The Andhra Agric. J 62(3):518-522, 2015

Influence of *Rabi* Legumes and Nitrogen Levels on Growth and Yield of Summer Maize

M Sree Rekha, G Subbaiah, R Veeraraghavaiah, Y Ashoka Rani and P Prasuna Rani
Department of Agronomy, Agricultural College, Bapatla 522101, Andhra Pradesh

ABSTRACT

A field experiment was conducted for two years in *rabi* and summer seasons of 2011-12 and 2012-13 on sandy clay loam soils of Agricultural College Farm, Bapatla to study the nitrogen requirement of maize when preceded by *rabi* legumes in a legume-maize sequence. Among the *rabi* legumes, greengram performed well and maize responded to nitrogen levels till 300 kg N ha^{-1}. Total system productivity in terms of maize equivalent yields (MEY) in legume-maize sequence was more in greengram –maize sequence.

Key words : Maize, *R*abi legumes, Maize equivalent yield, Nitrogen levels.

In coastal uplands of Andhra Pradesh, growing a successful *kharif* crop has become uncertain due to vagaries in the onset of south – west monsoon. Sowing of k*harif* crops has become a problem in certain areas where the land preparation is difficult due to continuous heavy rains or loss of already sown crop at harvest due to heavy rains leading to loss of two crops in season. Under such situations, a suitable *rabi* legume - cereal (summer) can be taken up to compensate the loss. Inclusion of legumes in cropping system will help in maintaining the soil health and also sustain the productivity. Maize area is increasing in Krishna Agro Climatic Zone of Andhra Pradesh during late *rabi* and summer in coastal uplands. The area under maize in A.P is 7.86 l.ha with a production of 4.15 m.t (Ministry of Agriculture, Government of India, 2011-12, www.indiastat.com). Nitrogen is one of the most expensive nutrients demanded in huge quantity and maize being an exhaustive crop requires optimal nitrogen for achieving high yield. Rotating cereals and legumes is a cheaper means of improving soil fertility and system productivity (Klaij and Ntare, 1995). Hence the present study was taken up to study the influence of legumes in *rabi* and nitrogen management in summer maize in a legume-maize sequence.

MATERIAL AND METHODS

A field experiment was conducted at Agricultural College Farm, Bapatla during 2011-12 and 2012-13 under irrigated conditions. The trial was repeated on a separate site with same type of soil i.e. sandy clay loam in the second year. The soils were slightly alkaline in reaction (pH 8.0 and 7.1), low in available nitrogen (154 and 186 kg ha^{-1}), medium in phosphorus (33 and 30 kg ha^{-1}) and high in available potassium (298 and 314 kg ha^{-1}) respectively, during the two years of study. The experiment was conducted in split plot design and replicated thrice with four legumes viz., groundnut (M_1) ,soybean (M_2), greengram (M_3) and clusterbean (M_4) as main plot treatments taken up in *rabi* and four levels of nitrogen (N_1:150; N_2:200; N_3:250 and N_4: 300 kg ha^{-1}) as sub plot treatments with maize in summer. During the two years of study in *rabi* season popular legume varieties viz., groundnut (TAG-24), soybean (JS-335), greengram (LGG-460) and clusterbean (local-Sarada) were followed by the most popular and high yielding hybrid maize suitable for this region (Pioneer 30 V 92) in summer. A total rainfall of 159.0 mm and 337.6 mm was received during the crop period of *rabi* legumes in 2011 and 2012, respectively. A total amount of 21.5 mm and 75.6 mm rainfall was received during the crop period of maize in 2011-12 and 2012-13, respectively.

The four *rabi* legumes were sown on 30.10.2011 and 13.10.2012, respectively. The recommended fertilizer of respective crops were applied viz., groundnut 40:40:50, soybean 60:60:40, greengram 20:50:0 and clusterbean 20:60:80 NPK kg ha^{-1}. The entire dose of N(Urea),P (Single Super Phosphate)and K (Muriate of Potash)were applied as basal for all legumes except clusterbean, where only P and K were applied as basal and nitrogen was top dressed at 30 DAS. Sowing of maize at 60 cm x 20 cm was done at four different dates i.e., on 24.1.12, 30.1.12, 7.2.12 and 10.2.12 during first year and on 9.1.13, 11.1.13, 24.1.13 and 28.1.13 during second year of the study, respectively as and when the individual legumes were harvested. Nitrogen in the form of urea was applied as per the treatments in three equal splits, one each at sowing, knee-high stage and tasseling stage. A uniform dose of 60 kg P_2O_5 ha^{-1} and 50 kg K_2O ha^{-1} was applied at the time of planting through Single superphosphate (SSP) and muriate of potash (MOP), respectively, for maize. Maize equivalent yield was calculated by converting the different legume yields into maize equivalent yields on the basis of selling price in each year.

