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Enhancing Seed Yield of Daincha (*Sesbania aculeata* L.) New Variety TRY1 Through Optimum Spacing and Nutrient Management

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ABSTRACT

Background: Increasing demand for leguminous green manure crop daincha seed is being noticed throughout the country mainly to restore the soil fertility. For maximizing seed production of newly released daincha variety, an optimum plant density per unit area and fertilizer application are an important management tool. The study was conducted to optimize the plant spacing and fertilizer dose for achieving higher seed yield of daincha variety TRY 1.

Methods: Field experiments were conducted during *Summer* and *Kharif* 2023 to study the effect of different spacing and fertilizer doses on growth, yield and economics of new daincha variety TRY1. The treatments consisted of five different spacing (S_1-75×30 cm, S_2-60×30 cm, S_3-75×45cm, S_4-60×45 cm and S_5-90×30 cm) in main plots and three fertilizer levels (F_1-12.5:25:12.5 kg N, P_2O_5, K_2O ha^{-1}, F_2-18.75:37.5:18.75 kg N, P_2O_5, K_2O ha^{-1}, F_3-25:50:25 kg N, P_2O_5, K_2O ha^{-1} and control) in sub plots were tested. The treatments were replicated thrice in split plot design.

Result: Growing of daincha variety TRY 1 at 60×45 cm spacing produced significantly taller plants (223 cm), more number of branches per plant (15.9) and dry matter production (1766 kg ha^{-1}), yield parameters *viz.,* higher mean number of pods per plant (114), pod length (22.4 cm) and seeds per pod (36.7), seed yield (567 kg ha^{-1}), mean net returns (Rs.24512 ha^{-1}) and benefit cost ratio (2.36) than other spacing. Application of 25:50:25 kg N, P_2O_5, K_2O ha^{-1} recorded significantly mean taller plants (217 cm), more number of branches per plant (19.3), dry matter production (1831 kg ha^{-1}), nodules/plant (40.7), more number of pods /plant (121), pod length (23.7 cm) and seeds per pod (37.8), seed yield (572 kg ha^{-1}), net returns (Rs.23369 ha^{-1}) and benefit cost ratio (2.20) over other fertilizer doses. Thus, the optimum spacing of 60×45 cm and fertilizer dose of 25: 50:25 kg N, P_2O_5, K_2O ha^{-1} could be recommended for getting higher growth, yield parameters, seed yield, net returns and benefit cost ratio of newly released daincha variety TRY 1.

Key words: Daincha, Economics, Fertilizer dose, Green manure, Spacing, Yield.

INTRODUCTION

Daincha (*Sesbania aculeata* L.) is a quick-growing succulent, leguminous green manure crop, incorporated *in-situ* around 45-55 days after sowing to increase the soil fertility. It adopts well in various soil and climate conditions and grown even under the adverse conditions like drought, water logging, sodicity, salinity, *etc.* Before the advent of mineral fertilizers, green manuring was considered as an indispensable practice in crops like rice, sugarcane, potato, wheat, mustard *etc.* But later with easy availability of chemical fertilizers and intensive cropping systems, practice of green manuring was almost given up which resulted in many adverse effects on natural resources such as decline in soil health, deficiency of major and micro-nutrients, energy crises, stagnation in yield and ecological-environmental imbalance. In this context, there has been revival of interest in green manuring which plays a vital role in minimizing the ill effect of intensive cropping system and continuous use of fertilizers.

