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Effect of Dates of Sowing and Plant Geometry on Yield and Economics of Ricebean (*Vigna umbellata* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *kharif* 2022 at College of Agriculture, Kalaburagi to evaluate the effect of dates of sowing and plant geometry on yield and economics of ricebean. The experiment was laid out in Split plot design with three replications. The experiment was comprised of two factors *viz*., dates of sowing in main plot with four dates *i.e.* second fortnight of July, first fortnight of August, second fortnight of August and first fortnight of September and spacing in sub plot with three plant geometry *i.e.* 30 cm x 10 cm, 45 cm x 10 cm and 60 cm x 10 cm. The results of the experiment indicated that ricebean sown during first fortnight of August recorded significantly higher seed yield and stover yield (1016 kg ha^{-1} and 2574 kg ha^{-1}, respectively) besides higher gross returns (₹. 63547 ha^{-1}), net returns (₹. 39300 ha^{-1}) and Benefit Cost ratio (2.62). Among different plant geometry, 30 cm x 10 cm recorded significantly higher seed and stover yield (1009 kg ha^{-1} and 2302 kg ha^{-1}, respectively) besides higher gross returns (₹. 62852 ha^{-1}), net returns (₹ 38205 ha^{-1}) and BC ratio (2.55). Further, it was onpar with 45 cm x 10 cm plant geometry (989 kg

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ha^{-1}, 2253 kg ha^{-1}, ₹. 61583 ha^{-1}, ₹. 37355 ha^{-1} & 2.54, seed yield, stover yield, gross returns, net returns & BC ratio, respectively). The interaction between dates of sowing and plant geometry on yield attributes, yield and economics was found non significant.

Keywords: Dates of sowing; plant geometry; ricebean; seed yield and economics.

1. INTRODUCTION

Ricebean (*Vigna umbellata* L.) is a legume crop with a potential to mitigate food and nutritional security. It has favorable agronomic attributes and climatic resilience due to which thrives well in unpredictable and hostile growing conditions. The high protein content, balanced amino acid profile and appreciable vitamins and minerals content make this neglected legume as a crucial recruit in the category of commonly consumed pulses. The origin of the crop is thought to be in Hindustan. Ricebean is a multipurpose legume, sometimes considered as neglected and underutilised [1]. It is presumed that the centre of domestication of the ricebean is Indo-China. In India, it is cultivated in 20,000 ha with average green fodder productivity of 15-30 t/ha [2]. It is a good source of various nutrients. It is an N-fixing legume that improves the N status of the soil, thus providing N to the succeeding crop. Further, as of now literature is lacking on right time of sowing and plant geometry in ricebean crop. Among various agronomic factors, plant geometry is considered to be of great importance. Increase in yield can be ensured by maintaining appropriate plant density through different plant geometry. Some of the important reasons for low productivity are improper time of planting, population density and spatial arrangement. Since rice beans are a relatively new crop so technologies must be developed, particularly to determine the best time to sow and how far apart to grow plants to get maximum output. The degree of plant competition has been found to be influenced by plant spacing, or planting geometry [3]. Under the specified environmental circumstances, the ideal plant density yields the more yield per unit area without compromising quality.

2. MATERIALS AND METHODS

The experiment was conducted at College of Agriculture, Kalaburagi which is situated in the North Eastern Dry Zone of Karnataka (Zone 2), University of Agricultural Sciences, Raichur (Karnataka). It is situated at 17^0 34' North latitude, 76^0 79' East longitude and at an altitude of 478 m above the mean sea level. The soil of the experimental site was black and clay in texture, belongs to the order *vertisols*, low in organic carbon (0.49%) and available nitrogen (245.25 kg ha^{-1}) medium in available phosphorous (52.2 kg ha^{-1}) and high potassium (389 kg ha^{-1}). The ricebean variety, KBR-1 was used for experimentation. The crop was sown by dibbling and spacing was maintained as per treatments. The recommended dose of fertilizer at 20 kg N and 40 kg P_2O_5 ha^{-1} was applied as basal, through urea and Di ammonium phosphate in furrow at 5 cm depth by dibbling. Well decomposed FYM at 6 tones ha^{-1} was incorporated into the soil 15 days before sowing.

