The Pharma Innovation Journal 2022; 11(12): 604-609

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 604-609

www.thepharmajournal.com
Received: 22-09-2022
Accepted: 25-10-2022

P Ammaji
Agricultural College,
Acharya N. G. Ranga
Agricultural University,
Rajamahendravaram,
Andhra Pradesh, India

Corresponding Author:
P Ammaji
Agricultural College,
Acharya N. G. Ranga
Agricultural University,
Rajamahendravaram,
Andhra Pradesh, India

Yield and nutrient uptake of maize (*Zea mays* L.) as influenced by legume crops, residue management practices and nitrogen levels in legume-maize sequence

P Ammaji

Abstract
Field investigations were carried out to find out yield of maize as influenced by different management practices and N, P and K uptakes and nutrient balance sheet of maize as influenced by legume crops, residue management practices and nitrogen levels in legume- Maize sequence. The experiment was conducted in split plot design for two consecutive years on sandy clay soil at Agricultural college, Aswaraopeta, Khammam (dt.), Telangana state. The treatments consisted of three legumes, *viz*., cowpea, (M_1) field bean (M_2) and greengram (M_3) as main plot treatments during the kharif season and two residue management practices *viz*., residue removal (I_0) and residue incorporation (I_1) as sub- plot treatments. Four nitrogen levels 75 kg ha^{-1} (N_1), 150 kg ha^{-1}(N_2), 225 kg ha^{-1} (N_3) and 300 kg ha^{-1}(N_4) as sub- sub plot treatments allocated to maize during rabi season. The results of the experiments revealed that yield and yield attributes of maize were significantly more when cowpea was taken as a preceding crop to maize. Incorporation of crop residues were also increased the yield of maize over its removal. Each increment in the level of nitrogen also contributed positively in increasing the yield of maize up to the highest level tried. The uptake of N, P and K was highest by the maize when cowpea was taken as a preceding crop to maize during both the years under investigations. Incorporation of crop residues was also had a positive influence on the up take of all the three nutrients. Increment in the dose of nitrogen had a positive influence on the uptake on N by maize crop during two years of study. The highest uptake N, P and K by grain and stover was 124,29.39 and 101.25 kgha^{-1}, respectively was recorded at highest level of N application. The NPK balance of the soil after harvest of the maize crop was highest in greengram and field bean compared to cowpea grown as a proceeding crop to maize. There exits differential response of legume crops in increasing the fertility of the soil.

Keywords: Crop residues, NPK uptake, nitrogen levels

1. Introduction
The annual production of crop residues in India are estimated over 500 million tons (Mt). There exists a large variability in the production of crop residues with regards to different crops. Intensive agricultural practices further increased the production of residues. Burning of crop residues inorder to clear the field for the subsequent crop has resulted in several pollution problems and environmental impact. Long-term field experiment has confirmed that adding crop residues to agricultural land leads to a large increase in soil carbon stocks which serves as a substratum for the growth and development of the microorganisms. Soil microbes play a key role in the nutrient cycling by decomposing the organic matter in to plant available nutrients. Legume-Maize sequence is the important cropping system followed in large extent of area in Andhra Pradesh and Telangana states. Grain legumes were cultivated during the kharif season and after harvesting the economic yield the harvested remnants are either used as an animal feed or else burned to clear the succeeding crop. Since, Maize is an exhaustive crop for nutrients and responds positively with increase in the level of nitrogen fertilizers. Furthermore, Intensive agricultural practices ignoring the addition of organic nutrient sources resulting in the manifestation of nutrient deficiencies. Added to the problem continuous usage of chemical fertilizers leading to the decline in the yield levels and loss of soil physical, chemical and biological properties. Under these circumstances, formulation of ideal nutrient management strategy is very much essential to increase to maintain the yields and sustain the soil health.

2. Materials and Methods
Field experiments were conducted at Agricultural College farm, Aswaraopeta, Khammam (Dist.) Telangana state for two consecutive years.