Daincha is one of the important green manure crops with multiple uses *viz.,* green manure, mulch for moisture conservation, weed suppression, ground cover, firewood, fuel, fibre and bioenergy sources, providing live support fencing wood, raw materials for industrial uses andin traditional agroforestry systems, animal feed, fodder and medicinal importance (Chanda *et al*., 2021; Masilamani *et al*., 2021). It produces higher green biomass of 22.3 t ha^{-1}, which supplies 47.85 kg N ha^{-1} under sodic soil condition (Ramesh and Rathika, 2017). It improves the soil fertility, crop productivity, reduces the application of inorganic fertilizers and reduces sodicity. Green manuring of daincha also acts mainly as soil acidifying matter to decrease the alkalinity / pH of alkali soils by generating humic

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acid and acetic acid. Daincha incorporation improves soil structure, aeration, permeability and also protect the soil from leaching of nutrients. It is fast growing crop and produce more number of nitrogen nodules. Adoption of suitable management technologies like optimum spacing and fertilizer dose are important to achieve better utilization of resources and ultimately increased biomass and seed yield of daincha (Rajesh *et al.*, 2017).

Recently, a new daincha variety TRY 1 was released from Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, first variety from TNAU (Anonymous, 2024). Before commercializing the cultivation, suitable agronomic techniques have to be developed to achieve its production potential. Agronomic techniques *viz.,* optimum spacing and fertilizer dose have to be standardized for increased production of good quality seeds of daincha. Adoption of optimum spacing favours greater light interception right from early period of crop growth. Further, supply of nutrients through application of optimum dose of fertilizer favours better growth and seed yield of daincha. Hence, the objectives of present study were formulated to identify the optimum spacing and fertilizer dose to obtain a higher seed yield of newly released daincha variety TRY 1.

Materials and Methods

The experiment was conducted during *Summer* and *Kharif* 2023 at Anbil Dharmalingam Agricultural College and Research Institute, TNAU, Tiruchirappalli, Tamil Nadu. The site was geographically located in the central part of Tamil Nadu with a latitude of 10°45′N, longitude of 78°36′ E and 85 m above mean sea level. Weather parameters prevailed during the experimental period revealed that the mean maximum and minimum temperatures recorded were 37.4°C and 25.5°C during *Summer* and 36.3°C and 23.6°C during *Kharif*, 2023 respectively. Over the course of the cropping period, a total of 225 mm of rainfall was received in 21 rainy days during *Summer* and a total of 412 mm of rainfall was received in 27 rainy days during *Kharif*, 2023. The soil type of the experimental site was sandy clay loam with a moderate drainage system. The soil was sodic in nature with a pH of 8.9. The soil contained 0.45% organic carbon, 206: 15.8: 243.0 kg ha^{-1} available NPK respectively.

The experiment was conducted in split plot design with three replications. Main plots consisted of five different spacing *viz.,* S_1-75×30 cm, S_2-60×30 cm, S_3-75×45 cm, S_4-60X45 cm and S_5-90×30 cm. The sub plots treatments were consisted of three fertilizer levels *viz.,* F_1-12.5:25:12.5 kg N, P_2O_5, K_2O ha^{-1}, F_2-18.75:37.5:18.75 kg N, P_2O_5, K_2O ha^{-1}, F_3-25:50:25 kg N, P_2O_5, K_2O ha^{-1} and control. Recommended dose of fertilizers for pulses *i.e.* 25: 50: 25 kg NPK ha^{-1} was taken as 100% NPK treatment (F_3) and from that the treatment 50% (F_1) and 75% NPK(F_2) were worked out. The entire fertilizers were applied as basal at the time of sowing. The new daincha variety TRY 1 released from ADAC and RI, Tiruchirappalli during (2024) was a selection from Sivagangai local producing average green biomass of 17.86 tonnes ha^{-1}. The special features of this variety were low C: N ratio, higher nodulation and no incidence of major pest and diseases (Anonymous, 2024).

Ten plant samples were randomly tagged from each treatment for taking biometric observations. Growth parameters like plant height, number of branches per plant were recorded at harvesting stage and number of nodules per plant were counted at 45 days after sowing. Ten plants were taken at random from the sampling rows for estimating dry matter production. Samples were shade dried and then dried in hot air oven at 80°C for 72 hours to attain a constant weight. The dry weight was then expressed in kg ha^{-1}. Yield attributes like number pods per plant, pod length, number of seeds per pod and test weight were recorded at the time of harvest. Seed yield was recorded from the net plot area at harvest stage and expressed as kg ha^{-1}. Economics of various treatments were worked based on the prevailing market price of inputs and outputs. Experimental data collected was statistically analysed as outlined by Gomez and Gomez (1984). A critical difference at 5 per cent probability level was calculated for the treatments with significant differences.

