Eco. Env. & Cons. 30 (January Suppl. Issue) : 2024; pp. (S321-S325)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i01s.065

Growth and productivity of direct seeded rice as influenced by seed rates and timing of knockdown of Dhaincha in rice-maize sequence

Botha Prashanthi[1], P.V.N. Prasad[2], K. Srinivasulu[2], P. Venkata Subbaiah[3] and S. Ratna Kumari[4]

[1,2]Department of Agronomy, Agricultural College, Bapatla, ANGRAU, India
[3]Dr. K.L. Rao Krishi Vigyan Kendra, Garikapadu, ANGRAU, India
[4]Department of Crop Physiology, Agricultural College, Bapatla, ANGRAU, India

(Received 27 June, 2023; Accepted 28 August, 2023)

ABSTRACT

A field experiment was conducted during the *kharif* seasons of 2020-21 and 2021-22 to evaluate the effect of seed rates and timing of knockdown of dhaincha on growth and productivity of direct seeded rice. The experiment was laid out in split-plot design. The main plot treatments consisted of brown manure species of Dhaincha (*Sesbania aculeata*) sown at three seed rates (20, 30 and 40 kg ha^{-1}) and sub plot treatments comprising knockdown of dhaincha at four stages (20, 25, 30 and 35 DAS) using 2,4-D @ 0.5 kg ha^{-1} with three replications. Dhaincha seed rate @ 40 kg ha^{-1}recorded significantly taller plants, higher number of tillers m^{-2}, number of panicles m^{-2}, test weight and grain yield and among the timing of knockdown days of dhaincha the highest values were observed with treatment of brown manuring at 30 DAS. However, BM at 25 DAS maintained parity with BM at 35 DAStreatment. Thus, brown manuring practice with dhaincha seed rate @ 40 kg ha^{-1} and knocking it down at 30 days has displayed profound effectiveness in realizing higher grain yield of direct seeded rice in rice-maize system.

Key words: *Brown manuring, Knockdown, Dhaincha and Direct seeded rice*

Introduction

Rice based cropping systems described as a mix of farming practices comprise rice as a dominant crop followed by other crops in subsequent sequence. As a staple food source for most of the Indians, rice occupies a pragmatic status in the agricultural economy of this country with an area of 45.07 M ha producing 122.27 Mt and a productivity of 2.71 t ha^{-1}. India is the second largest producer and consumer of rice among the world nations (Directorate of Economics and statistics, Ministry of Agriculture, Government of India, 2021). As farmers solely depend on chemical fertilizers for crop cultivation, the imbalance supply of nutrients take place. Lack of adequate knowledge and limited facility for soil testing also results in fertilizer application without any scientific basis. The use of single nutrient fertilizers adds to the misery and the practice gradually reduces soil fertility and productivity. There is also increasing advocacy for use of green manure and natural nutrients for preventing the harmful effects of chemical fertilizers. This has generated a lot of attention for the integration of nutrients from organic, inorganic and biological sources. As chemical fertilizer cost is increasing progressively; brown manuring is an unconventional approach for supplying almost all nutrients to the crops which are

([1]Ph.D (Ag.) Scholar, [2]Professor, [3]Programme Coordinator, [4]Professor) considered advantageous for weed management as well as improving soil properties which ultimately leads to increase in crop yield by influencing overall agroecosystem. Interference by sesbania plants at initial stage (0-35 DAS) may affect rice growth and yield. This requires proper optimization of sesbania seed rate and time of 2,4-D application for higher rice-sesbania coordination.