The experimental site is situated at an altitude of 854 m above mean sea level, 16^0 10´ N latitude, 80^0 29´ E longitude and about 110 km away from Khammam town and falls in the Central Telangana Agro climatic Zone of Telangana State. The experimental site was sandy clay in texture, slightly alkaline in reaction, low in available organic carbon and nitrogen, medium in available phosphorus and potassium. The investigations were carried out with an objective to find out the yield and N, P, K uptake and balance sheet of the legume-maize sequence. The treatments consisted of three legumes, *viz*., cowpea, (M_1) field bean (M_2) and greengram (M_3) as main plot treatments during the *kharif* season and two residue management practices *viz*., residue removal (I_1) and residue incorporation (I_2) as sub- plot treatments. Four nitrogen levels 75 kg ha^{-1} (N_1), 150 kg ha^{-1}(N_2), 225 kg ha^{-1} (N_3) and 300 kg ha^{-1} (N_4) as sub- sub plot treatments allocated to maize during *rabi* season. The yield of kharif legumes, growth parameters, yield and yield attributes of rabi maize were recorded. The soil samples were collected from the experimental plots before sowing of the legume crops and after harvest of the maize crop to assess the nitogen balance of the system. Plant samples were collected analysed for N (Modified Microkjeldhal method, Piper, (1960) [8] P (Vanado molybdo phosphoric acid method suggested by Jackson (1973) [3] K (Flame photometer method suggested by Jackson (1973) [3]. At maturity, the percent nutrient content of N, P and K in grain as well as stover was estimated and total uptake of N, P and K in grain and stover was estimated and expressed as kg ha^{-1}. The nutrient uptake was calculated by making use of the following formula.

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient content (\%) X Dry matter accumulation kg ha}^{-1}}{100}$$

3. Results and Discussion
3.1 Yield attributes and Yield of Maize
3.1.1 Number of kernels per cob
Number of kernels per cob was significantly influenced by *kharif* legumes, residue management practices and nitrogen levels in both the years. The highest kernel number per cob of 320 and 325 were recorded during first and second years, respectively, with cowpea as a preceding crop to maize and was significantly superior to other two preceding legume crops. The residue incorporation or non-incorporation had no significant effect on kernel number per cob during both the years. The number of kernels per cob increased significantly with increase in level of N application. The increase in kernel number per cob due to preceding legumes, residue management practices and nitrogen levels might be due to more dry matter accumulation in the respective treatments leading to extension of grain filling period along with effective translocation of photosynthates to sink, which might have resulted in significant improvement in yield attributes of maize.

3.1.2 Test Weight
The 100-kernel weight was significantly influenced by *kharif* legume crops, residue management practices and nitrogen levels during both the years. Among the *kharif* legumes, cowpea proceeded to maize recorded maximum test weight of 27.8 g and 29.1 g during the first and the second year respectively, and was found to be significantly superior to green gram-maize sequence. Residue incorporation has resulted in significant increase in test weight compared to the removal during both the years of study. The percent increase in test weight due to incorporation of residue was 8.8 percent and 6.4 percent in first and second year, respectively. The superior performance of maize when grown as a subsequent crop to cowpea might be due to higher biomass accumulation of cowpea resulted in the buildup of soil organic carbon, which in turn improved the soil physicochemical properties, which might have translated into superior growth of yield components compared to other legumes. Significant improvement in yield components with the incorporation over non incorporation of legume residue might be attributed to the nodulated roots and the above ground residues after the harvest of seed represent the potentially viable source of nitrogen for the soil microbes when these residues were incorporated into the soil. The increase in soil microbial population with residue incorporation was better evident in the present investigation. This might have increased the nutrient availability to the succeeding maize in sequence. These results are in conformity with the findings of Egbe and Ali (2010) [2].

3.1.3 Kernel yield (kgha^{-1})
Kernel yield of maize was the affected by *kharif* legume crops, residue management practices and nitrogen levels during the both the year of experimentation However, the interactions of these factors were found to be non- significant. Among different *kharif* legume crops tested, cowpea preceded to maize resulted in the highest kernel yield of 6092 kg ha^{-1} and 6317 kg ha^{-1} during the first and the second year of study, respectively, while the kernel yield of maize with field bean and green gram as preceding crops were comparable during both the years of study. Residue incorporation resulted in significant increase in kernel yield of succeeding maize during both the years. The percent increase in kernel yield of maize due to residue incorporation was 6 and 7 percent during the first and second year, respectively, over no incorporation. Increase in the level of nitrogen significantly increased the kernel yield of maize. Application of 225 kg N ha^{-1} and 300 kg N ha^{-1} increased the kernel yield by 48.3 and 54.7 percent, respectively over 75 kg N ha^{-1} (Table 1). The superior performance of maize when grown as a subsequent crop to cowpea might be due to higher biomass accumulation of cowpea resulted in the buildup of soil organic carbon, which in turn improved the soil physico- chemical properties, which might have translated into superior growth and yield. Significant improvement in yield components with the incorporation over non incorporation of legume residue might be attributed to the nodulated roots and the above ground residues after the harvest of seed represent the potentially viable source of nitrogen for the soil microbes when these residues were incorporated into the soil.

