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System of Crop Intensification in Ragi for Sustained Productivity to Meet the Challenges in Climate Change

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Abstract

System of crop intensification is one of the important concept to improve the productivity and to sustain the income of the farmers in long run. The doubling of farmers' income is the talk of the day to help them in their livelihood in spite of various constraints face in the field. Climate change is another challenge in the years to come for the farming sectors. Field experiments were conducted from 2016 to 2019 to evaluate the establishment technique in ragi (SRgI) wherein the experiment was laid out in Factorial Randomized Block Design, replicated thrice. The treatment consists of three establishment techniques *viz.,* Spacing: S_1 (22.5 X 22.5 cm), S_2 (25 X 25 cm) and S_3 (30 X 30 cm), Number of seedling: N_1 (one seedling per hill) and N_2 (two seedlings per hill) and Age of seedling: A_1 (12 days old seedling), A_2 (15 days old seedling) and A_3 (18 days old seedling) and control (22.5 X 10 cm, two seedlings per hill and 18 days old seedlings). The results revealed that single seedling with 12 days' age under wider spacing (30 X 30cm) was the suitable establishment technique to meet the challenges of increased production in millets. It was found that SRgI technique could result in single stroke harvest of ragi, avoiding multiple harvests. The results from the previous research of SRgI was considered, as a tool for mitigating climate change strategies *viz.,* high temperature and low rainfall. The experiments were taken up (2019-21) under Factorial Randomized Block Design, replicated thrice. The treatments consist of two factors *viz.,* Date of sowing: S_1 (Sowing on June 1st week), S_2 (Sowing on June 2nd week), S_3 (Sowing on June 3rd week) and S_4 (Sowing on June 4th week); and Variety: V_1(TRY1), V_2 (CO14), and V_3 (CO 15). SRgI method of planting was adopted *i.e.,* single seedling with wider spacing. From the reference of the pertaining data, it can be deduced that early sowing of variety TRY 1 and CO 15 on 1st and 2nd week of June respectively could increase the production of ragi, minimize the risk of pest incidence and reduce the cost of production thereby support as a resistant crop to mitigate the climate change concepts projected in near future keeping in view of the System of Crop Intensification and its benefits.

Key words: System of Ragi Intensification(SRgI), climate change, resilient crop, small millets.

Introduction

Finger millet (*Eleusine coracana* L. Gaertn) is one of the promising food potential for ensuring food and nutritional security of our country. Finger millet is an ecologically sound crop having flexibility and resilience to a variety of agro-climatic adversities. As the crop requires very less moisture and nutrient demand, it is largely cultivated among small farmers. With respect to area and production in our country it has the pride of place in having the highest productivity (1661 kg ha^{-1}) among the millets (Seetharam and Krishne Gowda 2007). The combined potential of millets as both resilient crops for resource constrained farmers and as a nutritious foodstuff for growing populations, millets are slowly being rediscovered by the agricultural research and development community. Also in view of celebration of International year of millets 2022–23; Ragi is promoted in large sale to meet the future challenges of farming community. The modern agronomic approaches like suitable variety, planting and time of planting were imperative in boosting the yields. Crop geometry is a very important factor to achieve higher production by better utilization of resources (Uphoff *et al.,* 2011).

System of Ragi Intensification (SRgI) is called as 'Gulli ragi' in local language at Karnataka which applies the same kind of management practices as used in SRI (System of Rice Intensification), to grow ragi with often doubling the yield without dependence of seed, variety and other inputs. Yield enhancement in finger millet is possible when cultivated with SCI, because there is less competition among plants and weed, where plants can utilize resources efficiently (Bhatta *et al.,* 2017). System of rice intensification is a proven technique in elevating rice production. Integrating SRgI techniques for millet cultivation also shows similar results under long term study conducted by All India coordinated Small Millets Improvement Project from 2016-2021.

A major problem in Ragi cultivation is crop establishment technique; faced by farmers which decides the population. The reason behind the success of SRgI is the uniform establishment, flowering and maturity which facilitate single stroke of harvest and enable reduction in cost of cultivation especially with respect to labour consumption involved in multiple harvest.

Methods

Field experiments were conducted from 2016 to 2019 to evaluate the establishment technique in ragi (SRgI) at Karaikal region. The experiment was laid out in Factorial Randomized Block Design, replicated thrice. The treatment consists of three establishment techniques *viz.,* Spacing: S_1 (22.5 x 22.5 cm), S_2 (25 x 25 cm) and S_3 (30 x 30 cm), Number of seedling: N_1 (one seedling per hill) and N_2 (two seedlings per hill) and Age of seedling: A_1 (12 days old seedling), A_2 (15 days old seedling) and A_3 (18 days old seedling) and control (22.5 x 10 cm, two seedlings per hill and 18 days old seedlings).