2.1 Yield Parameter Analysis

Five randomly selected and tagged plants from each net plot were collected and the following observations on yield components was recorded at harvest.

2.2 Total Number of Pods Per Plant

The total number of pods picked from five tagged plants were counted and average value per plant was worked out.

2.3 Number of Seeds Per Pod

For counting the number of seeds per pod, the pods taken for counting the seeds were used. The average number of seeds per pod was worked out and recorded separately.

2.4 100-Seed Weight (g)

A representative sample of seeds are drawn randomly from the produce of each net plot yield and one hundred seeds were counted from the sample and their weight was recorded as test weight for each treatment and expressed as grams.

2.5 Seed Yield (kg ha^{-1})

At physiological maturity, all the plants from the net plot were harvested and are left in the field for complete sun drying. After threshing and cleaning, the seeds of each net plot were sun dried and weighed separately for each treatment and later it was converted into kg per hectare.

2.6 Stover Yield (kg ha^{-1})

Plants from net plot were sun dried for 10 days after harvesting. Soon after complete drying, the weight was recorded and expressed in kg per plot. Later the stover yield was converted into kg per hectare.

2.7 Harvest Index (%)

Harvest index was calculated by dividing the economic yield by total biological yield which includes grain plus stover [4].

HI (%) = Economic yield (kg ha-1) / Biological yield (kg ha-1) × 100

2.8 Economic Analysis

2.8.1 Cost of cultivation (₹ ha^{-1})

The prices of the inputs prevailing at the time of their use and market price of crop commodities was taken to work out the cost of cultivation and expressed in rupees per hectare.

2.8.2 Gross returns (₹ ha^{-1})

Gross monetary returns are the total earnings from crop produce in terms of ₹ ha^{-1}. The gross monetary return was calculated by considering the prevailing price of the produce and expressed in rupees per hectare.

Gross returns (₹ ha^{-1}) = [Grain yield (kg ha^{-1}) x Grain price (₹ kg^{-1})] + [Stover yield (kg ha^{-1}) x Stover price (₹ kg^{-1})]

2.8.3 Net returns (₹ ha^{-1})

The net monetary returns was calculated after deducting all the expenditure from gross returns. It was obtained by subtracting cost of cultivation from gross returns.

Net returns (₹ ha^{-1}) = Gross returns – Cost of Cultivation

2.8.4 Benefit cost ratio

The benefit cost ratio was worked out by dividing the gross returns by total cost of cultivation of respective treatments by using the formula given below.

Benefit Cost ratio = Gross Returns (ha-1) / Cost of Cultivation (ha-1)

3. RESULTS AND DISCUSSION

3.1 Effect of Dates of Sowing and Plant Geometry on Yield Parameters of Ricebean (c.f Fig.1)

Number of pods : Number of pods per plant at harvest differed significantly with respect to dates of sowing. The crop sown during first fortnight of August beared more number of pods per plant (24.82), which was statistically higher than other treatments. This may be due to the fact that there were improved environmental circumstances throughout the crop growth period, which may have encouraged higher sink strength and allowed for more photosynthate translocations. These results are in agreement with the findings of Rajan katoch and Salej Sood [5] in ricebean. Among different plant geometry, 60 cm x 10 cm resulted in statistically maximum number of pods per plant (21.20), as compared to 30 cm x 10 cm and it was on par with 45 cm x 10 cm (20.49). This might be attributed to least inter plant competition and greater availability of growth resources. These results are in conformity with the findings of Rudragouda *et al*. [6] in ricebean.

Number of seeds: The number of seeds per pod did not differ significantly with respect to dates of sowing. However, the crop sown during first fortnight of August recorded more number of seeds per pod (6.51). This might be due to better environmental conditions throughout the crop growth period, which might have encouraged a higher sink strength and enabled more photosynthate translocations. These results are in agreement with the findings of Rajan katoch and Salej Sood [5] in rice bean. Among different plant geometry, number of seeds per pod did not differ significantly. However, 60 cm x 10 cm resulted the maximum number of seeds per pod (6.5). The increase in number of seeds per pod was recorded under wider row spacing (60 cm x 10 cm) than narrow spacing. This might be due to availability of more space per plant ultimately enhanced availability of nutrients, moisture and light consequently. The findings are in conformity with those reported by Reddy *et al*. [7] for french bean and Patel *et al*. [8] for moth bean.