Table 1: Yield and yield attributes of Maize as influenced by legume crops and residue management and nitrogen levels

Treatment	First year			Second year		
	No. of grains /cob	Test weight (g)	Grain yield (kg ha-1)	No. of grains /cob	Grain yield (kg ha^{-1})	Grain yield (kg ha^{-1})
Cowpea	320	320	27.8	325	29.1	6317
Field bean	307	307	27.5	313	26.7	5864
Greengram	300	300	27.0	302	28.3	5683
S.Em+	2.20	2.20	0.16	2.68	0.11	93.2
CD (P=0.05)	6.67	6.67	0.62	10.5	0.45	560
Residue management Practices						
Residue removal	304	26.1	5532	309	27.8	5742
Residue incorporation	344	28.4	5884	318	29.6	6167
S.Em+	3.78	0.16	95.0	1.38	0.07	100.6
CD (P=0.05)	NS	0.56	329.0	NS	0.27	348.2
Nitrogen levels (Kgha^{-1})						
75 kg ha-1	234	26.0	4379	234	27.1	5565
150 kg ha-1	284	27.2	5257	284	28.3	5571
225 kg ha-1	364	28.1	6435	364	29.4	6608
300 kg ha-1	371	28.4	6762	371	29.8	7073
S.Em±	2.96	0.14	186.4	2.96	0.14	195.3
CD (P=0.05)	8.50	0.41	534.7	8.50	0.41	560.1

3.1.4 Nitrogen uptake

The nitrogen uptake at maturity by grain and stover is (97.6 kg ha^{-1} and 109.0 kg ha^{-1}) of maize was significantly more with cowpea as a preceding crop during first and second year, respectively. While maize preceded by greengram recorded lowest uptake of 87 kg ha^{-1} and 98 kg ha^{-1} in first and second years, respectively. The percent increase in the uptake by grain and stover in first and second year is 12 and 11 percent respectively. Legume residue incorporation has increased the total uptake of nitrogen by grain and stover during both the years compared to the residue removal treatments. Significant improvement in N uptake by grain and stover was observed up to 300 kg ka^{-1}. The total uptake by grain and stover with 300 kg ha^{-1} was 111.4 kg ha^{-1} in first year and 124.5 kg ha^{-1} in second years, respectively (Table 2).

Table 2: Nitrogen uptake (kg ha^{-1}) in maize as influenced by legume crops, residue management practices and nitrogen levels

Treatment	First Year					Second Year				
	Percent N	Uptake Grain	Percent N	Uptake Stover	Total (kg ha^{-1})	Percent N	Uptake Grain	Percent N	Uptake (kg ha^{-1}) Stover	Total (kg ha^{-1})
Legume crops										
Cow pea	1.12	68.19	0.42	29.49	97.68	1.23	78.01	0.39	30.99	109.0
Field bean	1.11	63.29	0.37	27.85	91.14	1.22	72.18	0.38	29.54	101.72
Greengram	1.12	60.53	0.35	26.81	87.34	1.22	70.07	0.36	28.49	98.56
SE m±		1.31		0.78			1.14		0.46	
CD (P=0.05)		5.15		3.09			4.49		1.83	
CV (%)		19		24			18		20	
Residue Management Practices										
Residue removal	1.11	62.09	0.39	26.8	88.89	1.21	70.76	0.46	26.8	99.41
Residue incorporation	1.12	66.12	0.41	29.23	95.35	1.23	76.08	0.49	29.23	106.78
S.Em±		1.06		0.19			1.24		0.19	
CD (P=0.05)		3.67		0.65			4.29		0.65	
CV (%)		21		20			15		20	
Nitrogen levels (Kgha^{-1})										
75	1.11	48.75	0.38	19.95	77.03	1.20	55.85	0.39	21.18	77.03
150	1.12	58.96	0.39	25.39	93.47	1.21	68.61	0.41	26.86	93.47
225	1.13	72.52	0.40	31.64	115.3	1.22	81.75	0.42	33.59	115.3
300	1.13	76.18	0.41	35.22	124.54	1.23	87.47	0.44	37.07	124.54
S.Em±		2.09		0.52			2.40		0.58	
CD (P=0.05)		5.99		1.49			6.90		1.68	
CV (%)		15		11			14		12	

