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Residual Effect of Seed Rates and Timing of Knockdown of *Sesbania* and Nitrogen Levels on Growth and Yield of Zero till Maize in Rice-Maize Sequence

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***Abstract*:** Field experiment was conducted during *rabi* seasons of 2020-21 and 2021-22 on a clay loam soil at the Agricultural College Farm, Bapatla to study the residual effect of brown manuring on growth and yield of zerotill maize in rice-maize sequence. The experiment was laid out in split-split plot design and the main plot treatments consisted of brown manure species *Sesbania* (*Sesbania aculeata*) sown at three seed rates (20, 30 and 40 kg ha^{-1}) and sub plot treatments comprising knockdown of *Sesbania* at four stages (20, 25, 30 and 35 DAS) using 2,4-D @ 0.5 kg ha^{-1} applied to *kharif* preceded rice and three sub-sub-plots to receive three nitrogen levels *viz.,* control (no nitrogen), 75 % and 100 % RDN applied to succeeding maize, The higher plant height. cob length, cob girth, 100 kernel weight and grain yield of *rabi* maize was recorded when its preceding rice crop received highest seed rate of *Sesbania* . The brown manuring at 35 DAS followed by BM at 30 DAS registered higher values. The highest plant height. cob length, cob girth, test weight and grain yield was with application of 100% RDN to *rabi* maize., *Sesbania* seed rate @ 40 kg ha^{-1}and knockdown of *Sesbania* at 35 DAS in preceding rice crop and application of 100% RDN to succeeding maize is also essential for accomplishing higher growth and yield of zerotill maize in rice-maize system.

***Keywords*:** Brown manuring, Nitrogen levels, Rice-Maize Sequence and zero till maize

Maize (*Zea mays*. L) is one of the most unique emerging crops under varied agro-climatic conditions ranks third after rice and wheat in India occupying an area of 9.86 M ha, producing 31.51 Mt with a productivity of 3195 Kg ha^{-1} (Directorate of Economics & statistics, Ministry of Agriculture, Government of India, 2021).Having the highest genetic yield potential among the cereals, maize provides food, feed and fodder and also serves as a source of raw material for number of agro-based industries. The changing cultivation scenario of the Krishna Godavari Zone has rendered Rice-Maize as the most commanding cropping system replacing the age old tradition of Rice-Blackgram system because of diversified hurdles decreasing its efficiency and profitability. Nitrogen, an essential primary nutrient for rice, however the sky rocketing prices and the meager availability of inorganic nitrogen has often been beyond the reach of the farmers. Added to this meladay, use of either the organic manures or green manures in the rice-eco system encountered limitations in terms of shift in the season, scarce water availability and delay in time of application. Soil nutrient losses caused by an exhaustive cropping system like rice-maize cannot be fully offset by applying only the recommended doses of NPK fertilizers. To maintain soil productivity under continuous intensive cropping, additional measures are required (Kumari and Kaur 2016). Therefore, by keeping all these in view, present investigation was under taken to study the residual effect of brown manuring on growth and yield of zerotill maize in rice-maize sequence.

MATERIAL AND METHODS

The experiment was carried out on clay loam soils of Agricultural College Farm, Bapatla during *rabi* seasons of 2020-21 and 2021-22. The soil pH was slightly alkaline in reaction, low in organic carbon, low in available nitrogen, medium in available phosphorus and high in available potassium status. The*kharif* experiment was laid out in a split plot design during both the years of rice crop. The main plot treatments consisted of brown manure species *Sesbania* (*Sesbania aculeata*) sown at three seed rates (20, 30 and 40 kg ha^{-1}) and sub plot treatments comprising knockdown of *Sesbania* at four stages (20, 25, 30 and 35 DAS) using 2,4-D @ 0.5 kg ha^{-1} with three replications. During the succeeding *rabi*, the experiment was laid out on the same site in a split-split plot design to accommodate maize crop wherein, the three sub plot treatments imposed to *kharif* rice were divided into three sub-sub-plots to receive three nitrogen levels *viz.,* control (no nitrogen), 75 % and 100 % RDN to each plot thus, making a total of 12x3=36 treatments during *rabi.* The cultivars used in the investigation were Samba mashuri (rice) and Pioneer P-3396 (maize) respectively.

