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Yield Potential and Economics of Rabi Maize as Influenced by Legume Crops, Residue Management Practices and Nitrogen Levels

P. Ammaji * and Ch. Pulla Rao
Department of Agronomy, Agricultural College, Rajamahendravaram 522 101, Andhra Pradesh, India.
*Corresponding author email id: ammajiagronomy@gmail.com

Abstract **– A field experiment was conducted on sandy clay soils of Agricultural College Farm, Aswaraopet, Khammam (dt.) to study the performance of Kharif legume crops residue management practices and nitrogen levels on the soil physical, chemical and microbial characters as influenced by legume residue management practices in legume maize sequence. The experiment was laid out in split- split plot design and the treatments were replicated thrice with three legumes, viz., cowpea, (M_1) fieldbean (M_2) and greengram (M_3) as main plot treatments taken up during the kharif season and two residue management practices viz., residue removal (R_0) and residue incorporation (R_1) as sub plot treatments. Four nitrogen levels 75 (N_1), 150 (N_2), 225 (N_3) and 300 kg ha^{-1} (N_4) as sub- sub plot treatments to maize. The experiment was conducted for two consecutive years. Among legume crops, the maximum fresh weight was produced by cowpea i.e., 20,280 and 22,815 kg ha^{-1} during the first and the second year of experimentation respectively, followed by field bean, while the lowest fresh weight of 8,676 and 9,760 kg ha^{-1} was obtained with greengram in the first and the second year, respectively. However, the highest pod yield and greengram equivalent yields were also recorded by cowpea followed by field bean and greengram. The dry matter accumulation of 7753 kg ha^{-1} and 8722 kg ha^{-1} were recorded with cowpea in the first and the second year, respectively. The economic yield in terms of greengram equivalent yield was maximum (1088 and 1091 kg ha^{-1}) with cowpea during 2011 and 2012, respectively. While, the lowest greengram equivalent yields of 952 and 976 kg ha^{-1} were recorded with greengram in the first and the second years respectively. Gross returns, net returns and benefit cost ratio worked out for entire legume - maize sequence taking into consideration of the inputs used in kharif and rabi seasons, and the economic yield for both the seasons during the two years of the study. Maximum net returns of maize Rs. 80,646 ha^{-1} and 97,442 ha^{-1}, respectively obtained during the first and the second year with incorporation of cowpea residues along with application of nitrogen @ 300 kg ha^{-1}, followed by cowpea with residue incorporation at 225 kg N ha^{-1}. While the lowest net returns of Rs 40,786 ha^{-1} and Rs 55,115 ha^{-1} were obtained with greengram as preceding crop without residue at 75 kg N ha^{-1}.**

Keywords **– Maize, Legume Crops, Equivalent Yields, Economics, BCR.**

I. INTRODUCTION

Maize (Zea mays L) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. It is cultivated on nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36% (782 m t) in the global grain production. In India, maize is the third most important food crops after rice and wheat. Maize in India, contributes nearly 9 % in the national food basket. In addition to staple food for human being and quality feed for animals, maize serves as a basic raw material as an ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc. Maize is cultivated both in temperate and tropical regions of the world. The full yield potential of maize crop can be exploited through adoption of hybrids with better nitrogen management

practices. Further, maize is a heavy feeder of nutrients, especially nitrogen, the deficiency of which limits the growth and yield of the crops. Over dependence on chemical fertilizers alone would lead to gradual decline in organic matter content and native fertility status of the soil, which in turn, reflects on productivity. Legume crop residues after the harvest of the economic part are the good source of plant nutrients and serves as readily available energy for soil microbes because of their relatively high nutrient content, low lignin content and easy decomposition. Therefore, a strategy of integrated use of nitrogen through fertilizers in combination with cheaper sources of organic matter which is abundantly available should be tried to satisfy the higher nitrogen requirement of the maize crop to produce higher quantity and quality yield of maize without impairing the soils health.