Significant improvement in uptake of nitrogen by maize preceded by legumes suggests that mineralized N was utilized efficiently by the crop plants for their growth. Higher uptake of N by maize due to incorporation of legume crop residues might be due to better availability of nitrogen in soil after their decomposition and consequent increase in drymatter production. Several researchers like Tiwari *et al.* (2004) [12], Sujatha *et al.* (2008) [11] and Sharma *et al.* (2009) [9] observed significant increase in N uptake of maize with incorporation of crop residues. Higher uptake of nitrogen with the increase in nitrogen levels can be attributed to increase in nitrogen content in drymatter coupled with increased drymatter accumulation. These findings are in accordance with Shivay and Singh (2000) [10], and Mercy *et al.* (2012) [7] and Meena *et al.* (2013) [6].

3.1.5 Phosphorus uptake
Phosphorus uptake by maize was also followed the similar trend as that of nitrogen. The total uptake of Phosphorus by grain and stover of maize was significantly more with cowpea as a preceding crop to maize in the first year. However, no significant difference was observed in respect of phosphorus uptake of stover by different legumes preceded to maize during first year. The highest total phosphorus uptake of by grain and stover of maize recorded was 22.5 kg ha^{-1} in first year and 24.1 kg ha^{-1} in the second year with cowpea as a preceding crop to maize. (Table-3) Residue incorporation retained its superiority over the residue removal during both the years with regard to phosphorus uptake. The maximum total phosphorus uptake of 22.19 kg ha^{-1} and 23.7 kg ha^{-1} in the first and second years, respectively was recorded by maize due to residue incorporation.

Each successive increase in level of nitrogen has significantly increased the uptake of phosphorus by grain and stover over the preceding level. The maximum p uptake of 26.63 kg ha^{-1} in first year and 28.31 in second year was recorded with application of nitrogen at 300 kg ha^{-1}. However, no significant difference was observed between 225 kg N ha^{-1} and 300 kg N ha^{-1} during first year (Table-3). Significant variation among different factors under investigation with regard to uptake of P may be due to increase in drymatter accumulation coupled with percent increase in nutrient content in drymatter that might have contributed for the increase uptake of P. These findings are in accordance with Meena *et al.* (2007) [6], Bharathi (2010) [1].

Table 3: Phosphorus uptake (kg ha^{-1}) of maize as influenced by legume crops, residue management practices and nitrogen levels

Treatment	First Year					Second Year				
	Percent P	**Uptake Grain**	**Percent P**	**Uptake Stover**	**Total**	**Percent P**	**Uptake (Grain)**	**Percent P**	**Uptake stover**	**Total**
Legume crops										
Cow pea	0.212	12.38	0.172	10.21	22.59	0.205	12.92	0.151	11.18	24.1
Field bean	0.191	11.18	0.165	9.84	21.02	0.203	11.60	0.146	10.62	22.2
Greengram	0.203	10.66	0.173	9.60	2026	0.198	11.17	0.141	10.48	21.65
SE m±		0.24		0.26			0.18		0.27	
CD (P=0.05)		0.94		1.05			0.71		1.08	
CV (%)		10.35		13.25			7.51		12.59	
Residue Management Practices										
Residue removal	021	10.81	0.152	9.58	2039	0.241	11.22	0.162	10.40	21.62
Residue incorporation	0.19	12.00	0.156	10.19	22.19	0.221	12.58	0.172	11.12	23.70
SE m±		0.17		0.04			0.20		0.14	
CD (P=0.05)		0.61		0.16			0.70		0.50	
CV (%)		9.29		2.87			10.23		8.16	
Nitrogen levels (Kgha^{-1})										
75	0.184	7.96	0.164	6.72	14.68	0.19	8.30	0.141	7.57	15.87
150	0.202	10.28	0.175	8.94	19.22	0.212	10.90	0.158	9.76	20.66
225	0.212	13.18	0.177	11.44	24.62	0.226	13.54	0.163	12.25	25.79
300	0.223	14.20	0.185	12.43	56.63	0.231	14.86	0.167	13.45	28.39
SE m±		0.37			0.14		0.38		0.16	
CD (P=0.05)		1.06			0.41		1.11		0.47	
CV (%)		13.7			0.16		13.89		6.51	