Results and Discussion

Growth parameters

Growth parameters such as plant height, number of branches per plant and dry matter production (DMP) of daincha variety TRY 1 were significantly varied with different spacing and fertilizer treatments (Table 1). Among the spacing tested, the spacing 60×45 cm produced significantly taller plants (223 cm) and dry matter production (1766 kg ha^{-1}) than other spacing. However, it was statistically comparable with spacing of 75×30 cm in plant height, number of branches per plant and DMP. Even though, the wider spacing 90×30 cm produced higher number of branches/plants, it was comparable with 60×45 cm. Optimum plant spacing supports favourable conditions for enhanced space, light, nutrients and soil moisture for increased photosynthesis, metabolic activities, growth and development right from early period of crop growth which resulted in higher growth characters. The results were in accordance with Jiotode *et al.* (2017). Further, it is also an important factor to realize the production potential of daincha without much competition among the plants. The closer spacing 60×30 cm recorded significantly lower growth characters than other treatments. Among the fertilizer treatments, application of 25:50:25 kg N, P_2O_5, K_2O ha^{-1} recorded significantly taller plants (217 cm), more number of branches per pant (19.3) and DMP (1831 kg ha^{-1}) over other doses and control. This was flowed by application of 18.75:37.5:18.75 kg N, P_2O_5, K_2O ha^{-1}. Reduced fertilizer levels showed lesser growth parameters of daincha. The control plot registered the shortest plants (164 cm), lesser number of branches per plant (11.2) and DMP (1065 kg ha^{-1}) than other treatments. In general, the crop growth

Table 1: Effect of spacing and fertilizer levels on growth parameters of daincha variety TRY 1.

Treatments	Plant height (cm)			No. of branches plant^{-1}			Dry matter production (kg ha^{-1})			No. of nodules plant^{-1}		
	Summer 2023	*Kharif* 2023	Mean	*Summer* 2023	*Kharif* 2023	Mean	*Summer* 2023	*Kharif* 2023	Mean	*Summer* 2023	*Kharif* 2023	Mean
Spacing												
S_1: 60×30 cm	178	206	192	10.6	12.9	11.7	1081	1247	1164	23.8	28.6	26.2
S_2: 60×45 cm	202	243	223	14.3	18.3	15.9	1625	1907	1766	27.2	32.5	29.8
S_3: 75×30 cm	195	237	216	14.4	17.2	15.8	1537	1844	1690	29.0	34.4	31.7
S_4: 75×45 cm	189	219	204	14.2	17.3	15.8	1287	1540	1414	32.5	38.5	35.5
S_5: 90×30 cm	191	229	210	14.2	17.7	16.3	1225	1512	1368	35.5	41.6	38.6
SEm±	5.2	6.3	5.7	0.4	0.5	0.5	37	45	41	0.7	0.8	0.7
CD (P≤0.05)	11.3	13.8	12.5	0.9	1.1	1.0	80	98	89	1.4	1.8	1.6
Fertilizer level (N, P_2O_5, K_2O kg ha^{-1})												
F_1: 12.5: 25: 12.5	181	204	193	11.8	14.4	13.1	1192	1428	1310	31.7	38.7	35.2
F_2: 18.75:37.5:18.75	190	218	204	14.9	17.9	16.4	1439	1746	1593	33.5	40.0	36.8
F_3: 25: 50:25	199	234	217	17.5	21.2	19.3	1582	2079	1831	35.8	45.6	40.7
Control	164	192	178	9.9	12.4	11.2	970	1161	1065	27.1	32.4	29.7
SEm±	4.9	5.9	5.4	0.5	0.7	0.6	55	69	62	1.0	1.2	1.1
CD (P≤0.05)	11.5	14.1	12.8	1.17	1.43	1.3	119	149	134	2.4	3.0	2.7

Interaction not significant.

parameters were higher during *Kharif*, 2023 than *Summer*, 2023 mainly due to higher temperature and low rainfall during summer season which reduced the growth of daincha.