Test weight (100 Seed weight): Test weight of ricebean seeds did not differ significantly with respect to dates of sowing. However, higher test weight (6.69 g) was recorded when crop sown during first fortnight of August. Test weight of ricebean seeds did not differ significantly. However, among plant geometry 30 cm x 10 cm recorded higher seed weight (6.5 g).

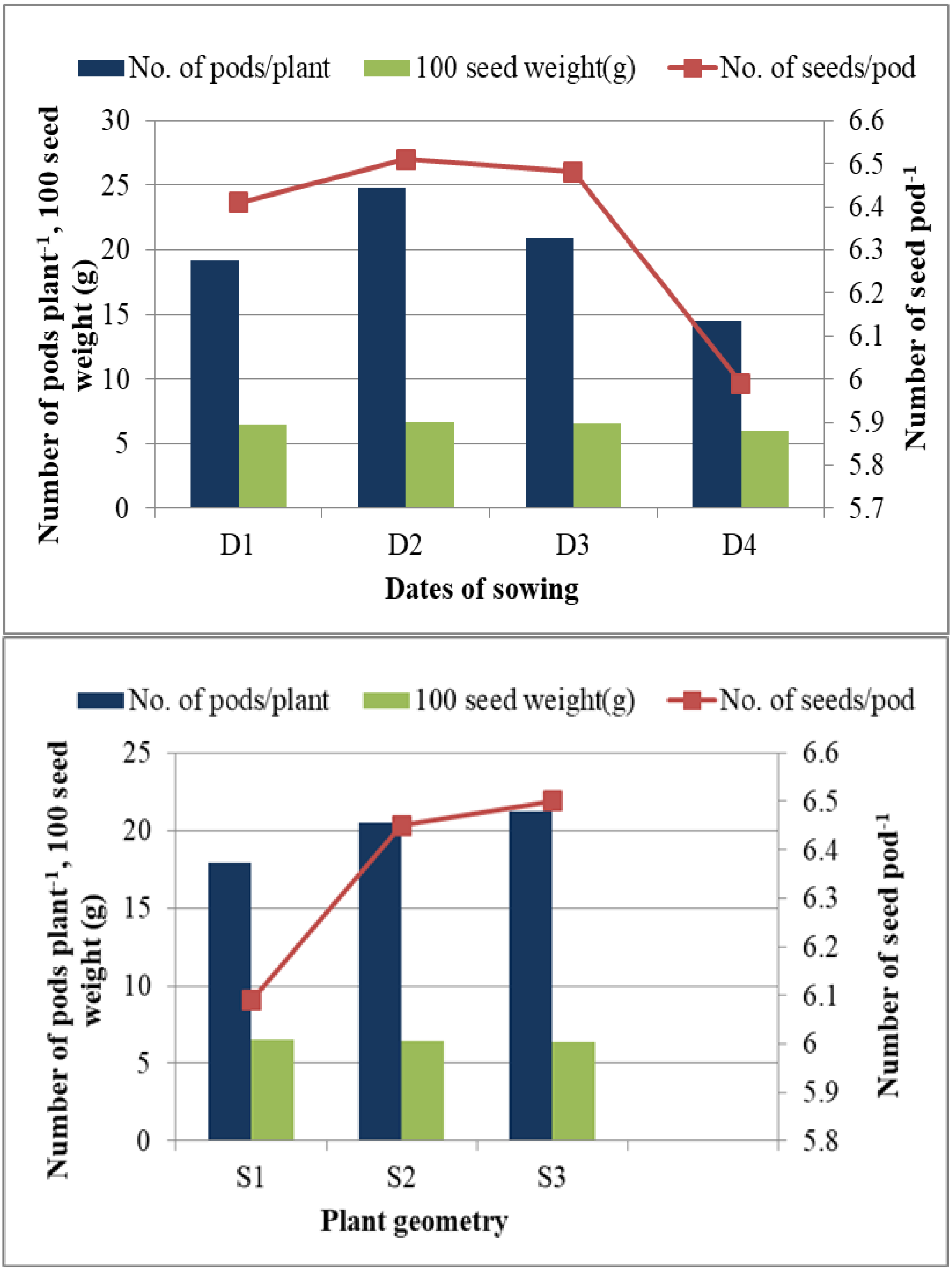

Fig. 1. Yield parameters of ricebean as influenced by different dates of sowing and plant geometry