3.1.6 Potassium up take
Potassium uptake by kernel and stover at maturity followed the similar trend. Cowpea has retained its superiority as preceding crop with regard to uptake of potassium by maize compared to greengram. While no significant difference was found between cowpea- maize or fieldbean – maize sequence during first year regarding uptake of K by grain and stover. The highest total potassium uptake of 85.74 kg ha^{-1} and 88.44 kg ha^{-1} was recorded with cowpea as preceding crop to maize in first and second year, respectively. Residue incorporation was found to increase the uptake of K upto 85.3 and 88.1 kg ha^{-1} during first and second year, respectively. K uptake by kernel and stover was found to be significantly high with application of N at 300 kg ha^{-1}., which was significantly superior to lower levels during both the years. The variations among different treatments with regard to K uptake were due to higher drymatter accumulation along with percent increase in K nutrient content in the drymatter which might have resulted in the increased uptake of K in respective treatments (Table-4). Similar results reported by Meena *et al.* (2007) [13] and Bharathi (2010) [1].

Table 4: Potassium uptake (kg ha^{-1}) of maize as influenced by legume crops, residue management practices and nitrogen levels

Treatment	First year					Second year				
	Percent K	Uptake Grain	Percent K	Uptake Stover	Total	Percent K	Uptake (Grain	Percent K	Uptake Stover	Total
Legume crops (LC)										
Cow pea	0.38	22.48	0.91	63.26	85.74	0.38	23.43	0.88	65.01	88.44
Field bean	0.36	20.81	0.88	61.31	82.12	0.36	21.61	0.86	63.51	85.12
Greengram	0.35	19.92	0.86	59.13	79.05	0.35	20.88	0.85	61.28	82.16
SE m±		0.44		1.70			0.34		0.99	
CD (P=0.05)		1.72		6.70			1.34		3.92	
CV (%)		10.23		13.66			7.65		7.73	
Residue Management Practices (RMP)										
Residue	0.39	20.37	0.89	58.80	79.17	0.35	21.14	0.85	61.66	82.8
Residue	0.37	21.76	0.91	63.67	85.43	0.39	22.81	0.87	65.37	88.18
SE m±		0.33		0.41			0.37	0.89	0.60	
CD (P=0.05)		1.16		1.43			1.29	0.89	2.09	
CV (%)		9.57		4.07			10.17		5.74	
Nitrogen levels (NL)										
75	0.35	15.31	0.86	46.76	62.07	0.34	15.96	0.83	48.33	64.29
150	0.37	19.09	0.89	57.75	76.84	0.37	20.23	0.85	59.59	79.82
225	0.38	24.09	0.91	68.31	92.40	0.36	24.74	0.89	70.87	65.61
300	0.39	25.79	0.92	72.11	97.90	0.37	26.98	0.89	74.27	101.25
SE m±		0.68		1.14			0.71		1.25	
CD (P=0.05)		1.96		3.29			2.06		3.60	
CV (%)		13.81		7.96			13.89		8.43	

3.1.7 Post harvest status of available N, P and K after the harvest of maize

Considerable variation in the soil available N, P and K status was observed in both the years of study as seen from Table-5, Perusal of the data indicated that the soil N, P and K after the harvest of maize was highest in plots of greengram and field bean as preceding crops to maize compared to cowpea, which was reflected by the low yields and uptakes obtained in the two years with these legumes as the preceding crops. Further, the available status soil N, P and K was more in plots where crop residues are incorporated compared to their removal. The data also indicated that the available N, P and K in the soil during both the years increased with increase in N dose from 75 kg to 300 kg N ha^{-1}. The differential behavior of a legume in influencing the fertility status of soil largely depends on the growth of the legume (Table-4). Higher yield of cereals may remove large amount of nutrients leaving the soil under nutrient stress as stated by Jain *et al*. (2021) [4].