The average maximum and minimum temperatures during the cropping period were 31.6°C and 20.0°C during 2020-21 and 31.7°C and 18.8°C during 2021-22,

respectively. the average relative humidity was 69.8 % and 74.7 % during 2020-21 and 2021-22, respectively. A total rainfall of 23 mm was received in 2 rainy days and 60.3 mm was received in 2 rainy days during *rabi,* 2020-21 and 2021-22, respectively.

Sesbania was grown as co-culture with direct sown rice for brown manuring. Its seeds at three rates (20, 30 and 40 kg ha^{-1}) as per the treatments were broadcasted manually all through the respective plots after sowing of rice in rows and allowed to grow with rice crop. Application of 2,4-D spray @ 0.5 kg ha^{-1} was done uniformly at 20, 25, 30 and 35 DAS by using a knapsack sprayer @ 500 l ha^{-1} of spray fluid to knockdown *Sesbania* as per the respective treatments in the experimental plots which resulted in gradual killing of *Sesbania* plants. As per the treatments, nitrogen (240 kg ha^{-1}) was applied in three equal splits at basal, knee-high and tasseling stage in the form of urea in the respective sub-sub plots. Entire recommended dose of 80 kg P_2O_5 ha^{-1} and 80 kg K_2O ha^{-1} was applied at basal in the form of single super phosphate and muriate of potash, respectively at the time of sowing during the both the years of study.Statistical significance was tested by applying F-test at 0.05 level of probability.

RESULTS AND DISCUSSION

Plant height (cm) at harvest: Plant height was significantly influenced by residual effect of different seed rates and timing of knockdown of *Sesbania* and by the levels of nitrogen applied to maize. The interaction among the seed rates, timing of knockdown of *Sesbania* and levels of nitrogen were non-significant in pooled data (Table 1). The maximum plant height of maize was recorded when the preceding rice was supplied with *Sesbania* seed rate @ 40 kg ha^{-1}which was significantly higher when compared to other treatments. The lower values of plant height of *rabi* maize at all the growth stages were noticed in the *Sesbania* seed rate @ 20 kg ha^{-1} as preceded plots. The taller plants in the higher seed rate plots might be due to enhanced availability of nitrogen from the decomposition of *Sesbania*. Higher seed rate of *Sesbania* might have created a positive effect on availability of nutrients to the succeeding maize crop which resulted in enhanced plant height. The results were in agreement with the research findings of Wolfe and Eckert (2002) and Sujatha et al (2008)

At harvest, significantly the highest plant heightof succeeding maize was observed with *Sesbania* brown manuring at 35 days in preceding rice which was statistically comparable to brown manuring at 30 days. The lowest maize plant height was with the BM at 20 days treatment given to the preceding rice crop. As the decomposition of the aged crop is slow which will help to enhance the period of availability of nutrients that matches the nutrient demand of succeeding crop. That may be the reason for significant difference in plant height of maize due to knockdown of green manures at different ages. These results are in accordance with the findings of Muntasir et al (2010) and Patel and Kumhar (2010).

Plant height increased significantly with increasing levels of nitrogen throughout all the growth stages of *rabi* maize and the tallest plants were recorded when the crop was supplied with 100% RDN. This increase in plant height might be due to better availability and utilization of nutrients resulting in improved assimilation, cell division, cell elongation and plant height at higher levels of nitrogen. Similar result of taller plant at higher nitrogen levels and shorter plants at lower nitrogen was also reported by Kunjir et al (2007), Wasnik et al (2012)

Days to 50 Percent tasseling and silking: Days to 50 percent tasseling and days to 50 percent silking of rabi maize was not affected by the seed rates and timing of knockdown of *Sesbania* in *kharif* rice and nitrogen levels to *rabi* maize during both years of experiment and their interaction was found non-significant (Table 1).

Cob length (cm) and cob girth (cm): The cob length and cob girth in maize was significantly influenced by seed rates and timing of knockdown of *Sesbania* treatments given to preceding rice and by the levels of nitrogen given to maize. The interaction among main plot, sub plot and sub-sub plot treatments was non-significant (Table 2). Among the seed rates of *Sesbania* given to preceding rice, seed rate @ 40 kg ha^{-1}recorded significantly higher cob length and cob girth in maize which was statistically superior over other seed rates of *Sesbania* . The cob length and cob girth observed with the seed rate @ 20 kg $ha^{-1}$was significantly lower and was comparable to seed rate @ 30 kg ha^{-1}.