Nodulation

The data on nodules per plant revealed that wider spacing produced significantly a greater number of nodules per plant than closer spacing (Table 1). The spacing 90×30 cm registered significantly greater number of nodules per plant (38.6) then other spacing. This was followed by the spacing 75×45 cm, 75×30 cm and 60×45 cm. The lowest nodules per plant was obtained with closer spacing of 60×30 cm. Higher dose of fertilizer (25: 50:25 N, P_2O_5, K_2O ha^{-1}) recorded more number of nodules per plant (40.7) than lower doses. This was followed by application of 18.75:37.5:18.75 kg N, P_2O_5, K_2O ha^{-1}, which exhibited 36.8 numbers of nodules/plant. Application of nitrogen and phosphorus during early stages of crop supplied more nutrients to Rhizobacteria which fix more atmospherics N in the form of nodules than no fertilizer application (Singh and Gangaiah, 2012). The treatment which received no fertilizer application reduced the nodulation capacity of plants to the tune of 27.0% over higher dose of fertilizer application.

Yield parameters

Yield parameters of daincha variety TRY 1 *viz.,* number of pods per plant, pod length and seeds per pod were significantly influenced by various spacing and fertilizer treatments (Table 2). Daincha variety TRY 1 sown at spacing of 60×45 cm recorded significantly higher number of pods per plant (114), pod length (22.4 cm) and seeds per pod (36.7) than other treatments. It was on par with the spacing 75×30 cm which recorded 108, 21.7 cm and 33.0 number of pods per plant, pod length and seeds per pod, respectively. The next best treatment was 90×30 cm which registered lesser number of pods/plant (105) and seeds/ pod (26.1). Higher yield attributes under 60×45 cm spacing was mainly due to that appropriate plant spacing with adequate plant population improved growth attributes *viz.,* plant height, number of branches per plant, dry matter production which might have helped in better translocation of nutrients towards yield attributes. These results are in conformity with the earlier findings of Rajesh *et al.* (2017). The lowest number of pods (87), pod length (17.2 cm) and number of seeds per pod (26.1) were obtained with closer spacing of 60×30 cm. Seed test weight was not significantly varied among the spacing tested. Higher plant population in narrow spacing might have higher competition for moisture, nutrients, space and sunlight which ultimately produced poor source as compared to wider spacing which ultimately negatively affected sink *i.e.* yield attributes.

Higher dose of fertilizer 25: 50:25 kg N, P_2O_5, K_2O ha^{-1} showed significantly a greater number of pods /plant (121), pod length (23.7 cm) and number of seeds /pod (37.8) over lower doses and control. The nest best treatment was application of 18.75:37.5:18.75 kg N, P_2O_5, K_2O ha^{-1} which showed 9.0% reduction in number of pods $plant^{-1}$ than higher dose of fertilizer. The lowest yield attributes *viz.,* pods per plant (78), pod length (19.9 cm) and seeds per pod (26.1) were noticed with control plot. Seed test was varied significantly with fertilizer treatments and higher dose of fertilizer application recorded higher test weight (1.93 g) than other treatments. The balanced application of NPK at the highest dose satisfied the crop requirements and increased photosynthetic efficiency and translocation of more photosynthates from source to sink resulted in higher yield parameters of daincha. Similar effect of NPK application in pigeon pea has been documented by Sultana *et al.* (2018).

