ASSESSING OF RESIDUAL LEGUME EFFECT ON GROWTH AND YIELD PARAMETERS OF *rabi*MAIZE UNDER IRRIGATED CONDITIONS

ABSTRACT

An experiment was conducted tostudy the residual influence of preceding legumes and nitrogen levelson growth and yield parametersof *rabi*maize at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad, duringkharif and rabi of 2021and 2022.The experiment ~~is~~ was laid out in split-plot design with 18 treatments consisted of Groundnut-zero-till maize, Soybean-zero-till maize and Greengram- zero-till maize as main plotsand 6 subplots*viz.*100%RDN - 100%RDN, 100%RDN - 125%RDN, 100%RDN - 150%RDN, 75%RDN - 100%RDN, 75%RDN - 125%RDN, 75%RDN - 150%RDN (*kharif*and*rabi* respectively) during two years of study. Among the different cropping systems, the preceding *kharif*greengram on *rabi* zero-till maize showed higher growth interms *i.e.* plant height, leaf area, leaf chlorophyll content (SPAD reading) at30 DAS, cob length, cob girth and yield in both years. However, with respect to nitrogen levels,application of 100%RDN to the preceding*kharif* legumes followed higher level of RDN @150%to *rabi* maize showed significantly higher growth and yield followed by 100%RDN - 125%RDN which was on-par with 75%RDN - 150%RDN followed by 100%RDN - 100%RDN which was in-line with 75%RDN - 125%RDN and lowest was seen in 75% - 100% RDN in *kharif-rabi* respectively.On the other hand, the interaction effect with the preceding legume residues on succeeding *rabi* maize with addition of varied nitrogen levels was found non-significant in 2021and 2022

Key words: Residues of legumes, nitrogen levels, Zero-till maize, growth and yield

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Introduction:

Intensive maize production requires a lot of fertilizer N, which is expensive and inaccessible to resource poor farmers. More so, production of N fertilizers is high energy consuming and its use in farming is regarded as unsustainable. Therefore, sustainable management systems for intensive maize production ~~are~~ is~~ought~~eligible. Often, crop sequence involve legumes since they are capable of fixing nitrogen~~.~~ (Parihar *et al*., 2016). It is noted that legumes play a vital role in having beneficial food secure systems, and rotations involving legumes diversify crop production systems and improve fertility of soils. Another important aspect of residue management is the quality. Residue quality determines the effect of legumes on productivity of soils either by affecting availability of nutrients or soil organic matter. In that context, greengram, soybean and cluster-bean were known higher residual companion for the succeeding cereal system~~.~~(Pandey *et al*., 2008).

Substantially among legumes *i.e.*soybean being known as natural fertilizer capacity of fixing nitrogen property with rhizobium which accounts around 125-150 kg N ha^{-1} through nodules and by leaves about 30-40 kg N ha^{-1} for succeeding crops (Lowrance *et al*., 2017). Further greengram being extensively grown as legume crop in India and capable to grow year-round as a pure crop in sequential cropping systems and thus plays a vital role in furthering sustainable agriculture. Although groundnut is energy-rich leguminous crop by fixing atmospheric nitrogen by the root nodule bacteria. Hence,lower doses of nitrogen would be sufficient to raise a good crop and also application of phosphorus and potassium become more essential for obtaining higher yields.

The effect on nutrient availability occurs through release of nutrients or indirectly through decomposition products. Legume crop residues after mineralization by soil enhance the plant parameters. Hence there is the need to evaluate the growth and yield by the residual retention and nitrogen levels on *rabi* maize in both years.