Materials and Methods

The experiment was laid out in a split plot design on clay loam soils of Agricultural College Farm, Bapatla with 12 treatments during *kharif* 2020-21 and 2021-22. Each treatment was replicated thrice and were randomized as per procedure given by Cochran and Cox (1957). The main plot treatments includes brown manure species Dhaincha (*Sesbania aculeata*) sown at three seed rates (20, 30 and 40 kg ha^{-1}) and sub plot treatments comprising knock-down of dhaincha at four stages (20, 25, 30 and 35 DAS). 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 average maximum and minimum temperatures during the cropping period were 32.0 °C and 24.4 °C during 2020-21 and 32.0 °C and 23.8 °C during 2021-22, respectively. A total rainfall of 847.2 mm and 1219 mm was received during 2020-21 and 2021-22, in 58 and 76 rainy days, respectively. The test variety used for sowing was BPT-5204 and crop was sown at 20 cm and 15 cm inter and intra row distance, respectively and adopted all the standard package of practices. 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 dhaincha as per the respective treatments in the experimental plots which resulted in gradual killing of sesbaniaplants. The data on growth attributes, yield attributes and grain yield were recorded as per standard procedures. Statistical analysis of the data recorded was done following the fisher's method of analysis of variance as outlined by Panse and Sukhatme (1978) for the design adopted in this study.

Results and Discussion

Effect of seed rates and timing of knockdown of dhaincha on growth and yield of rice

Plant height (cm) at harvest

From Table 1, dhaincha seed rate @ 40 kg ha^{-1} recorded the tallest plants at harvest during 2020-21 and 2021-22, respectively and was statistically higher than those at 30 kg ha^{-1}. These results are in accordance with the findings of Muntasir *et al.* (2010) and Patel and Kumhar (2010) who reported that more quantity of fresh biomass addition which led to release more quantity of nutrients. Addition of nitrogen by brown manure species is associated with increase in protoplasm, cell division and cell enlargement resulting in taller plants.

The tallest plants were registered under S_3 treatment *i.e.,* brown manuring at 30 days. However, the shortest plants at harvest was associated with brown manuring at 20 days. When the brown manuring crop was annihilated with 2, 4-D ethyl ester spray at 30 days, the decomposition followed by mineralization of these dead plants might have resulted in proper blend of both organic and inorganic nitrogen fructifying a favorable environment in the rhizo-ecosystem of rice. Immediate release of fertilizer N in the initial stages followed by subsequent release of organic N thereafter favored their increased meristamatic activity and plant height of rice at subsequent stages. The results of the present investigation are in agreement with the findings of Gill and Wallia (2014) and Sarangi *et al.* (2016).

Number of tillers m^{-2} at harvest

During both the years of study, the total number of tillers m^{-2} measured at harvest was significantly influenced by seed rates and knockdown treatments. However, their interaction depicted non-significant behaviour.

Data analyzed for number of tillers m^{-2}at harvest presented in Table 1 revealed that the seed rate @ 40 kg ha^{-1} disclosed higher number of tillers m^{-2} during 2020-21 and 2021-22, respectively, which was found significantly superior to 30 and 20 kg ha^{-1} seed rate. The lower number of tillers m^{-2} was recorded with the seed rate @ 20 kg ha^{-1} during both the years of experiment. It could be a outcome of larger nutrient availability that encouraged superior tiller production. These findings are in conformity with Ramesh and Rathika (2017) who, found that tiller production being a vegetative attribute demands liberal supply of nitrogen and release of nutrients at a slow pace for better uptake by the crop. Sufficient availability of nitrogen increases plant height and photosynthesis which in turn helps in development of tillers according to research findings of Sanodiya and Singh (2018). Application of higher seed rate (40 kg ha^{-1}) aided in steady release of nutrients that resulted in maximum number of tiller production. The least number of tillers m^{-2} were noticed with the application of lower quantity of dhaincha biomass with a seed rate of 20 kg ha^{-1}.

At harvest, of direct seeded rice, the maximum number of tillers m^{-2} was recorded with BM at 30 days, which exerted significant superiority over BM at 25, 35 and 20 days and the minimum number of tillers m^{-2} was recorded with BM at 20 days. This could be due to the fact that the individual plants have effectively utilized the available resources such as space, foraging area for root system, light utilization etc. reflecting on enhanced tiller production. Dhaincha, as BM component knocked down at 30 days with a post-emergence herbicide 2,4-D functions as mulch which decomposes providing a substantial amount of nitrogen besides other nutrients to the crop succeeding in enhanced nutrient absorption by the crop for augmented tillering.