II. MATERIALS AND METHODS

The experiment was conducted at Agricultural College Farm, Aswaraopet during *kharif* and *rabi* seaons of 2011-12 and 2012-13. The soil of the experimental site was sandy clay in texture, slightly alkaline in reaction (P^H 7.8), low in available nitrogen, 148 kg ha^{-1}), medium in available phosphorus (33 kg ha^{-1}) and high available K (256 kg ha^{-1}). The experiment was laid out in split- split plot design and the treatments were replicated thrice with three legumes, viz., cowpea, (M_1) fieldbean (M_2) and greengram (M_3) as main plot treatments taken up during the *kharif* season and two residue management practices viz., residue removal (I_0) and residue incorporation (I_1) as sub- plot treatments and 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 to maize as 150 kg N ha^{-1} being the recommended dose during *rabi* in Central Telangana Zone, of Telangana state which corresponds to 50,100, 150, and 200 per cent recommended dose of nitrogen (RDN), respectively. The trial was repeated in a separate field in the second year. During two years of study Co-4, HA-3, MGG-295 varieties of cowpea, field bean and greengram respectively, were raised as *kharif* legumes while 30-V-92 a popular maize hybrid was grown during *rabi*.

For all the three crops, pods were harvested as and when they were matured and the economic yields were recorded plot wise. The entire main plot was divided into two sub plots, in one plot, the entire biomass was removed by uprooting the plants and utilized for fodder purpose and in another half of the plot all the biomass was finely chopped into pieces, incorporated in the soil and the biomass was allowed to decompose for one month in the field. Since the nature of the produce and the economic yield of the three crops is entirely different, it cannot be compared statistically and hence, the economic yield (green pod yield of fieldbean and cowpea), were converted in to greengram equivalent yield. The maize crop test variety 30 V92 was sown by adopting a spacing of 60 cm X 20 cm for the two successive seasons. Nitrogen was applied in the farm of urea as per the treatments in three splits viz., ¼ th at the time of sowing, ½ at knee-high stage and the remaining ¼ at tasselling stage. A common dose of 60 kg P_2O_5 and 50 kg K_2O was applied in the form of single super phosphate and muriate of potash at the time of sowing. Immediately after sowing pre emergence herbicide Atrazine @ 1.5 kg ha^{-1} was sprayed uniformly was sprayed on the entire field.

Maize equivalent yield was calculated by multiplying the economic yield of cowpea, field bean, and greengram with the price per kg of individual crops and divided by price per kg of maize in the local market by making use of the following formula as stated by Munda *et al.*(2008). The gross returns from each treatment during both the years of the study were worked out with the then existing prices of maize, cowpea, fieldbean and greengram. The net returns from each treatment were arrived by deducting the cost of cultivation worked out

with the then existing costs of inputs and labour wages. Benefit cost ratio (BCR) for all the treatments was worked out on the basis of net returns in terms of rupees after deducting the cost of treatments from gross returns.

III. RESULTS AND DISCUSSION

Performance of Kharif Legume Crops

Performance of *Kharif* legumes was assessed by taking into consideration the mean grain / pod yield, greengram equivalent yield, fresh weight of the residues after the harvest of the economic yield, dry matter. Among legume crops, the maximum fresh weight was produced by cowpea i.e., 20,280 and 22,815 kg ha^{-1} during the first and the second year of experimentation respectively, followed by field bean, while the lowest fresh weight of 8,676 and 9,760 kg ha^{-1} was obtained with greengram in the first and the second year, respectively. However, the highest pod yield and greengram equivalent yields were also recorded by cowpea followed by field bean and greengram. The dry matter accumulation of 7753 kg ha^{-1} and 8722 kg ha^{-1} were recorded with cowpea in the first and the second year, respectively. Nutrient (N, P and K) uptake was also followed the similar trend. The maximum N, P and K uptake of 91.8, 56.5 and 72.1 kg ha^{-1} and 156.1, 67.7 and79.3 kg ha^{-1} was recorded with cowpea in the first and the second year, respectively (Table 1).

Table 1. Seed yield (Kg Ha^{-1}), drymatter accumulation (at harvest), greengram equivalent yield and N P, K uptake of different *Kharif* Legumes.