MATERIALS AND METHODS

The present experiment was carried out at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad, during*kharif* and *rabi* seasons() of 2021and 2022. The farm is geographically situated at an altitude of 542.3 m above mean sea level at 17°19' N latitude and 78°23' E longitude in the Southern TelanganaAgro-Climatic Zone of Telangana State and it falls under Semi-Arid Tropics (SAT)according to Troll's classification. The weather during the crop period was most congenial for better performance of legume-maize sequence. Theweather parameters did not deviate much from the normal mean values of the location of study. Ideal weather conditions prevailed during the crop season for the legume-maize sequence, with temperatures at a normal range (12.60 to 33.20°C), consistent rainfall of 878.54mm, and ~~sufficient~~ sunshine (0.9 to 10 hours day^{-1}) in both years. The experiment was planned in a split-plot design with 3 main-plots and 6 sub-plots which consisted of C_1: Groundnut-zero-till maize, C_2: Soybean-zero-till maize, C_3: Greengram-zero-till maize cropping systems and sub-plots: N_1:100%RDN- 100%RDN, N_2:100%RDN - 125%RDN, N_3:100%RDN - 150%RDN,N_4: 75%RDN - 100%RDN, N_5:75%RDN - 125%RDN, N_6: 75%RDN - 150%RDN (*kharif* - *rabi* respectively) during two years.

*Kharif*legumes *viz.* (groundnut, soybean and greengram) were sown on June 25thwith row spacing of 30 cm and~~x~~10 cm between plants ~~and subsequently~~.*rabi* maize was sown on25thSeptember after harvest of greengramand 23th October in case of soybean and groundnut as sequence crop under zero-tillage conditions with mechanical planterin both the years of 2021-22 and 2022-23. However, the spacing followed for *rabi* maize was 60 cm x20 cm with recommended doses of phosphorus (80 kg ha^{-1} P_2O_5) and potash ~~levels~~ (~~80 P_2O_5;~~80kg ha^{-1} K_20 ~~kg ha^{-1}~~) respectively were applied at basal, along with varied levels of nitrogen as per the treatments in both years.Need based recommended plant protection and cultural practices like weed control, irrigation were adopted for both legumes and maize during the crop growth period.The recommended dose of nitrogen applied for groundnut, soybean and greengram during *kharif*~~are~~were20, 60, 20and 240 kg ha^{-1}for*rabi*maize respectively.

Plant height was recorded from 5 randomly selected plants at 30 DAS by measuring from the base of the stem (ground level) to the top most node in Maize. Leaf area from five destructively sampled plants was measured at regular intervals using the LI-COR Model LI-3100 leaf area meter with transparent conveyor belthavingelectronicdigitaldisplayandexpressedincm^2.Leaf Chlorophyll content-SPAD reading (Soil Plant Analysis Development) was measured from five tagged plants of the net plot with the instrument CCM-200 plus chlorophyll content meter regular intervals by putting the leaf between the sensors of the instrument. Five cobs were randomly selected from the net plot produce of maize and used for studying length and girth of cob. Length of five cobs was measured in centimeter from the butt end to the tip of the cob. Ordinary string (thread) was used for measuring the girth. The thread was wrapped around the cob and the length of thread was measured. From the net plot, cobs were picked, sun dried, threshed and cleaned separately for each treatment. Finally, the yield obtained from net plot was expressed on hectare basis as kg ha^{-1}. Grain yield of five tagged plants assigned for post-harvest observations were also added to the net plot yield.

Results and discussion

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~~On the perusal of the data~~the results indicated thatgrowth parameters at 30DAS, was influenced by the residual retention of *kharif* legumes on *rabi* maize and even by the nitrogen levels application (Table 1).

Plant height (cm)

At 30 DAS, the plant height was recorded significantly higher with a cropping sequence of greengram-*rabi*maize (36.84, 36.38 cm) compared to soybean-*rabi*maize (32.65, 32.41 cm) and groundnut-*rabi*maize (26.23, 26.13 cm).Thus, the improved plant height was seen with the greengram residual retention which favored for the improved moisture and nutrient status and enhanced the decomposition and availability at 30 DAS and also improved overall crop phenology. The findings were in tune withBharathi *et al*. (2015)