Number of panicles m^{-2} of rice

Significantly the highest number of panicles m^{-2} during 2020-21 and 2021-22, respectively were recorded in seed rate @ 40 kg ha^{-1} treatment over other seed rates (Table 1). The lowest number of panicles m^{-2} was observed with the 20 kg seed of dhaincha per ha. The higher number of panicles per unit area could be due to higher essential nutrients to the plant, that promoted plant growth and development, resulting in increased number of productive tillers. The present findings are in close conformity with the earlier findings of Schomberg *et al.* (2007).

Among the timing of knockdown of dhaincha the highest number of panicles per m^{-2} was observed in treatment brown ma-

Table 1. Plant height, Number of tillers m^{-2}, No. of panicles m^{-2}, Test weight and Grain yield of direct seeded rice as influenced by seed rates and timing of knockdown of dhaincha during *kharif*, 2020-21 and 2021-22

Treatments	Plant height (cm) at harvest		Number of tillers m^{-2} at harvest		No. of panicles m^{-2}		Test weight (g)		Grain yield (kg ha^{-1})	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Seed rate of dhaincha (M)										
M_1- Seed rate of dhaincha @20 kg ha^{-1}	86.6	88.3	354	356	349	354	14.7	14.9	5096	5284
M_2- Seed rate of dhaincha @30 kg ha^{-1}	98.1	100.5	406	409	365	371	15.2	15.5	5532	5655
M_3- Seed rate of dhaincha @40 kg ha^{-1}	108.2	110.4	459	463	389	396	15.6	15.8	5883	5994
S.Em±	2.50	2.83	7.5	9.1	3.75	4.42	0.36	0.37	109.3	112.2
CD (p = 0.05)	9.6	9.8	26	32	13	15	NS	NS	298	312
CV (%)	11.9	12.6	6.9	7.5	6.7	6.9	7.1	7.2	7.1	6.9
Timing of knockdown of dhaincha (S)										
S_1- Brown manuring at 20 DAS	83.3	85.5	351	353	343	348	14.8	14.9	5094	5248
S_2- Brown manuring at 25 DAS	103.0	105.6	414	419	373	379	15.2	15.5	5581	5735
S_3- Brown manuring at 30 DAS	114.1	117.2	442	448	388	396	15.7	15.8	5873	5989
S_4- Brown manuring at 35 DAS	95.4	97.1	405	413	366	371	15.0	15.3	5468	5604
S.Em±	3.6	3.72	7.6	8.1	3.35	4.32	0.24	0.29	59.6	60.3
CD (p = 0.05)	10.7	11.0	22	23	10	13	NS	NS	192	226
CV (%)	10.9	11.0	6.5	6.8	6.2	6.8	6.7	7.0	6.2	6.0
Interaction										
M x S	NS	NS	NS	NS	NS	NS	NS	NS	S	S
S x M	NS	NS	NS	NS	NS	NS	NS	NS	S	S

nuring at 30 DAS which was significantly superior to brown manuring at 25, 35 and 20 DAS. The lowest number of panicles m^{-2} was registered with time of 2,4-D application at 20 DAS treatment during 2020-21 and 2021-22, respectively. The higher number of panicles m^{-2} with brown manuring at 30 DAS might be due to higher and profused tillering, which could have facilitated plants for better utilization of the resources such as nutrients, moisture and light. More availability of these natural resources might have encouraged growth and development of rice plant to express more number of productive tillers (Ali *et al*., 2013).

Test weight (g)

Data on 1000 grain weight (g) are presented in Table 1. The data revealed that the 1000 grain weight (g) was not significantly influenced by seed rate and timing of knockdown of dhaincha during 2020-21 and 2021-22. Interaction effect between seed rate and timing of knockdown of dhaincha with respect to 1000 grain weight was not significant.

