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Performance of Summer Mungbean (*Vigna radiata* L.) under Different Sowing Time at Farmers' Field

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A B S T R A C T

A comparative study to evaluate the effect of different time of sowing on productivity and economics of summer mungbean (*Vigna radiata* L.) production was undertaken under 'Cluster Frontline Demonstrations on Pulses' of Indian Council of Agricultural Research (ICAR), New Delhi. The demonstrations were carried out in 72 different locations at farmers' fields in district Tarn Taran of Punjab. Summer mungbean variety SML 668 was supplied to all the farmers. Likewise, similar seed rate, nutrient applications and other agronomic practices were followed in all the locations of experimentation. The demonstrations were categorized into seven groups based on sowing dates and standard meteorological weeks from March 11 (11th week) to April 28, 2016 (17th week). The results of investigation indicated, overall best performance of summer mungbean when sown between 18th to 24th March (12th standard meteorological week) at all the locations of demonstration. The significant increases of 47.3 and 112.6% in economic yield was registered in crop sown between 18-24 march respectively over crop sown between the period of 15th to 21st April and sowing between the period of 22nd to 28th April. Similarly, extent of increase in biological yield with crop sown in 12th standard meteorological week (D_2) was significantly higher by 48.4 and 84.3%, respectively over crop sown in 16th and 17th standard meteorological week. Sowing of summer mungbean between 18th and 24th March also provided maximum production and monetary efficiency to the farmers. Present results thus, indicated that summer mungbean grower may get higher production and maximum economic returns by sowing crop between 11th March and 14th April.

Keywords

Monetary efficiency, Net returns, Production efficiency, Sowing time, Summer mungbean, Yield.

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Introduction

The predominance of rice-wheat cropping system in Punjab has resulted in number of ecological problems in the state such as depletion of underground water table, deterioration of soil health by adversely affecting the physical, chemical and biological properties of the soil (Kumar *et al.*, 2016). However, for over a decade, rice-wheat cropping system yields in high productivity zones have either stagnated or declined, which is attributable to decline in total factor productivity as a result of continuous depletion in soil fertility (Shukla *et al.*, 2005; Kumar *et al.*, 2016; Kumar *et al.*, 2017). In order to tackle these problems, there is need of diversification and increasing area under pulse crops. Pulses help in restoring fertility status of the soils by fixing atmospheric nitrogen (N) and improve organic matter status of the soils. Pulses need less nitrogen as external input because much of their N requirement is met through biological N-fixation (Kumar *et al.,* 2014; Basu *et al.,* 2016). Moreover, pluses also act as a cheapest source of protein fulfilling and 20 to 30% of protein requirement of our population is being supplemented through pulses (Grover and Singh, 2015). The area under pulses in Punjab is declining regularly. During 1960-61, pulses were grown over 9.03 lakh hectare area with production of 7.09 lakh tons, which has declined to 61 thousand hectares with production of 44 thousand tonnes only in 2000-01. However, according to an estimate of year 2012-13, area under pulses was 64 thousand hectares with production of 53 thousand tons, indicating a slight increase in area and production under pulses (Anonymous, 2013). Inclusion of pulses in crop rotation not only plays an important role in crop diversification but, also solves the soil fertility related issues (Kumar *et al.,* 2014). Thus, area under such crops needs to be enhanced significantly. Among pulses, mungbean being short duration crop, can fit well in the number of cropping systems and can improve soil nutrient status by fixing atmospheric N. In order to realize the potential yield of summer mungbean, sowing date plays an important role (Panwar and Sharma, 2004; Singh *et al.,* 2010). Under Punjab conditions, very early sowing results in poor germination due to low temperature in February, while delaying in sowing resulted in coinciding of maturity stage with early rain showers resulting in serious damage to the crop. So there is dire need to guide summer mungbean growers for ideal time of sowing of this particular crop, in order to get good productivity and returns from this crop. Thus, present investigation considered above lacunas and planned at farmers' field with different time of sowing to evaluate the effect of sowing dates on crop productivity potential as well as economic returns of the farmers, so that necessary recommendations may be provided to the farmers of the area.