Similarly, during 2019-2021 various experiments were taken up under Factorial Randomized Block Design, replicated thrice to study the mitigation of climate change with SRgI as a tool. The treatments consist of two factors *viz.,* Date of sowing: S_1 (Sowing on June 1st week), S_2 (Sowing on June 2nd week), S_3 (Sowing on June 3rd week) and S_4 (Sowing on June 4th week); and Variety: V_1 (TRY 1), V_2 (CO 14), and V_3 (CO 15). SRgI method of planting was adopted *i.e.,* single seedling with wider spacing.

Results and Discussion

The pooled result revealed that LAI, DMP, number of tillers m^{-2}, number of ear heads m^{-2} and number of fingers earhead^{-1} were maximum with single seedling and wider spacing (30 x 30 cm) along with an age of 12 days old seedlings. Also the yield characters like thousand grain weight, harvest index were better and resulted in higher average grain yield of 1200 kg ha^{-1}. It was also found that SRgI technique could result in single stroke harvest of ragi, avoiding multiple harvests.

It was proved that wider spacing, young seedlings was the better option to have higher yield attributes in finger millet. Similar findings of number of seedlings per hill attributed exceedingly to the production of commendable number of ear head hill^{-1}, finger earhead^{-1}, finger length and 1000 grain weight as reported by Gnanamurthy (1980). Highest fingers earhead^{-1} was registered for the treatment with wider spacing (30 x 30 cm) along with an age of 12 days old seedlings as compared to other treatments (Fig.6) as envisaged by Vijayavalli (2015).

Therefore, the farmers can adopt square planting with single seedlings at the younger age to enjoy a high remuneration in finger millet production as alos envisaged by Shukla *et al.* (2014). From the forgoing long term investigation, it can be concluded that SRgI practice [*i.e.* Single seedling with wider spacing (30 x 30 cm) along with 12 days old seeding ($S_3N_1A_1$)] could increase the production strategy of ragi and help to meet the challenges and sustain the nutritional security which will be the best option to obtain maximum remuneration by the farming community.

Also the high temperature prevailing during June to September and poor rainfall distribution at Karaikal region is another predicament factor that hinders the ragi production. The late sowing leads to reduction in the yield; however, this variation can be minimized by sowing a variety which has relatively less reduction in yield. This not only benefits maximum yield but also reduce cost spent on plant protection.

The results from the previous research of SRgI was considered, as a tool for mitigating climate change strategies *viz.,* high temperature and low rainfall experiments were designed to meet the challenges in climate change to evaluate the suitable variety and transplanting window of ragi using SRgI technique from 2019-22.

The pooled results obtained from the year 2019 to 2021 indicated that, plant height , thousand grain weight, straw yield and grain yield (1638 kg ha^{-1}) were superior in variety TRY 1 sown at the 1st week of June (S_1V_1). Also TRY 1

(V_1) a saline resistant genotype performed better at all four sowing windows (**Table 1 & Table 2**). The variety CO 15 when sown at 2nd week of June was next superior treatment (S_2V_3) which brought about 1229 kg/ha of average grain yield. The finding also depicted that late sown crop was susceptible to pest occurrence especially stem borer.

Table1. Effect of date of sowing and variety on grain yield of ragi

Treatment	Grain yield (kg ha^{-1})			
	V_1 (TRY 1)	V_2 (CO 14)	V_3(CO 15)	Mean
S_1 (Sowing on June 1st week)	1638	1094	848	1193
S_2 (Sowing on June 2nd week)	1098	671	1221	994
S_3 (Sowing on June 3rd week)	976	546	591	704
S_4 (Sowing on June 4th week)	1026	916	518	820
Mean	**887**	**605**	**596**	
	SE d		**CD**	
S	426.7		2030.9	
V	655.7		2380.1	
SXV	1311.3		3593.1	

Table 2. Effect of date of sowing and variety of ragi on straw yield of ragi (kg ha^{-1})

Treatment	Straw yield of ragi (kg ha^{-1})			
	V_1 (TRY 1)	V_2 (CO 14)	V_3(CO 15)	Mean
S_1 (Sowing on June 1st week)	2900	2117	1644	**2220**
S_2 (Sowing on June 2nd week)	1089	1329	1221	**1213**
S_3 (Sowing on June 3rd week)	1378	969	1013	**1120**
S_4 (Sowing on June 4th week)	1500	1726	1124	**1450**
Mean	**1287**	**1151**	**938**	
	SE d		**CD**	
S	689.7		3283.0	
V	2340.5		8496.2	
SXV	4681.1		12826.2	

Conclusion

From the reference of the pertaining data, it can be deduced that early sowing of variety TRY 1 and CO 15 on 1st and 2nd week of June respectively could increase the production of ragi, minimize the risk of pest incidence and reduce the cost of production in Karaikal region thereby support as a resistant crop to mitigate the climate change concepts projected in near future keeping in view of the System of Crop Intensification and its benefits.

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