Table 5: Available N, P and K (kg ha^{-1}) in the soil after harvest of maize as influenced by different legumes, residue management practices and nitrogen levels

Treatments	N levels (Kg ha^{-1})	First year			Second Year		
		N	P	K	N	P	K
M_1I0	N_1	98	25.2	228	102	26.5	221
	N_2	125	27.6	237	132	26.7	248
	N_3	168	28.2	242	179	27.4	251
	N_4	178	29.3	258	182	29.8	267
M_1I_2	N_1	109	25.7	218	118	27.2	227
	N_2	112	26.2	227	121	28.4	231
	N_3	181	26.8	238	173	28.8	248
	N_4	184	27.6	268	181	29.9	261
M_2I_0	N_1	112	25.4	234	108	24.5	275
	N_2	149	27.3	246	152	25.2	248
	N_3	167	27.4	252	172	26.5	256
	N_4	187	28.6	259	195	27.7	275
M2I1	N_1	108	26.2	239	115	25.6	238
	N_2	145	27.3	246	148	26.5	259
	N_3	168	28.0	259	179	27.5	257
	N_4	197	28.5	261	194	29.3	275
M_3I_0	N_1	121	26.3	242	125	24.4	246
	N_2	136	27.6	258	146	25.7	264
	N_3	179	28.6	261	184	27.7	272
	N_4	183	29.2	268	197	28.6	288
M_3I_1	N_1	138	27.3	249	141	25.5	258
	N_2	144	28.3	257	152	27.6	268
	N_3	183	28.7	261	175	29.2	275
	N_4	194	29.3	268	198	29.4	285

4. Conclusion

From the research results trials it is concluded that inclusion of legume crops in cereal-based cropping systems contributing for the nitrogen economy of the succeeding cereal in sequence. The nitrogen contribution is different for different crops. Legume crop residue incorporation was also proved to be better in increasing the native soil fertility, which inturn reflected in the yields of maize. Higher uptake of NPK by maize at highest level of nitrogen tried is positively correlated with the higher yield of maize.

5. References

1. Bharathi S. Productivity and nitrogen requirement of maize (*Zea mays* L.) in *rabi* as influenced by kharif cropping practices Ph.D. Thesis, Acharya N.G. Ranga Agricultural University, Hyderabad, India; c2010.
2. Egbe O, Ali A. Influence of soil incorporation of food legume stover on yield of maize in sandy soils of Moist savanna Woodland of Nigeria. Agriculture and Biology Journal of North America. 2010;1(2):156-162.
3. Jackson ML. Soil chemical analysis. Prentice Hall India Private Limited, New Delhi; c1973. p. 41.
4. Jain NK, Yadav RS, Jat RA. Productivity, Profitability, Enzyme Activities and Nutrient Balance in Summer Peanut (*Arachis hypogaea* L.) as Influenced by NPK Drip Fertigation. Communications in Soil Science and Plant Analysis; c2007, c2021. p. 443-435.
5. Jayesh Shesh, Santosh Kumar Jha, Ritesh Kumar Singh, Swati Kunjam. Effect of de-topping and nitrogen levels on yield and nutrients uptake of maize (*Zea mays* L.). Int. J Res. Agron. 2020;3(1):45-48.
6. Meena SK, Mundra SL, Singh P. Response of maize to nitrogen and zinc fertilization. Indian Journal of Agronomy. 2013;58(1):127-128.
7. Mercy Z, Chandrasekhar K, Subbaiah G. Response of maize to plant densities and nitrogen levels under late rabi conditions. The Andhra Agricultural Journal. 2012;59(4):517-519.
8. Piper CS. Soil and plant analysis. Inter Science Publishers, New York; c1960. p. 47-49.
9. Sharma AR, Behera UK. Nitrogen contribution through sesbania green manure and dual-purpose legumes in maize-wheat cropping system: agronomic and economic considerations. Plant and Soil. 2009;325:289-304.
10. Shivay YS, Singh RP. Yield attributes yield and nutrient uptake of maize (*Zea mays* L.) as influenced by cropping systems and nitrogen levels. Annals of Agricultural research. 2000;21(4):494-498.
11. Sujatha MG, LingaRaju BS, Palled YB, Asha latha KV. Importance of Integrated nutrient management Practices in Maize under Rainfed Condition. Karnataka Journal of Agricultural Sciences. 2008;2(3):334-338.
12. Tiwari RC, Sharma PK, Khadelwal SK. Effect of green manuring through *Sesbania cannabina* and *Sesbania rostrata* and nitrogen application through urea to maize (*Zea mays*) in maize wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy. 2004;49(1):15-17.
13. Meena O, Khafi HR, Shekh MA, Mehta AC, Davda BK. Effect of vermicompost and nitrogen on content, uptake and yield of *rabi* maize. Crop Research. 2007;33(1-3):53-54.