From the two years of research data, it was found that higher plant height was recorded with application of 100% RDN to preceding *kharif* legume followed by 150% RDN to *rabi* maize (38.83, 38.27 cm) over the 100% - 125% RDN (34.25, 33.47 cm) which was onpar with 75% - 150% RDN (33.70, 32.22 cm) followed by 75% - 125% RDN (29.67, 28.73 cm) which was comparable with 100% - 100% RDN (26.30, 29.27 cm) and lowest in 75% - 100% RDN (25.17, 24.73 cm) respectively. With the higher level of nitrogen at 150% RDN enhanced the nutrient availability, mobilization under zero-till condition that helped the crop to response to higher cell development and enhanced plant growth. However, the interaction effect of residual retention of legumes and nitrogen levels on *rabi* maize was found to be not significant at 30 DAS in both years.

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Leaf area

Significantly higher leaf area was measured at 30 DASforgreengram-maize (105.13, 99.91 cm^2) cropping sequenceover the corresponding soybean-maize (97.31, 93.38 cm^2) and groundnut-maize (89.29, 84.65 cm^2)crop sequences. Higher leaf area was registered with green gram residues in all the stages and even in both years, there might be the availability of the photosynthates due to faster deposition of nutrients for extended growth of leaf morphology over the crop duration.The higher leaf area was conferred with 100% - 150% RDN (110.16, 106.32 cm^2) over the subsequent levelssuch as 75% - 150% (103.10, 100.03 cm^2) and 100% - 125% (97.20, 92.54 cm^2) which were in line statistically. However, the lower leaf area was recorded with, 75% - 100% RDN (84.67, 80.6 cm^2) in 2021-22 and 2022-23 year of study.Two years of research observed that100% - 150% RDN showed its phenomenal development of leaf area due to the accessibility of nitrogen in sufficient amount favored for the cell division and elongation and subsequent growth upto vegetative phase, there after a slight decline due to shift in nutrient source sink for flowering. Which were in line with Gantaya*et al*. (2021). The interaction effect was found to be not significant at 30 DAS.

Leaf chlorophyll content (SPAD reading)

At 30 DAS, Leaf chlorophyll content of maize was significantly affected by adding residues of *kharif* legumes during 2021-22 and 2022-23, Growing of greengram as a preceding crop had recorded significantly higher Leaf chlorophyll content (22.54, 22.08) in *rabi* maize, however, soybean (20.50, 20.02) and groundnut (18.62,18.25) are comparable with each other. Thus the overall Leaf chlorophyll content showed increased trends after sowing in both years as the amount of residual activity on the

crop stand enhanced the source- sink relation that influenced the photosynthesis activity in the leaves upto vegetative stage.

From the study in both years *i.e.* 2021-22 and 2022-23, at 30 DAS that data showed that significantly higher Leaf chlorophyll content (SPAD reading)with N_3: treatment-100% - 150% RDN (23.47, 23.15),compared to N_6:treatment75% - 150%(22.05, 21.64),but $N_6$was onpar with N_2: treatment 100% - 125% (21.74, 21.19), followed by N_5: treatment 75% - 125% (19.45, 19.06) and low in N_4: treatment 75% - 100% (17.54, 16.97). Thus from the statistically data the increased doses of nitrogen levels helped in effective leaf development at middle and upper portion where the greater part of photosynthesis takes place that encouraged for the higher reading. Finding were in-line with Raghavendra *et al*. (2020). The interaction effect of residual *kharif* legumes and nitrogen levels on *rabi* maize were not significant at 30 DAS.

Yield and yield attributes

From the research study in both years of 2021-22 and 2022-23, the yield and yield attributes were recorded and were mentioned in table 2.