Legumes	2011							2012						
	Grain yield (kg ha^{-1})	Green gram equivalent yield (kg ha^{-1})	Fresh weight (kgha^{-1})	Drymatter accumulate-on at harvest (kgha^{-1})	Nitrogen uptake (kgha^{-1})	Phospho-rus uptake (kgha^{-1})	Potassi-um uptake (kgha^{-1})	Grain yield (kg ha^{-1})	Green gram equivalent yield (kg ha^{-1})	Fresh weight (kgha^{-1})	Drymatter accumulate-on at harvest (kgha^{-1})	Nitrogen uptake (kgha^{-1})	Phospho-rus uptake (kgha^{-1})	Potassiu-m uptake (kgha^{-1})
M, Cowpea	1058	1088	20280	7753	93.8	56.5	72.1	1120	1091	22815	8722	116.6	67.7	79.3
Field bean	912	1042	18528	6470	65.3	40.1	55.6	945	1017	20844	7279	83.7	47.3	64.7
Green gram	952	952	8676	3045	35.0	16.1	27.1	976	976	9760	3412	41.0	18.7	30

(Source: Data recorded from two years of field experimentation from 2011 and 2012)

The economic yield in terms of greengram equivalent yield was maximum (1088 and 1091 kg ha-1) with cowpea during 2011 and 2012, respectively. While, the lowest greengram equivalent yields of 952 and 976 kg ha-1 were recorded with greengram in the first and the second years respectively. Cowpea recorded highest gross returns of F37030 ha-1 followed by field bean and greengram in both the years, while the net return of F23160 ha-1 was the maximum with greengram followed by field bean and cowpea. The maximum benefit cost ratio was recorded with greengram at 1: 1.4 and 1:1.5 during 2011-12 and 2012-13, respectively.

Though cowpea produced the highest quantity of crop residues could not result in the highest monetary return. In the present trial, greengram recorded the highest net return, while cowpea produced the highest quantity of crop residues and consequently added large quantity of nutrients to the succeeding maize crop. Although the highest quantity of green pod yield and green gram equivalent yields are recorded with cowpea,

since more labour cost involved for multiple pickings and marketing of the pods, the net returns and benefit cost ratio was less. Therefore, the choice of crop for the purpose of crop residues should be of short duration with a capability to produce large quantity of crop residues as possible along with the production of sizeable economic yield. Similar results were reported by Radha Kumari and Srinivasulu Reddy (2009) and Bharathi (2010).

IV. ECONOMICS

Gross returns, net returns and benefit cost ratio worked out for entire crop sequence taking into consideration of the inputs used in *kharif* and *rabi* seasons, and the economic yield for both the seasons during the two years of the study are presented in Maximum net returns of Rs. 80,646 ha^{-1} and 97, 442 ha^{-1}, respectively during the first and the second year was obtained with incorporation of Cowpea residues along with application of nitrogen @ 300 kg ha^{-1} followed by cowpea with residue incorporation at 225 kg N ha^{-1}. While the lowest net returns of P 40,786 ha^{-1} and Rs 55,115 ha^{-1} were obtained with greengram as preceding crop without residue at 75 kg N ha^{-1}.

Table 2. Seed/Pod yield (Kgha^{-1}), gross returns, net returns (P Ha^{-1}) and benefit cost ratio of *Kharif* Legume crops.

Legume crops	2011-12					2012-13				
	Legume crop yield	Cost of cultivation (P.ha^{-1})	Gross returns	Net returns (P.ha^{-1})	BCR	Legume crop yield	Cost of cultivation (P.ha^{-1})	Gross returns (P.ha^{-1})	Net returns (P.ha^{-1})	BCR
Cowpea	1058	17600	37030	19430	1 .1	1120	16500	39200	22700	1.4
Field bean	912	16000	36480	20480	1.2	945	16000	37800	21800	1.4
Greengram	952	10750	33320	22580	1.4	976	11000	34160	23160	1.5

(Source: Data recorded from two years of field experimentation from 2011 and 2012) Cowpea F 36/ kg, Fieldbean F.40/kg and greengram P 35/kg. Cowpea P 38/ kg, Fieldbean F 42/kg and greengram F.39/kg.

