate solubilizing fungi on P uptake and growth of tobacco with rock phosphate application in Soil Korean. *Journal of Soil Science and fertile* 36: 233-238.

Saad, A. 2014. Conservation agriculture for improving productivity and resource-use efficiency in maize (*Zea mays*) based cropping system. *Ph. D. Thesis*. ICAR, IARI New Delhi *agronomy and Crop Science* 190: 324-331.

Sharma, A. R. and Behera, U. K. 2009. Recycling of legume residues for nitrogen economy and higher productivity in maize (*Zea mays*) - wheat (*Triticum aestivum*) cropping system. *Nutrient Cycling in HYPERLINK "http://link.springer.com/journal/10705" Agroecosystems*., 83 (3): 197-210.

Zhang, C.J., Tu, G.Q. and Cheng, C.J. 2004. Study on potassium dissolving ability of silicate bacteria. *Shaguan College Journal* 26: 1209-1216.

How to cite this article:

Meena, H.N., K.S. Rana, Ashok Kumar, Livleen Shukla, Meena Shekhar, Arvind Kumar, Adarsh Kumar and Santosh K. Meena. 2018. Influence of Crop Residue and Potassium Management on Yield, Quality, Nutrient Uptake and Nutrient Use Efficiency by Mungbean in Maize (*Zea mays* L.) - Wheat (*Triticum aestivum* L.) - Mungbean Cropping System. *Int.J.Curr.Microbiol.App.Sci.* 7(04): 3284-3295. doi: https://doi.org/10.20546/ijcmas.2018.704.372