Cob Length (cm)

Significantly higher cob length (18.14, 1.84 cm) in *rabi* maize was evidenced with greengramfollowed by soybean as preceding *kharif* legumes (16.26, 15.98 cm) and lower was observed in groundnut as preceding crop to maize (14.88, 14.52 cm)in both theyears. With respect to the levels of nitrogen statistically higher cob length was noticed with 100% RDN to *kharif* legumes and subsequent dose of Nat 150% RDN(17.87, 17.61 cm) to*rabi* maize over 100% - 125% RDN (17.11, 16.81 cm) and was comparable with 75% - 150% RDN (17.07, 16.78 cm) and 75% - 125% (15.80, 15.46 cm) which was similar with 100% - 100% (15.77, 15.54 cm) and lowest in 75% - 100% (14.93, 14.49 cm) in 2021-22, 2022-23 of *kharif* and *rabi*respectively. The interaction effect was found non-significant in both years. Similar findings were also reported by Prabhavathi *et al*., (2021).

Girth of cob (cm)

Data at two years of research indicated that, greengram-maize sequence had recorded significantly higher girth of cob (15.94, 15.59 cm) over the soybean(14.07, 13.72 cm) and groundnut- maize (12.68, 12.33 cm) cropping sequence.From the study in both years, irrespective of the cropping sequences, levels of nitrogen showed influence on cob girth with N_3 level- 100% - 150% RDN (15.89, 15.46 cm) over the N_2level- 100% - 125% (14.63, 14.32 cm) which was onpar with N_6 level- 75% - 150% (14.59, 14.27 cm),N_1 -100% - 100% (13.38, 13.19 cm) and N_5levels- 75% - 125% (13.30, 13.21 cm) and lower cob girth was found with N_4 level- 75% - 100% RDN (12.13, 12.09 cm).The interaction effect was found to be non-significant with respect to levels of nitrogen and preceding *kharif*legume- *rabi* maize on the girth of the cob. Similar research findings are corroborated by Pasha *et al*., 2019.

Grain yield (Kg ha^{-1})

Throughout the study of two years, residues of *kharif* legume crops along with varied nitrogen levels notably impacted the grain yield of *rabi* maize under zero-till conditions. This influence on grain yield was consistent across both years(Table 2).

Among the cropping sequences, in 2021-22 and 2022-23, the pooled data revealed that,greengram-maize sequence exhibited notably maize superior grain yield(8812 kg ha^{-1})compared to the soybean-maize sequence (8013 kg ha^{-1}), whereas the groundnut-maize sequence reported lowermaize grain yield (7369 kg ha^{-1}).In both years of study, the impact of nitrogen levels on grain yield was most pronounced with the application of 100% RDN to preceding *kharif* crops and150% RDN to *rabi* maize(9038 kg ha^{-1}) followed by 100% - 125% RDN (8479 kg ha^{-1}) and 75% - 150% RDN(8380 kg ha^{-1}). The other levels such as 75% - 125%RDN (7857 kg ha^{-1})and 100% - 100% RDN(7795 kg ha^{-1}) exhibited comparable effects with intermediate maize grain yieldswhile the nitrogen levels of 75%-100% RDN (6840 kg ha^{-1}) demonstrated lower grain yields in all the cropping sequences(Table 2). This pattern was consistent across both years of the experiment, similar findings by reported by Wadile*et al.*,(2017).

The interaction effect of preceding *kharif* legume residue and nitrogen levels on*rabi* maize grain yields revealed that, the green gram as preceding *kharif* crop followed by maize as sequential *rabi* crop under zero-till conditions outyielded significantly higher grain yield at a recommended nitrogen level of 100% to the *kharif* crop and higher level of 150% RDN to *rabi* maize (9752 kgha^{-1})which was closely followed by 100% - 125% RDN (9331 kg ha^{-1}) and 75% - 150% RDN(9107 kg ha^{-1}).Further, the lower grain yields were realized with 75% - 100% RDN(6074 kg ha^{-1}).The less soil disturbance under zero-till conditions and also immobilization of nitrogen, the maize might have showed response to higher nitrogen levels compared to lower nitrogen levels. Overall, in a system perspective 250 % and 225% levels have showed superior performance interms of growth and yield (Table 4).

Table 1:Effect of preceding *kharif* legume residue and nitrogen levels on growth parameters at 30 DAS of zero-till *rabi* maize during 2021and 2022.