Grain yield (kg ha^{-1})

Main plot treatments receiving seed rates of dhaincha were found to display considerable influence on grain yield. Significantly higher grain yield was recorded with the application of dhaincha seed @ 40 kg ha^{-1} and found significantly superior over the seed rate @ 30 and 20 kg ha^{-1}. The lowest grain yield was associated with seed rate @ 20 kg ha^{-1}. The yield increase in the treatment receiving dhaincha seed rate @ 40 kg ha^{-1} might be attributed to the increased growth components besides marked yield components. Higher nutrient input of dhaincha promotes improvement in leaf photosynthetic rate, biomass production and sink formation, which increased the grain yield of rice as reflected in the present investigation were also reported by Deshpande and Devasenapathy (2011).

Grain yield (Table 1) of rice was influenced significantly due to different knockdown days. The highest grain yield was observed with BM at 30 DAS, which was significantly superior to BM at 25, 35 and 20 DAS. Significantly the lowest grain yield was registered with early knockdown of dhaincha at 20 DAS. The highest grain yield obtained with BM at 30 DAS subscribes to the view that there was greater availability of growth inputs matching with formation and development of yield components. The lower grain yield recorded in treatments which received early 2,4-D application (BM at 20 DAS) might be due to low availability of nutrients and photosynthates at critical stages of crop growth period which displayed a decreased trend in the yield attributes and yield as reported by many workers (Winarni *et al*., 2016). The loss in grain yield in delayed time of knockdown *i.e.*, BM at 35 DAS could be due to severe competition among plants for nutrients, solar radiation and space which might have offered greater interference with rice during the initial 35 DAS. Lower light penetration to lower leaves increases foliar shading and produces thinner stem. All these factors collectively contribute to a decrease

Table 2. Interaction between seed rates and timing of knockdown of dhaincha on grain yield (kg ha^{-1}) of direct seeded rice during *kharif*, 2020-21 and 2022-21

Treatments	2020-21					2021-22				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	4467	4967	5821	5133	5096	4533	5313	5873	5417	5284
M_2	5000	5829	5833	5467	5532	5350	5866	5929	5475	5655
M_3	5817	5947	5966	5806	5883	5861	6027	6167	5922	5994
Mean	5094	5581	5873	5468		5248	5735	5989	5604	
	SEm+	CD(p=0.05)	CV(%)			SEm+	CD(p=0.05)	CV (%)		
Main Plot	109.3	298	7.1			112.2	312	6.9		
Sub Plot	59.6	192	6.2			60.3	226	6.0		
Interaction										
M X S	198.6	596				205.3	613			
S X M	132.9	412				136.4	422			

Main Plot treatments-Seed rate of dhaincha (M)M_1- Seed rate of dhaincha @20 kg ha^{-1}M_2- Seed rate of dhaincha @30 kg ha^{-1}M_3- Seed rate of dhaincha @40 kg ha^{-1}
Sub Plot treatments- Timing of knockdown of dhaincha S_1- Brown manuring at 20 DASS_2- Brown manuring at 25 DASS_3- Brown manuring at 30 DASS_4- Brown manuring at 35 DAS

in photosynthesis; assimilate production and its partitioning and finally results reduction in drymatter production and grain yield.

Interaction effect of seed rates and timing of knockdown of dhaincha is presented in Table 2. and was significant with grain yield. The seed rate @ 40 kg ha^{-1} along with application of 2,4-D spray at 30 DAS registered highest grain yield followed by BM at 25 DAS at same seed rate. While, grain yield was minimum with the seed rate @ 20 kg ha^{-1} and knockdown at 20 DAS during both the years of study. Higher yield with seed rate of sesbania @ 40 kg ha^{-1} in combination with knocking down at 30 DAS might have offered greater interference against weeds but less interference on rice by the dhaincha during initial stages of growth, thus, providing competitive advantage to the rice crop. These results are in close conformity with those of Subramani *et al*. (2009) and Sraw (2017) who earlier reported that lesser crop weed competition and higher growth and yield attributes lead to enhanced photosynthetic accumulation and translocation together contributed for higher grain yield. The supply of the required nutrients through brown manuring facilitated balanced nutrition of the crop, which might have resulted in enhanced grain yield (Chaudhary *et al*., 2018).