RESULTS AND DISCUSSION

Legume Yield

In both the years of study, groundnut has recorded more seed yield followed by greengram. However, the groundnut equivalent yields were calculated which were more in greengram followed by soybean in 2011 and 2012. Greengram recorded 26.8 per cent more groundnut mean equivalent yield over groundnut (Table 1).

Maize Growth and Yield

At maturity, maize plant height was influenced by preceding legumes in the first year only where greengram as preceding crop recorded the maximum plant height of 263 cm which was significantly superior over clusterbean as preceding crop. The plant height was however, comparable with soybean and groundnut as preceding crops. Mean plant height of maize also was highest when preceded by greengram. Higher plant height of maize succeeding legumes was reported by Sharma and Behera (2009). Among the nitrogen levels, 300 kg N ha^{-1} resulted in maximum plant height which was significantly superior over 150 kg N ha^{-1} but was comparable with 250 kg N ha^{-1} during both the years of study. However, the plant height recorded at 250 kg N ha^{-1} was comparable with lower doses of 200 and 150 kg N ha^{-1} in the two years of study. Mean plant height obtained was the highest with 300 kg N ha^{-1} (Table 2). Irrespective of preceding crops and with increase in nitrogen levels there was increase in plant height. The increase in plant height might be due to more cell division and cell elongation with increased N levels providing more N to crop. These results are in consonance with the findings of Bakht *et al*. (2006).

Significantly higher drymatter accumulation in maize was recorded with greengram as the preceding crop compared to other legumes in 2011 while, in 2012 the drymatter accumulated was comparable between greengram and soybean as the preceding crops. However, the drymatter accumulated was the lowest in clusterbean-maize sequence during both the years. The mean drymatter accumulated in maize was more with preceding greengram followed by soybean. Similar results were reported by Cheruiyot *et al.* (2001). Drymatter accumulated at 300 kg N ha^{-1} was significantly superior over lower dose of nitrogen, 150 kg N ha^{-1} in both the years (Table 2). Increase in N levels might have resulted in production of more leaves per plant and enhanced the photosynthates production, which contributed to more drymatter production. The findings are in accordance with the results of Patel *et al*. (2006).

In 2011-12, significantly higher number of kernels cob^{-1} were obtained in greengram-maize

Table 1. *Performance of legumes in *rabi*, 2011-12 and 2012-13.

Legumes	Seed yield (kgha^{-1})			Groundnut equivalent yield (kgha^{-1})		
	2011	2012	Mean	2011	2012	Mean
Groundnut	1225	1010	1117	1225	1010	1117
Soybean	786	745	765	1019	1079	1049
Greengram	1194	933	1063	1548	1287	1417
Clusterbean	623	554	588	692	649	670

* Data statistically not analyzed

Table 2. Growth and yield of summer maize as influenced by *rabi* legumes and nitrogen levels.

Treatments	Plant height at maturity (cm)			Drymatter accumulation at maturity (kg ha^{-1})			Number of kernels cob^{-1}			Kernel weight cob^{-1}			Kernel yield (kg ha^{-1})		
Rabi legumes(RL)	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean
Groundnut	253.0	237.5	245.2	13126	10548	11837	436	413	424	91.8	90.0	90.9	5527	4595	5061
Soybean	256.9	244.8	250.8	16265	12315	14290	490	440	465	115.7	105.5	110.6	6548	5724	6136
Greengram	263.0	250.6	256.8	18041	13004	15522	524	464	494	117.1	111.0	114.0	6731	5803	6267
Clusterbean	236.4	230.5	233.4	11856	9910	10883	398	405	401	75.9	85.1	80.5	4723	4341	4532
SEm±	4.67	5.65	-	428.9	408.2	-	22.0	19.0	-	5.04	4.90	-	201.2	140.8	-
CD(p=0.05)	16.1	NS	-	1484	1412	-	75	NS	-	17.4	16.9	-	696	487	-
Nitrogen levels (N) (kg ha^{-1})															
150(N_1)	241.5	234.7	238.1	12843	10376	11609	420	393	406	79.6	75.2	77.4	4596	3911	4253
200(N_2)	249.3	237.1	243.2	13442	11064	12253	432	410	421	96.4	88.5	92.4	5573	4748	5160
250(N_3)	254.5	240.8	247.6	15998	11886	13942	484	440	462	106.0	105.2	105.6	6235	5398	5816
300(N_4)	264.0	250.8	257.4	17005	12452	14728	512	478	495	118.4	122.8	120.6	7125	6405	6765
SEm±	5.36	3.61	-	404.6	325.5	-	19.0	15.0	-	2.71	3.53	-	287.7	227.9	-
CD(p=0.05)	15.6	10.5	-	1181	950	-	56	44	-	7.9	10.3	-	840	665	-
Interaction (RL x N)	NS	NS	-	NS	NS	-	NS	NS	-	NS	NS	-	NS	NS	-