Treatments	Plant height (cm)			Leaf area(m^2)			Leaf chlorophyll content (SPAD reading)		
Cropping sequence	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**
C_1: Groundnut-zero-till maize	26.23	26.13	26.18	89.29	84.65	86.97	18.62	18.25	18.44
C_2: Soybean-zero-till maize	32.65	32.41	31.53	97.31	93.38	95.34	20.50	20.02	20.26
C_3: Greengram-zero-till maize	36.84	36.38	36.61	105.13	99.91	102.52	22.54	22.08	22.31
SEm±	1.41	1.33	-	2.55	1.83	-	0.45	0.34	-
C.D. (P=0.05)	4.11	3.86	-	7.40	6.32	-	1.55	1.18	-
F-Test	S	S	-	S	S	-	S	S	-
Nitrogen levels									
N_1: 100%-100% RDN	26.30	29.27	27.79	90.29	87.33	88.81	19.09	18.70	18.90
N_2: 100%-125% RDN	34.25	33.47	33.86	97.20	92.54	94.41	21.74	21.19	21.47
N_3: 100%-150% RDN	38.83	38.27	38.55	110.16	106.32	108.24	23.47	23.15	23.31
N_4: 75%-100% RDN	25.17	24.73	24.95	84.67	80.76	82.71	17.54	16.97	17.26
N_5: 75%-125% RDN	29.67	28.73	29.20	91.15	86.90	89.02	19.45	19.06	19.26
N_6: 75%-150% RDN	33.70	32.22	32.96	103.10	100.03	102.46	22.05	21.64	21.85
SEm±	1.51	1.38	-	3.21	3.02	-	0.47	0.50	-
C.D. (P=0.05)	4.37	4.02	-	6.15	8.59	-	1.34	1.43	-
F-Test	S	S	-	S	S	-	S	S	-
Interaction effect									
SEm±	2.37	2.72	-	4.43	5.22	-	0.81	0.87	-

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C.D. (P=0.05)	6.87	7.73	-	12.85	14.88	-	2.32	2.48	-
F-Test	NS	NS	-	NS	NS	-	NS	NS	-

Table 2:Effect of preceding *kharif* legume residue and nitrogen levels on yield attributes and yield of zero-till *rabi* maize during 2021-22 and 2022-23.

Treatments	**Cob Length (cm)**			**Girth of cob(cm)**			**GrainYield (kg ha^{-1})**		
Cropping sequence	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**	**2021**	**2022**	**Pooled**
C_1: Groundnut-zerotill Maize	14.88	14.52	14.70	12.68	12.33	12.51	7460	7288	7370
C_2: Soybean-zerotill Maize	16.26	15.98	16.12	14.07	13.72	13.90	8104	7922	8013
C_3: Greengram-zerotill Maize	18.14	17.84	17.99	15.94	15.59	15.77	8869	8773	8813
SEm±	0.09	0.08	-	0.40	0.39	-	62	511	26
C.D. (P=0.05)	0.33	0.27	-	1.38	1.36	-	215	147	91
F-Test	S	S	-	S	S	-	S	S	S
Nitrogen levels									
N_1: 100% -100% RDN	15.77	15.54	15.66	13.38	13.19	13.29	7887	7721	7795
N_2: 100% -125% RDN	17.11	16.81	16.96	14.63	14.32	14.48	8582	8376	8479
N_3: 100% -150% RDN	17.87	17.61	17.74	15.89	15.46	15.68	9091	8986	9038
N_4: 75% -100% RDN	14.93	14.49	14.71	12.13	12.09	12.11	6927	6754	6840
N_5: 75% -125% RDN	15.80	15.46	15.63	13.30	13.21	13.26	7916	7832	7858
N_6: 75% -150% RDN	17.07	16.78	16.93	14.59	14.27	14.43	8463	8297	8380
SEm±	0.09	0.10	-	0.44	0.36	-	57	42	52
C.D. (P=0.05)	0.24	0.29	-	1.23	1.10	-	163	119	148
F-Test	S	S	-	S	S	-	S	S	S
Interaction effect									
SEm±	0.15	0.18	-	0.93	0.97	-	99	90	90
C.D. (P=0.05)	0.42	0.51	-	2.66	2.77	-	282	262	257
F-Test	NS	NS	-	NS	NS	-	S	S	S

Table 3 Interaction effect of preceding *kharif* legume residue and nitrogen levels on Grain yield (kg ha^{-1}) of zero-till *rabi* maize during 2021-22 and 2022-23.