Conclusion

The outcome of the above research findings can conclude that brown manuring with seed rate of dhaincha @ 40 kg ha^{-1} along with its knockdown at 30 days exhibited a significant response on growth and yield of rice during both the years of study.

Acknowledgements

I express gratitude to my Chairman Dr. PVN Prasad and every faculty member of the Department of Agronomy for constant support and guidance to hold out the entire experimental research study.

Conflict of Interest: The authors declare that they have no conflict of interest.

References

Ali, Q.M., Akhlaq, A., Mubarik, A., Muhammad. and Abbas, 2013. Establishment of planting methods for growth and yield of paddy (*Oryza sativa* L.) under Agro-Ecological conditions of district Shikarpur. *American Eurasian Journal of Agricultural and Environmental Science*. 13(11): 1503-1508.

Chaudhary, S.K., Marahatta, S. and Chaudhary, M. 2018. Impact of Different Seed Rates and Knocking Down Days of Sesbania on Weed Density and Yield of Dry Direct Seeded Rice. *International Journal of Applied Sciences and Biotechnology.* 6(4): 359-365.

Cochran, W.G. and Cox, G.M. 1957. *Experimental Design*. 2nd Edition, John Wiley and Sons, New York. 615.

Deshpande, H.H. and Devasenapathy, P. 2011. Effect of different organic sources of nutrients and green manure on growth and yield parameters of rice (*Oryza sativa* L.) grown under lowland condition. *Crop Research.* 41(1, 2 & 3): 1-5.

Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. 2021.

Muntasir, I.M., Tauhiduzzaman, S. and Ishaque, M. 2010. Study on the effect of N fertilizer and green manure on the growth and yield of BR 22 rice. *Indian Journal of Agricultural Chemistry*. 34(1-2): 15-21.

Panse, V.G. and Sukhatme, P.V. 1978. *Statistical Methods for Agricultural Workers.* ICAR, New Delhi.

Patel, A. and Kumhar, A.K. 2010. Effect of green manuring and nitrogen levels on soil health and yield of rice. *Green Farming*. 3(1): 20-22.

Ramesh, T. and Rathika, S. 2017. Optimization of Nitrogen Dose for Green Manure Incorporated Rice under Sodic Soil. *Madras Agricultural Journal.* 104(7-9): 221-225.

Sanodiya, P. and Singh, M.K. 2018. Effect of live mulches, cover crops and herbicides on weed flora, growth and yield of direct seeded rice (*Oryza sativa*). *Indian Journal of Agronomy*. 63(1): 60-66.

Schomberg, H.H., Martini, N.L., Diaz-Perez, J.C., Phatak, S.C., Balkcom, K.S. and Bhardwaj, H.L. 2007. Potential for using sunnhemp as a source of biomass and nitrogen for the Piedmont and coastal plain regions of the Southeastern USA. *Agronomy Journal*. 99: 1448-1457.

Sraw, P.K., Kaur, A. and Singh, K. 2017. To assess the scope of brown manuring in aerobic rice in central Punjab. *Journal of Crop and Weed*. 13(1): 17-22.

Subramani, T., Nalliah Duraira, J.S., Natarajan, S.K. and Thiruvarasan, S. 2009. Effect of nutrient management on yield and yield attributes of rice based cropping system in Tambarapavani command Area. *Journal of Agronomy*. 4(2): 127-129.

Vinod Kumar, Kumar, T., Singh, G. and Singh, R.A. 2017. Effect of integrated nutrient management on yield of rice and its residual effect on wheat in rice-wheat system under low land. *Annals of Plant and Soil Research*. 19(4): 360-365.

Winarni, M., Yudono, P., Indradewa, D. and Sunarminto, B.H. 2016. Application of perennial legume green manures to improve growth and yield of organic lowland rice. *Journal of Degraded and Mining Lands Management*. 4(1): 681.