Seed yield

Agronomic techniques *viz.,* spacing and fertilizer application favourably altered the seed yield of daincha variety TRY 1. Among the spacing treatments, significantly higher seed yield (567 kg ha^{-1}) was exhibited under 60×45 cm over other spacing (Table 3). However, it was statistically comparable with the spacing of 75×30 cm (540 kg ha^{-1}). Increased seed yield might have been possible due to sufficient availability of light andsupply of nutrients in balanced quantity under optimum plant spacing favoured better photosynthetic activities resulted in early vigour, growth and yield attributes and yield (Jasper and Singh, 2022). The other spacing 75×45 cm and 90×30 cm produced significantly lower seed yield than best treatment and comparable with each other. Significantly lower seed yield of 476 kg ha^{-1} was obtained with closer spacing of 60 ×30 cm. Application of NPK at 25: 50:25 kg ha^{-1} recorded significantly more seed yield of 572 kg ha^{-1} over other fertilizer doses. Application of the major nutrients might have improved the fertility status of the soil and effective nutrient supply system in growth stages might contributed better plant growth, dry matter production which positively influenced the yield attributes and ultimately the yield of daincha. The result of this study is concordance with the earlier findings of Saritha *et al.* (2012) in pigeon pea Sodavadiya *et al.* (2021) in chickpea. Reducing fertilizer doses caused reduction in seed yield of daincha to the tune of 8.9% and 20.2% under 18.75:37.5:18.75 kg N, P_2O_5, K_2O ha^{-1} and 12.5: 25: 12.5 kg N, P_2O_5, K_2O ha^{-1} fertilizer doses respectively. Minimum seed yield of 374 kg ha^{-1} was recorded under control plot. Interaction between spacing and fertilizer levels were not found significant.

Economics

With regard to economics, growing of daincha at spacing of 60×45 cm exhibited higher mean net returns (Rs.24512 ha^{-1}) and benefit cost ratio (2.36) than other spacing (Table 3). This was followed by spacing of 75×30 cm which registered the mean net returns of Rs. 22497 ha^{-1} and BCR of 2.25. Optimum plant spacing favoured better crop growth and

Table 2: Effect of spacing and fertilizer level on yield parameters of daincha variety TRY 1.

Treatments	No. of pods plant^{-1}			Pod length (cm)			No. of seeds pod^{-1}			Test weight (g)		
	Summer 2023	*Kharif* 2023	Mean	*Summer* 2023	*Kharif* 2023	Mean	*Summer* 2023	*Kharif* 2023	Mean	*Summer* 2023	*Kharif* 2023	Mean
Spacing												
S_1: 60×30 cm	81	93	87	16.0	18.5	17.2	19.1	22.1	20.6	1.87	1.91	1.89
S_2: 60×45 cm	105	123	114	20.6	24.2	22.4	33.8	39.6	36.7	1.91	1.93	1.92
S_3: 75×30 cm	98	118	108	19.7	23.7	21.7	30.0	36.0	33.0	1.90	1.92	1.91
S_4: 75×45 cm	90	108	99	16.5	20.3	18.4	22.8	27.3	25.0	1.91	1.94	1.93
S_5: 90×30 cm	94	116	105	17.1	20.5	18.8	23.4	28.9	26.1	1.88	1.96	1.92
SEm±	2.5	3.1	2.8	0.5	0.6	0.6	0.7	0.9	0.8	0.04	0.04	0.04
CD (P≤0.05)	5.5	6.7	6.1	16.0	18.5	17.2	19.1	22.1	20.6	NS	NS	NS
Fertilizer level (N, P_2O_5, K_2O kg ha^{-1})												
F_1: 12.5: 25: 12.5	85	101	93	19.5	23.3	21.4	29.1	34.9	32.0	1.83	1.86	1.84
F_2: 18.75:37.5:18.75	99	120	110	20.0	24.2	22.1	31.5	38.2	34.9	1.87	1.91	1.89
F_3: 25: 50:25	105	138	121	20.5	26.9	23.7	32.7	42.9	37.8	1.90	1.96	1.93
Control	71	85	78	18.1	21.7	19.9	23.8	28.5	26.1	1.77	1.82	1.80
SEm±	3.2	3.9	3.5	0.5	0.6	0.5	0.8	1.0	0.9	0.06	0.06	0.06
CD (P≤0.05)	7.5	9.1	8.3	1.0	1.2	1.1	1.9	2.3	2.1	0.15	0.15	0.15

Interaction not significant.