Table 3. Total productivity of the legume-cereal sequence in terms of Maize equivalent yields (MEY).

Treatments		Legume yield (kg ha^{-1})			Maize kernel yield (kg ha^{-1})			Maize equivalent yield (kg ha^{-1})			Total maize equivalent yields (kgha^{-1})		
		2011	2012	Mean	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean
Groundnut	N_1	1225	1010	1067	4980	3528	4254	2756	2253	2504	7736	5781	6758
	N_2	1225	1010	1067	5058	4284	4671	2756	2253	2504	7815	6537	7176
	N_3	1225	1010	1067	5470	4622	5046	2756	2253	2504	8227	6875	7551
	N_4	1225	1010	1067	6601	5946	6273	2756	2253	2504	9357	8199	8778
Soybean	N_1	786	745	765	5080	4276	4678	2292	2407	2349	7372	6683	7027
	N_2	786	745	765	6175	5371	5773	2292	2407	2349	8467	7778	8122
	N_3	786	745	765	7162	6542	6852	2292	2407	2349	9454	8949	9201
	N_4	786	745	765	7776	6706	7241	2292	2407	2349	10069	9113	9591
Greengram	N_1	1194	933	1063	5236	4395	4815	3482	2871	3176	8719	7265	7992
	N_2	1194	933	1063	6779	5472	6125	3482	2871	3176	10262	8343	9302
	N_3	1194	933	1063	7226	6388	6807	3482	2871	3176	10709	9259	9984
	N_4	1194	933	1063	7682	6956	7319	3482	2871	3176	11165	9827	10496
Clusterbean	N_1	623	554	588	3087	3446	3266	1557	1449	1503	4645	4895	4770
	N_2	623	554	588	4280	3864	4072	1557	1449	1503	5837	5313	5575
	N_3	623	554	588	5081	4042	4561	1557	1449	1503	6639	5491	6065
	N_4	623	554	588	6442	6012	6227	1557	1449	1503	8000	7461	7730

sequence compared to groundnut-maize and cluster bean-maize but it was comparable with that of soybean-maize sequence. Increase in nitrogen levels resulted in gradual increase in number of kernels cob^{-1}. The maximum number of kernels cob^{-1} (512 and 478) were recorded with 300 kg N ha^{-1}, which were significantly superior over 200 kg and 150 kg N ha^{-1} but were on a par with 250 kg N ha^{-1} during both the years of study. The mean kernel number cob^{-1} was the maximum in maize when preceded by greengram and was the highest at higher dose of 300 kg N ha^{-1}(Table 2). The increase in maize kernel number at higher nitrogen levels might be due to more drymatter accumulation leading to extension of grain filling period along with effective translocation of photosynthates to the sink. The results are in accordance with those of Panchanathan *et al.*(1987).

The maximum kernel weight cob^{-1} during both the years was recorded in greengram-maize sequence which was on a par with that of soybean-maize sequence but significantly superior over that of groundnut-maize and clusterbean-maize sequences. There was increase in kernel weight cob^{-1} with each increment in N level during both the years and significantly higher kernel weight cob^{-1} was recorded with 300 kg N ha^{-1} over all the other N levels tested during both the years of study. There was significant variation in kernel weight cob^{-1} between 250 kg and 200 kg N ha^{-1}and 200 kg and 150 kg N ha^{-1} during both the years. Mean kernel weight cob^{-1} was more with greengram as the preceding legume and the maximum kernel weight cob^{-1} was with N @ 300 kg N ha^{-1}(Table 2).