Significantly higher cob lengthand cob girth recorded with the higher seed rate of *Sesbania* might be due to slow release of nutrients and decomposition of green manure released additional N after mineralization by microbes and increased nitrogen availability in soil which led to better matching between nutrient demand by crops and its supply by soil to result in ultimately higher cob length. These results are in close conformity with the findings of Muntasir et al (2010) and Meena et al (2013).Significantly higher cob length and cob girth of *rabi* maize was recorded when its preceding rice crop received brown manuring at 35 DAS followed by BM at 30 DAS. The lower values were registered when the *kharif* rice received BM at 20 DAS whereas it was statistically differing with BM at 25, 30 and 35 DAS during both the years of study and pooled data. Delayed knockdown of *Sesbania* in preceded rice might have increased the physical and

biological properties and availability of nutrients leading to enhanced photosynthesis. Better accumulation of drymatter and photosynthates increased translocation to the sink leading to development of lengthy cobs. The experimental results are in compliance from findings of Arif et al (2011) and Anup Das et al (2016)

There was increase in the cob length and cob girth of *rabi* maize with increase in nitrogen levels during both the years of study. Higher cob length and cob girth of *rabi* maize was recorded with 100% RDN application and remained remarkably superior to all the other levels of nitrogen. Lower cob length and cob girth was registered with the control .The increased yield attributes might be due the increased supply of the major nutrients and the translocation and accumulation of photosynthates in the economic sinks, resulted in increased cob length and cob girth in maize The results are in consonance with the findings of Hari Om et al (2014), Venkata Rao et al (2014) and Pavithra et al (2015).

100 kernel weight (g): No significant differences were observed with the seed rates and timing of knockdown of *Sesbania* (Table 2). The thousand grain weight of maize was changed significantly among the levels of nitrogen. The interaction effect among these three factors was not statistically measurable. Among the levels of nitrogen tested, application of 100% RDN exhibited its better performance in registering significantly higher 100 kernel weight over control plot, while the 100 kernel weight recorded with N_2 was found to be on par with N_1. Though 100 kernel weight is a genetic character, due to its good management, weight of maize grain increased progressively with increased nitrogen levels. This might be due to increased translocation of photosynthates from source to sink. Reduction in nitrogen resulted in the reduced 100 kernel weight of maize. The results confirmed with the findings of Mercy et al (2012) and Owla et al (2015).

Grain yield (kg ha^{-1}): Grain yield was significantly influenced by different seed rates of *Sesbania* imposed to *kharif* rice crop. The highest grain yield of no till maize was registered

Table 1. Growth attributes of zerotill maize as influenced by seed rates and timing of knockdown of *Sesbania* applied to *kharif* rice crop and nitrogen levels to *rabi* maize (Pool data for 2 years)

Treatments	Plant height (cm) at harvest	Days to 50% tasseling	Days to 50% silking
Seed rate of *Sesbania* (M)			
M1- Seed rate of *Sesbania* @20 kg ha^{-1}	224.2	63	69
M2- Seed rate of *Sesbania* @30 kg ha^{-1}	238.9	62	67
M3- Seed rate of *Sesbania* @40 kg ha^{-1}	262.7	62	68
CD (p = 0.05)	16.5	NS	NS
CV (%)	11.5	9.6	8.6
Timing of knockdown of *Sesbania* (S)			
S1- Brown manuring at 20 DAS	222.8	63	69
S2- Brown manuring at 25 DAS	235.4	62	67
S3- Brown manuring at 30 DAS	248.5	61	67
S4- Brown manuring at 35 DAS	259.1	62	68
CD (p = 0.05)	12.5	NS	NS
CV (%)	11.0	9.1	7.1
Nitrogen levels applied to maize (N)			
N0- Control	221.2	63	70
N1- 75% RDN	247.8	62	67
N2- 100% RDN	268.4	61	67
CD (p = 0.05)	11.2	NS	NS
CV (%)	10.9	8.2	7.6
Interaction			
M x S		NS	
M x S		NS	
S x N		NS	
M x S x N		NS	