Materials and Methods

Experimental details

The field investigation was carried under 'Cluster Front Line Demonstrations on Pulses Programme, ICAR, New Delhi. The demonstrations were carried out in 72 different locations at farmers' fields of district Tarn Taran of Punjab. The climate of the district classified as tropical steppe, semi-arid and hot, which is mainly characterized by general dryness except for a short period during southwest monsoon season. During the summer months i.e. from April to June, weather is very hot and dry. The weather becomes hot and humid during July to September. The south-west monsoon which contributes 74%, sets in last week of June and withdraws in middle of September. Maximum rain fall is received during the months July – August and about 26% occurs in the non-monsoon months. The rainfall received during the month of April, May and June 2016 was 1.0, 28.1 and 44.9 mm, respectively. Similarly, average maximum and minimum temperature for respective April, May and June months were '35 and 17˚C', '40 and 23° C and '39 and 26°C. The soils are mostly loamy to loamy sand with average pH value of 8.0.

Agronomic practices

Common seed variety i.e. SML 668 of summer mungbean was supplied to all the farmers on an area of 0.4 ha. Just before sowing, the seed was treated with *Rhizobium* biofertilizer culture and then left to dry under shade for about 30 min followed by sowing in field. Urea and single super phosphate were used as source of plant nutrients and applied uniformly @ 27.5 and 100 Kg ha^{-1}, respectively, in all demonstrations at the time of sowing. Stomp (Pendimethalin) @ 2.5 ha^{-1} was used to control weeds and applied with in 48 hrs of sowing of the crop. The 72 demonstrations were divided into seven groups based on time of sowing with respect to standard meteorological weeks.

Demonstrations' detail

The details of demonstrations sown at different time period are given below:

Demonstrations ***(Standard Meteorological Week)***	**Time of Sowing**
D_1 (11)	Sowing between the period of 11^{th} March to 17^{th} March
D_2 (12)	Sowing between the period of 18^{th} March to 24^{th} March
D_3 (13)	Sowing between the period of 25^{th} March to 31^{st} March
D_4 (14)	Sowing between the period of 1^{st} April to 7^{th} April
D_5 (15)	Sowing between the period of 8^{th} April to 14^{th} April
D_6 (16)	Sowing between the period of 15^{th} April to 21^{st} April
D_7 (17)	Sowing between the period of 22^{nd} April to 28^{th} April

The observations on different parameters viz. economic yield, biological yield, net return, benefit cost (B:C) ratio, production and monetary efficiencies were recorded. For the purpose of biological yield, the total dry matter of the crop per hectare was calculated.

Production cost

The economic analysis of the experiment was carried out by taking into consideration the them prevailing prices of inputs used and selling price of summer mungbean. The various over head costs such as that on seed bed preparation, input costs, seed treatment, plant protection, etc. had also been taken into account. Yield was also taken into account for above purpose. The production cost (Rs. ha^{-1}) for raising summer mungbean, assuming owned land has been presented in table 1.

Economic returns and B:C ratio

The gross, net returns and B:C ratio were calculated as follow:

$$\text{Gross returns (Rs. ha}^{-1}\text{)} = \text{Yield (kg ha}^{-1}\text{)} \times \text{price of produce (Rs. kg}^{-1}\text{)}$$

$$\text{Net returns (Rs. ha}^{-1}) = \text{Gross returns (Rs. ha}^{-1}) - \text{cost of cultivation (Rs. ha}^{-1})$$

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs. ha}^{-1})}$$

Harvest index

The harvest index of the crop was calculated using following equation:

$$\text{Harvest Index (\%)} = \frac{\text{Seed yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})}$$

Production and monetary efficiencies

Production efficiency (PE) of summer mungbean (kg ha^{-1} day^{-1}) was computed using following expression:

$$PE = \frac{\text{Total economic yield of summer mungbean (kg ha}^{-1})}{\text{No. of days taken by crop from sowing to harvesting}}$$

Monetary efficiency (ME) (Rs. ha^{-1} day^{-1}) was calculated using following formula:

$$ME = \frac{\text{Total net returns of summer mungbean (Rs ha}^{-1})}{\text{No. of days taken by crop from sowing to harvesting}}$$

The data collected on above parameters was subjected to analysis of variance (ANOVA) using the SPSS statistical package. The comparison of treatment means was made by Tukey (CD) at $p = 0.05$.