3.2 Effect of Dates of Sowing and Plant Geometry on Yield of Ricebean (c.f Table 1)

Seed yield : The varying sowing dates for ricebean had a significant impact on the seed yield. The data on seed yield showed that crop sown during first fortnight of August had outstandingly greater seed yield (1016 kg ha^{-1}) and superior than other treatments. This might be due to that the crop sown during first fortnight of August gets ideal growing condition *i.e*. optimum temperature, sunshine hour and lower relative humidity during its peak growth stage. It is evident that crop sown during first fortnight of August showed better effect with respect to all the yield attributing factors implying substantial contribution to the ultimate yield. These results are in agreement with the findings of Rajan katoch and Salej Sood [5] in ricebean, Mukherjee *et al*. [9] in ricebean, Joshi and Rahevar [10] in Dolichos bean. Different plant geometry lead to significant differences on seed yield of ricebean. The crop sown with a spacing of 30 cm x 10 cm recorded notably higher seed yield (1009 kg ha^{-1}) as compared to 60 cm x 10 cm and it was on par with 45 cm x 10 cm plant geometry (989 kg ha^{-1}). Increase in seed yield of ricebean was recorded with closer spacing. This was because of higher plant population and optimum plant nutrients required for sufficient growth and yield which mitigated the difference in yield and higher seed yield in closer spacing as compared to wider spacing. These findings are in conformity with findings of Mahopatra [11] Joshi and Rahevar [10] for Dolichos bean.

Table 1. Seed Yield, stover yield and harvest index of ricebean as influenced by dates of sowing and plant geometry

Treatment	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest Index (%)
Main plot: Date of sowing (D)			
D_1 – Second fortnight of July	916	1988	31.55
D_2 - First fortnight of August	1016	2574	28.22
D_3 - Second fortnight of August	947	2209	29.99
D_4 - First fortnight of September	858	1823	32.55
S. Em.±	19	56	1.03
C.D. at 5 %	67	195	NS
Sub plot: Spacing (S)			
S_1 - 30 cm x 10 cm	1009	2302	30.52
S_2 - 45 cm x 10 cm	989	2253	30.60
S_3 - 60 cm x 10 cm	805	1891	30.62
S. Em.±	20	43	0.86
C.D. at 5 %	59	130	NS
Interaction: D×S			
D_1S_1	983	2136	31.55
D_1S_2	968	2075	31.80
D_1S_3	797	1753	31.31
D_2S_1	1097	2652	29.24
D_2S_2	1084	2638	29.10
D_2S_3	868	2432	26.31
D_3S_1	1032	2329	30.69
D_3S_2	984	2304	29.95
D_3S_3	827	1995	29.33
D_4S_1	925	2092	30.59
D_4S_2	919	1994	31.53
D_4S_3	728	1382	35.53
S. Em.±	52	131	2.48
C.D. at 5 %	NS	NS	NS

Note: NS – Non-significant

Table 2. Gross returns, net returns and BC ratio of ricebean as influenced by dates of sowing and plant geometry

Treatment	Gross returns (₹. ha^{-1})	Net returns (₹. ha^{-1})	BC ratio
Main plot: Date of sowing (D)			
D_1 – Second fortnight of July	56955	32707	2.35
D_2 - First fortnight of August	63547	39300	2.62
D_3 - Second fortnight of August	59056	34808	2.43
D_4 - First fortnight of September	53276	29028	2.19
S. Em.±	1145	1145	0.05
C.D. at 5 %	3962	3962	0.16
Sub plot: Spacing (S)			
S_1 - 30 cm x 10 cm	62852	38205	2.55
S_2 - 45 cm x 10 cm	61583	37355	2.54
S_3 - 60 cm x 10 cm	50191	26323	2.10
S. Em.±	1180	1180	0.05
C.D. at 5 %	3539	3539	0.14
Interaction: D×S			
D_1S_1	61136	36489	2.48
D_1S_2	60175	35947	2.48
D_1S_3	49553	25686	2.08
D_2S_1	68452	43805	2.78
D_2S_2	67658	43430	2.79
D_2S_3	54532	30664	2.28
D_3S_1	64229	39581	2.61
D_3S_2	61344	37116	2.53
D_3S_3	51595	27728	2.16
D_4S_1	57592	32944	2.34
D_4S_2	57154	32927	2.36
D_4S_3	45082	21214	1.89
S. Em.±	3083	3083	0.13
C.D. at 5 %	NS	NS	NS