due to seed rate of *Sesbania* @ 40 kg ha^{-1} imposed to rice crop during *kharif*, which was statistically significant to other seed rates.The significant decrease in grain yield was recorded with the seed rate of *Sesbania* @ 20 kg ha^{-1} but was however comparable to the seed rate of *Sesbania* @ 30 kg ha^{-1}.Brown manure with higher seed rate not only supplements large quantity of organic biomass, but on decomposition has a solubilizing effect of N, P, K, and micronutrients (Zn, Fe, Mn, and Cu) in the soil and alleviating the deficiency of several nutrient elements by way of recycling the nutrients through this practice. Further, it also minimizes the leaching and gaseous losses of N, thus accomplishing the efficiency of applied plant nutrients. The findings are in confirmity with the experimental results of Fabunmi and Agbonlahor (2012), Talebbeigi and Ghadiri (2012) and Usman et al (2013).

The highest grain yield of maize was observed when the brown manuring of *Sesbania* was taken up at 35 DAS in preceding rice crop but was however comparable to BM practice at 30 DAS, which remained significant over BM action at 25 and 20 DAS. The lowest grain yield of maize was tabulated with BM at 20 DAS. Delayed knockdown of *Sesbania* in preceding rice might have supported in justifying the buildup of soil organic matter, which in turn, helped in improving the soil structure, pore size and water-holding capacity, increase in microbial population in rhizosphere of maize which could have rendered better availability of nutrients including micronutrients by reducing the loss of nutrients and improving the fertilizer use efficiency. Increase in the soil microbial population subsequent to the brown manuring at 35 days in rice crop might have led to increased solubilization of all the nutrients for absorption, which also could have resulted in the enhanced yield attributes like number of kernel rows cob^{-1}, kernel weight and test weight and finally kernel yield as compared to early days of brown manuring (Uma Reddy and Sathish 2017).

With increase in nitrogen level supplying to no till maize, the grain yield increased significantly over no N application.

Table 2. Yield attributes and grain yield of zerotill maize as influenced by seed rates and timing of knockdown of *Sesbania* applied to *kharif* rice crop and nitrogen levels to *rabi* maize (Pool data for 2 years)

Treatments	Cob length (cm)	Cob girth (cm)	100 kernel weight (g)	Grain yield (kg ha^{-1})
Seed rate of *Sesbania* (M)				
M1- Seed rate of *Sesbania* @20 kg ha^{-1}	15.6	12.4	22.2	6874
M2- Seed rate of *Sesbania* @30 kg ha^{-1}	16.1	13.0	22.4	7432
M3- Seed rate of *Sesbania* @40 kg ha^{-1}	17.3	14.6	22.6	8387
CD (p = 0.05)	0.8	0.8	NS	610
CV (%)	7.7	8.8	8.5	8.6
Timing of knockdown of *Sesbania* (S)				
S1- Brown manuring at 20 DAS	14.7	12.2	22.2	6519
S2- Brown manuring at 25 DAS	15.8	12.9	22.3	7427
S3- Brown manuring at 30 DAS	17.3	13.9	22.5	7974
S4- Brown manuring at 35 DAS	17.7	14.6	22.8	8229
CD (p = 0.05)	0.8	0.8	NS	352
CV (%)	9.9	8.5	9.3	8.2
Nitrogen levels applied to maize (N)				
N0- Control	14.5	11.9	22.2	6375
N1- 75% RDN	16.1	13.4	22.9	7674
N2- 100% RDN	17.8	16.0	23.1	8435
CD (p = 0.05)	1.0	1.4	0.8	322
CV (%)	8.0	10.9	7.2	8.0
Interaction				
M x S		NS		
M x N		NS		
S x N		NS		
M x S x N		NS		

Significantly the higher and lower grain yield of maize were registered with 100% RDN and control, respectively in both the years of study. The response to increased level of nitrogen may be attributed to faster release of available nutrients from the inorganic sources and maize being an exhaustive feeder could use this nutrient for increasing the physiological processes of plants thereby resulting in higher grain yields. The experimental results corroborate with the findings of Bahar et al (2009) and Baryal et al (2019).

CONCLUSION

On the basis of two years field experiment, residual effect of seed rate of *Sesbania* @ 40 kg ha^{-1} imposed in rice had exhibited significant positive residual effect on increasing the succeeding maize growth and yield. Among the knockdown days, brown manuring at 35 days followed by 30 days displayed superior growth and yield of maize. Further, maize crop requires 100% RDN for realizing superior growth, yield attributes and yield.

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