Results and Discussion

Biological yield

Time of sowing affected the biological yield significantly (Table 2). Maximum biological yield was recorded with sowing dates between the period of 18th - 24th March (D_2), however, it was found statistically at par with the demonstration sown on dates D_1 (11th - 17th March), D_3 (25th - 31st March), D_4 (1st - 7th April), D_5 (8th - 14th April) (Table 2). The demonstrations sown between 12th SW (D_2) was found significantly superior over D_6 i.e. crop sown between the period of 15th - 21st April and D_7 (22nd - 28th April). The magnitude of increase in biological yield with D_2 was to the tune of 48.4 and 84.3%, respectively over D_6 and D_7. The above trend indicated the best suitability of sowing summer mungbean between 18th to 24th March. The later sowing time also performs statistically similar but, yield decreased numerically. A drastic decrease in biological yield was observed after 14th April (Table 2). The findings of Kumar *et al.*, (2009) and Ram *et al.*, (2016) also support current results presented above.

Economic yield

Likewise biological yield, different time of sowing influenced economic yield of summer mungbean significantly (Table 2). Maximum economic yield was registered following sowing of crop between 18th and 24th March (D_2), however, it was found statistically at par with D_1 (11th - 17th March), D_3 (25th - 31st March), D_4 (1st - 7th April), D_5 (8th - 14th April) (Table 2). The demonstrations sown between 12th SW (D_2) were found significantly superior over D_6 and D_7. The extent of increase in economic yield following demonstration D_2 was 47.3 and 112.6%, respectively over D_6 and D_7 (Table 2).

Realising higher seed yield of summer mungbean from the crop sown between 18th and 24th March, indicating its best suitability for sowing in the area. The later sowing time also performed statistically similar but, yields decrease numerically. A significant decrease in crop yield was observed after 14th April (Table 2). Moreover, due to higher rainfall intensity in the month of June (44.9 mm), there was an incident of whitefly, which resulted in transmission of yellow mosaic virus disease and caused significant economic loss to productivity particularly in late sown crop. The findings of current study are in conformity with the observations of Singh and Singh (2009), who registered significantly higher grain yield of summer mungbean, when it was sown in between March 20th - April 1st than sown during 10th - 20th April. The findings of Kumar *et al.*, (2009) and Ram *et al.*, (2016) also support current results presented above.

Harvest index

The highest value of harvest index was registered with demonstrations D_1 and D_3, which were however found statistically similar with D_2 (Table 2). Moreover, above treatments were also recorded statistically at par with demonstrations D_4, D_5 and D_6. The demonstration D_7 performed significantly inferior to all other treatments evaluated in the experimentation (Table 2). Singh and Singh (2009) also reported decrease in summer mungbean yield and yield under late sown conditions resulting in low value of harvest index.

Net returns

Maximum net returns were recorded with D_2 i.e. demonstrations sown between the period of 18th - 24th March followed by D_1 (11th - 17th March), both of which were recorded statistically similar with each other. Moreover, demonstrations D_1 and D_2 were also observed statistically at par with D_4 and D_5, but significantly superior to D_6 and D_7 treatments (Table 2). The magnitude of increase in net returns in the demonstration D_2 was 37.1% more over D_6. Similarly, treatment D_1 gave significantly higher net returns as compared to D_6 by 94.2%, respectively (Table 2).

Profitability (B:C ratio)

As regard B:C ratio (profitability), respective significant increase of 45.1 and 111.4% were recorded with demonstration D_2 in comparison with D_6 and D_7 (Table 2). Likewise, extent of increase in B:C ratio was 29.4 and 88.6% under demonstration D_1 over D_6 and D_7, respectively. The demonstrations D_6 and D_7 were recorded significantly inferior to all other treatments, both in case of net returns and benefit cost ratio (Table 2). The higher productivity of summer mungbean with D_2 is the reason of higher returns and B:C ratio to the farmers and as discussed above, this was the best suited time of sowing for summer mungbean cultivation. Later sowing dates caused economic loss to summer mungbean growers due to decreased seed yield (Table 2).