The highest kernel yield of 6731 and 5803 kg ha^{-1}, respectively in 2011-12 and 2012-13 were recorded with greengram as preceding crop, which was comparable with that of soybean-maize sequence with 6548 and 5724 kg ha^{-1} during the first and second year of study, respectively. Mean kernel yield was also highest when maize was preceded by greengram. The higher kernel yield obtained in greengram-maize sequence might be due to increased microbial activity which might have resulted in increased solubilization of all nutrients for absorption resulting in increased drymatter and enhanced yield attributes like number of kernels cob^{-1}, kernel weight cob^{-1} which finally gave higher kernel yield when compared to other sequences. The positive effect of preceding crops viz., greengram and soybean on maize yield might be due to mineralization of decomposing legume roots in the soil which can increase N availability to the associated crop (Evans *et al*. 2001). These results are in line with the findings of Agyare *et al*.(2006) and Adiku *et al*.(2009). The maximum kernel yield of 7125 and 6405 kg ha^{-1} , respectively, in first and second year was recorded with 300 kg N ha^{-1} which was significantly superior over other levels of nitrogen (Table 2). The mean kernel yield was more at higher level of N @ 300 kg N ha^{-1}. The positive response and beneficial effects of higher nitrogen application on kernel yield could be attributed to the overall improvement in crop growth by accumulating more drymatter and increase in various yield attributes which finally reflected in kernel yield. Similar response of maize to nitrogen was reported by Harikrishna *et al*.(2005) and Bakht *et al.*(2006).

Maize Equivalent Yield

Total productivity of the system expressed in terms of total maize equivalent yields (Table 3) revealed that the total MEY was the highest in greengram-maize sequence at 300 kg N ha^{-1} with 11165 kg and 9827 kg ha^{-1} in 2011-12 and 2012-13, respectively. However, the lowest total MEY was in clusterbean-maize sequence at 150 kg N ha^{-1} during both years with 4645 kg and 4895 kg ha^{-1} , respectively.

The interaction between the legumes grown in *rabi* followed by maize in summer at different nitrogen levels was not significant for any parameter in the two years of experimentation.

Overall, it can be concluded that highly exhaustive crop like maize can give higher kernel yield with nitrogen at 300 kg N ha^{-1} and with greengram as the preceding crop during *rabi* in coastal upland areas of Krishna agro-climatic zone when there are difficulties in growing *kharif* crop due to variation in the onset of monsoon.

LITERATURE CITED

Adiku S G K, Jones J W, Kumaga F K and Tonyigah A. 2009 Effects of crop rotation and fallow residue management on maize growth, yield and soil carbon in a savannah-forest transition zone of Ghana. *Journal of Agricultural Science,* 147: 313-322.

Agyare W A, Clottey V A, Mercer-Quarshie H and Kombiok J M 2006 Maize yield response in a long-term rotation and intercropping systems in the Guinea Savannah zone of Northern Ghana. *Journal of Agronomy,* 5(2): 232-238.

Bakht J, Ahmad S, Tariq M, Akbar H and Shafi M 2006 Response of maize to planting methods and fertilizer N. *Journal of Agricultural and Biological Science* 1(3): 8-14.

Cheruiyot E K, Mumera L M, Nakhone L N and Mwonga S M 2001 Rotational effects of grain legumes on maize performance in the rift valley highlands of Kenya. *African Crop Science Journal,* 9(4): 667-676.

Evans J, Mcneill A M, Unkovich M J Fettell N A and Heenan D P 2001 Net nitrogen balances for cool-season grain legume crops and contributions to wheat nitrogen uptake: A review. *Australian Journal of Experimental Agriculture*, 41: 347-359.

Harikrishna B L, Dasog G S and Patil P 2005 Effect of soil depths and N doses and its split application on maize plant height, LAI and dry matter yield at different growth stages. *Karnataka Journal of Agricultural Sciences*,18(2): 364-369.

Klaij M C and Ntare B R 1995 Rotation and tillage effects on yield of pearl millet (*Pennisetum glaucum*) and cowpea (*Vigna ungiculata*) and aspects of crop water balance and soil fertility in semi-arid tropical environment. *Journal of Agricultural Science,* 124: 39-44.

Ministry of Agriculture, Government of India. 2011-12 http://www.indiastat.com.

Panchanathan R M, Mohandas S and Kandaswamy P 1987 Effect of moisture regimes and nitrogen application on maize. *Indian Journal of Agronomy*, 34 (4): 471-472.

Patel J B Patel V J and Patel J R 2006 Influence of different methods of irrigation and nitrogen levels on crop growth rate and yield of maize (*Zea mays* L.). *Indian Journal of Crop Science,* 1 (1&2):175-177.

Sharma A R and Behera U K 2009 Nitrogen contribution through *Sesbania* greenmanure and dual-purpose legumes in maize – wheat cropping system: agronomic and economic considerations. *Plant Soil,* 325: 289-304.

(Received on 24.10.2013 and revised on 04.12.2014)