The benefit cost ratio ranged from 1.0 to 1.8 in first year and 1.3 to 2.2 in the second year with different treatments. The highest BC ratio was obtained with cowpea- maize sequence by incorporation of residues. During both the years of study, profitability and net returns of maize increased with increase in N application irrespective of the *kharif* legume crops. However, perceptible monetary advantage was not observed in all the sequences between 225 kg and 300 kg N ha^{-1} either with or without residue incorporation (Table 3).

Table 3. Gross returns (Gr), Net returns (Nr) and benefit cost ratio (Bcr) in the entire cropping sequence as influenced by legumes, residue management practices and fertilizer N on succeeding maize.

Treatment	N Levels	2011-12 (Rs./ ha)			2012-13 (Rs./ ha)		
		GR	NR	BCR	GR	NR	BCR
Cowpea without residue	N_1	93160	51250	1.2	100925	59615	1.4
	N_2	104156	61431	1.4	112750	70625	1.7
	N_3	116624	73084	1.7	125883	82943	1.9
	N_4	121064	76714	1.7	130700	86950	2.0
Cowpea with residue	N_1	96612	53702	1.3	104650	62340	1.5
	N_2	107632	63907	1.5	119829	76704	1.8
	N_3	121428	76888	1.7	135142	91202	2.1

	N_4	125996	80646	1.8	142192	97442	2.2
Field bean without residue	N_1	86048	45238	1.1	93708	52898	1.3
	N_2	97284	55659	1.3	106538	64913	1.6
	N_3	110856	68416	1.6	119846	77406	1.8
	N_4	114920	71670	1.7	124950	81700	1.9
Field bean with residue	N_1	89360	48050	1.2	97408	55598	1.3
	N_2	99444	57319	1.4	110633	68008	1.6
	N_3	117708	74768	1.7	122404	78964	1.8
	N_4	118244	74494	1.7	128442	84192	1.9
Greengram without residue	N_1	80096	40786	1.0	90925	55115	1.5
	N_2	90724	50599	1.3	101708	65083	1.8
	N_3	104492	63552	1.6	113854	76414	2.0
	N_4	108736	66986	1.6	120713	82463	2.2
Greengram without residue	N_1	85784	45474	1.1	95388	58578	1.6
	N_2	95048	53923	1.3	106979	69354	1.8
	N_3	108016	66076	1.6	119125	80685	2.1
	N_4	113680	70930	1.7	124121	84871	2.2

(Source: Data recorded from two years of field experimentation from 2011 and 2012) Cost of maize kernel F 12 kg $^{-1}$during 2011-12 Cost of maize kernel F 12.50 kg^{-1} during 2012-13.

The profitability of residue incorporation of cowpea-maize was higher followed by field bean residue incorporation- maize in the first and second year of study. This was due to the higher yields and market price of green pods of cowpea and field bean. These results are in accordance with the findings of Dasaraddi (2002) Hebbi (2000) Kumpawat (2001) Franke *et al.* (2004) and Channabasavanna *et al.* (2007).

V. Conclusion

From the two years of field study, the following conclusions could be drawn among the different legume crops cowpea found to be the best legume crop with highest net returns and benefit cost ratio. The influence of different legumes in terms of growth parameters and yields was more with cowpea-maize sequence with incorporation of crop residues. Incorporation of legume crop residues was found to be beneficial in improving the soil physical properties and yields of the crops application of nitrogen @ 225 kg ha-1 in combination with was found to be economical.

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AUTHOR'S PROFILE

First Author

Dr. P. Ammaji, She did her M. Sc (Ag) and Ph. D in the major discipline Agronomy from Acharya N. G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh, India. Working as Associate Professor in the Department of Agronomy, Agricultural College, Rajamahendravaram since from past 5 years She has been involved in the teaching of under graduate courses in Agronomy. She is instrumental in the preparation of effective teaching learning materials for better understanding. Worked as a scientist (Crop Production) in the extension wing of Acharya N.G. Ranga Agricultural University and formulated the effective transfer of technologies for the benefit of the farming community.

Second Author

Dr. Ch. Pulla Rao, He did his Ph. D in Agronomy from Banaras Hindhu Agricultural University. Worked at Acharya N.G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh for 30 year worked in different positions in the university. He has published several papers in national and international reputation. He has retired from service as Professor (Agronomy) from Agricultural College Bapatla during 2018.