Table 3: Effect of spacing and fertilizer level on seed yield and economics of daincha variety TRY 1.

Treatments	Seed yield (kg ha^{-1})			Net returns (Rs. ha^{-1})			Benefit cost ratio		
	Summer 2023	*Kharif* 2023	Mean	*Summer* 2023	*Kharif* 2023	Mean	*Summer* 2023	*Kharif* 2023	Mean
Spacing									
S_1: 60×30 cm	433	519	476	14487	20913	17700	1.80	2.16	1.98
S_2: 60×45 cm	518	615	567	20705	28319	24512	2.15	2.57	2.36
S_3: 75×30 cm	494	586	540	19053	25940	22497	2.06	2.44	2.25
S_4: 75×45 cm	466	552	509	16952	23366	20159	1.94	2.30	2.12
S_5: 90×30 cm	475	556	516	17642	23736	20689	1.98	2.32	2.15
SEm±	16	20	18						
CD (P≤0.05)	36	44	40			Data not statistically analysed			
Fertilizer level (N, P_2O_5, K_2O kg ha^{-1})									
F_1: 12.5: 25: 12.5	410	502	456	13115	19955	16535	1.74	2.13	1.94
F_2: 18.75:37.5:18.75	475	568	521	17006	23972	20489	1.91	2.29	2.10
F_3: 25: 50:25	503	641	572	18221	28517	23369	1.93	2.46	2.20
Control	340	407	374	10529	15551	13040	1.70	2.04	1.87
SEm±	16	20	18						
CD (P≤0.05)	39	47	43			Data not statistically analysed			

Interaction not significant.

increased seed yield was the main reason for higher net returns and BCR. Wider row spacing of 90 cm registered lesser net returns and BCR as compared to 75 cm spacing. The lowest mean net returns (Rs.17700 ha^{-1}) and BCR (1.98) were obtained with closer spacing of 60×30 cm. Fertilizer application in daincha increased the net returns and BCR and the higher values were noticed with the fertilizer dose of 25:50:25 kg N, P_2O_5, K_2O ha^{-1}. The mean net returns of Rs.23369 ha^{-1} and BCR of 2.20 were noticed with the fertilizer dose of 25: 50:25 kg N, P_2O_5, K_2O ha^{-1}. This was followed by lesser fertilizer dose of 18.75:37.5:18.75 kg N, P_2O_5, K_2O ha^{-1} which registered mean net returns and BCR of Rs. 20489 ha^{-1} and 2.10, respectively. Application of higher fertilizer dose improved the yield parameters and seed yield of daincha was the reason behind higher economic returns. These findings were supported by Gopal *et al*. (2016) who found that NPK fertilizers application increased the net returns and BCR of daincha. The control plot showed lower net returns and BCR than fertilizer applied plots.

Conclusion

The present investigation concluded that the newly released daincha variety TRY 1 produced higher growth, yield parameters, seed yield, net returns and benefit cost ratio under the spacing of 60×45 cm with fertilizer dose of 25:50:25 kg N, P_2O_5, K_2O ha^{-1} over other spacing and fertilizers. Hence, the optimum spacing of 60×45 cm and fertilizer dose of 25:50:25 kg N, P_2O_5, K_2O ha^{-1} could be recommended for enhancing the seed yield of the newly released daincha variety TRY 1.

Conflict of interest

All author declare that they have no conflict of interest.

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