Treatments(2021-22)	**Nitrogen levels**						
Cropping sequence	**N_1** (100% -100% RDN)	**N_2** (100% -125% RDN)	**N_3** (100% -150% RDN)	**N_4** (75% -100% RDN)	**N_5** (75% -125% RDN)	**N_6** (75% -150% RDN)	**Mean**
C_1: Groundnut-Maize	7450	7965	8454	6147	6988	7754	7460
C_2: Soybean-Maize	7818	8393	9020	6905	7969	8519	8104
C_3: Greengram-Maize	8393	9386	9799	7727	8791	9117	8869
Mean	7887	8581	9091	6926	7916	8463	
Factor	**Cropping sequence (C)**		**Nitrogen (N)**	**Cropping sequence at same level of nitrogen**		**Nitrogen at same level of cropping system**	
SEm±	62		57	99		92	
C.D. (P=0.05)	214		162	282		266	

Treatments(2022-23)	Nitrogen levels						
Cropping sequence	**N_1** (100% - 100% RDN)	**N_2** (100% -125% RDN)	**N_3** (100% - 150% RDN)	**N_4** (75% -100% RDN)	**N_5** (75% -125% RDN)	**N_6** (75% -150% RDN)	**Mean**
C_1: Groundnut-Maize	7299	7699	8319	6001	6933	7479	7279
C_2: Soybean-Maize	7576	8154	8934	6742	7811	8314	7922
C_3: Greengram-Maize	8287	9276	9704	7519	8753	9098	8773
Mean	7720	8376	8985	6754.	7832	8297	
Factor	**Cropping sequence (C)**		**Nitrogen (N)**	**Cropping sequence at same level of nitrogen**		**Nitrogen at same level of cropping system**	
SEm±	51		42	90		79	
C.D. (P=0.05)	147		118	262		231	

Table 4 Interaction effect of preceding *kharif* legume residue and nitrogen levels on Grain yield (kg ha^{-1}) of zero-till *rabi* maize pooled data during 2021-22 and 2022-23.

Treatments(Pooled)	Nitrogen levels						
Cropping sequence	**N_1** (100% - 100% RDN)	**N_2** (100% -125% RDN)	**N_3** (100% - 150% RDN)	**N_4** (75% -100% RDN)	**N_5** (75% -125% RDN)	**N_6** (75% -150% RDN)	**Mean**
C_1: Groundnut-Maize	7348	7833	8387	6074	6961	7616	7370
C_2: Soybean-Maize	7697	8274	8977	6824	7890	8416	8013
C_3: Greengram-Maize	8340	9331	9752	7623	8722	9107	8813
Mean	779	8479	9038	6840	7858	8380	
Factor	**Cropping sequence (C)**		**Nitrogen (N)**	**Cropping sequence at same level of nitrogen**		**Nitrogen at same level of cropping system**	
SEm±	26		52	90		87	
C.D. (P=0.05)	91		14	257		252	

Conclusions:

The study revealed that the cropping sequence of greengram as preceding legume in *kharif* followed by zero-till maize in *rabi*showed significant results in terms of growth and yield. Specifically, nitrogen levels at a recommended dose of 100% in *kharif*and 150% in *rabi* exhibited the superior performance, followed closely by 100%-125% RDN and 75%-150% RDN. This suggests that a balanced approach, with reduced nitrogen in the preceding season but higher doses with legume residue retention, significantly enhances crop growth phenology as well as productivity during the both years.

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