Note: NS – Non-significant

Stover yield : Stover yield of ricebean varied considerably with respect to different dates of sowing. The results revealed that higher stover yield (2574 kg ha^{-1}) was recorded when crop sown during first fortnight of August which was remarkably superior over rest of the treatments. This may be due to crops had longer photoperiods, which increased assimilation and translocation. As a result, ricebean produced more stover yield than a crop that was sown later. Due to the short growth time, delayed seeding greatly lowered the output of stover. Similar findings were also observed by Mukherjee *et al*. [9] in rice bean, Joshi and Rahevar [10] in Dolichos bean. Among different plant geometry, 30 cm x 10 cm produced significantly higher stover yield (2302 kg ha^{-1}) when compared to 60 cm x 10 cm and it was on par with a spacing of 45 cm x 10 cm (2253 kg ha^{-1}). Increase in stover yield of ricebean sown at closer spacing was because of higher plant population and optimum plant nutrients required for sufficient growth and yield which mitigated the difference in stover yield. Further, the higher stover yield in closer spacing was due to more number of plants per unit area compared to wider spacing. These findings are in conformity with those reported by Reddy *et al*. [7] for french bean and Patel *et al*. [8] in moth bean.

Harvest index : Harvest index did not differ significantly with respect to dates of sowing. However, crop sown during first fortnight of August had an harvest index of 28.22 %. Different plant geometry did not have significant effect on harvest index of ricebean. However, crop sown with 60 cm x 10 cm had an harvest index of 30.62 %.

3.3 Effect of Dates of Sowing and Plant Geometry on Economics of Ricebean (c.f. Table 2)

Gross returns, net reurns and BC ratio of ricebean was greatly influenced by different dates of sowing. Higher gross returns, net returns and BC ratio of ricebean (**₹.** 63547 ha^{-1}, **₹.** 39300 ha^{-1} and 2.62, respectively) was recorded when crop sown during first fortnight of August which was statistically superior over other treatments. The crop sown during first fortnight of September registered lower gross returns, net returns and BC ratio (**₹.** 53276 ha^{-1}, **₹.** 29028 ha^{-1} and 2.19, respectively). Among different indicators of economic efficiency in any production system, cost of cultivation and net returns, have a stronger influence on the practical utility and farmer adoption of the production technique. The main reason for the higher gross returns, net returns, and benefit cost ratio in the first two weeks of August compared to other sowing dates was due to the increased seed and stover production. These findings are similar to the results of Joshi and Rahevar [10] in Dolichos bean.

Among different plant geometry, 30 cm x 10 cm resulted in significantly higher gross returns, net returns and BC ratio (**₹.** 62852 ha^{-1}, **₹.** 38205 $ha^{-1}$and 2.55, respectively) when compared to 60 cm x 10 cm and it was on par with a spacing of 45 cm x 10 cm (**₹.** 61583 ha^{-1}, **₹.** 37355 ha^{-1} and 2.54, respectively). The higher gross returns, net returns and benefit cost ratio obtained with 30 cm x 10 cm and 45 cm x 10 cm plant geometry. This could be due to the manifestation of higher grain and straw yields fetching of higher net returns at narrow spacing. These findings are similar to the results of Joshi and Rahevar [10] in Dolichos bean.

Interaction Effect: The interaction between dates of sowing and plant geometry on yield attributes, yield and economics was non significant.

4. CONCLUSION

The experimental findings indicated that there were marked variations in the productivity of ricebean owing to dates of sowing and plant geometry. Based on the present investigation, it can be concluded that ricebean sown during first fortnight of August was advantageous in achieving higher yield and monetary benefits.

Among plant geometry, crop sown with a spacing of 30 cm x 10 cm and 45 cm x 10 cm was found economical in obtaining higher seed yield and net returns with high BC ratio.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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