Production efficiency

The highest production efficiency was registered in demonstration D_2 i.e. sowing of crop between 18th and 24th March followed by D_1 (11th – 17th) and D_5 (8th – 14th April) (Fig. 1). The magnitude of increase in production efficiency with D_2 was to the extent of 10.5% and 21.0% over D_1 and D_5, respectively (Fig. 1). However, demonstrations D_1 and D_5 were recorded statistically at par with each other. A sharp decrease in above parameter was registered in remaining demonstrations as the sowing time was delayed. Overall, treatment D_7 was found significantly inferior to all the demonstrations (Fig. 1). The highest production efficiency in D_2 is attributed to better crop yields governed by timely sowing of summer mungbean coupled with favourable soil and climatic conditions (Singh and Singh 2009).

Monetary efficiency

Monetary efficiency was recorded significantly higher with demonstration D_2 followed by D_1 and D_5. However, demonstrations D_2 and D_1 were reported statistically at par with each other (Fig. 2). The respective increases in monetary efficiency following demonstration D_2 was to the tune of 21.6 and 48.7 % in comparison with D_1 and D_5. The demonstrations D_3, D_4 and D_5 gave statistically similar monetary efficiency (Fig. 2). The D_7 was registered significantly inferior to all other demonstrations. Higher net returns from crop under timely sowing conditions may be the probable reason of higher monetary efficiency under D_2 demonstration in current study. In other words, it may be inferred that sowing of summer mungbean between 18th and 24th March gave maximum production and returns per day. The benefits from the crop in term of production and monetary efficiency decreased drastically as the sowing time are delayed.

Table.1 Cost of cultivation (Rs. ha^{-1}) for raising summer mungbean (assuming owned land)

Input factors	Cost
Seed Cost (@ Rs 120 kg^{-1})	4500
Herbicide cost (Stomp @ Rs 500 L^{-1})	1250
Fertilizer (Urea @ Rs 5.5 Kg $^{-1}$ and SSP @ Rs Rs 8 Kg^{-1})	2152
Insecticides (Chlorpyriphos @ Rs 250L^{-1} and Triazophos @ Rs 440L^{-1})	1600
Human Labour cost	14800
Tractor hours (Rs 385 hr^{-1})	3080
Irrigation (Rs 100 irrigation^{-1})	200
Transportation and Marketing	650
Quarterly interest on variable cost @ 9%	635
Total cost of cultivation	**28867**

Table.2 Yield and economics of summer mungbean with different time of sowing

Time of Sowing (Standard Meteorological Week)	Biological yield (q ha^{-1})	Economic Yield (q ha^{-1})	Harvest Index	Net return (Rs ha^{-1})	BC Ratio
D_1 (11)	36.27^{ab}	11.20^{ab}	0.31^{a}	28395^{ab}	1.98^{ab}
D_2 (12)	40.64^{a}	12.23^{a}	0.30^{a}	34660^{a}	2.22^{a}
D_3 (13)	31.10^{ab}	9.47^{ab}	0.31^{a}	20347^{ab}	1.70^{abc}
D_4 (14)	33.77^{ab}	9.89^{ab}	0.29^{ab}	25555^{ab}	1.79^{ab}
D_5 (15)	36.64^{ab}	10.01^{ab}	0.27^{ab}	23166^{ab}	1.81^{ab}
D_6 (16)	27.38^{bc}	8.38^{bc}	0.28^{ab}	14618^{bc}	1.53^{bc}
D_7 (17)	22.05^{c}	5.75^{c}	0.26^{b}	1033^{c}	1.05^{c}

Note: Means with different letters are significantly different at the 0.05 level of significance

Fig.1 Production efficiency of summer mungbean with different time of sowing (Means with different letters above bars are significantly different at the 0.05level of significance)

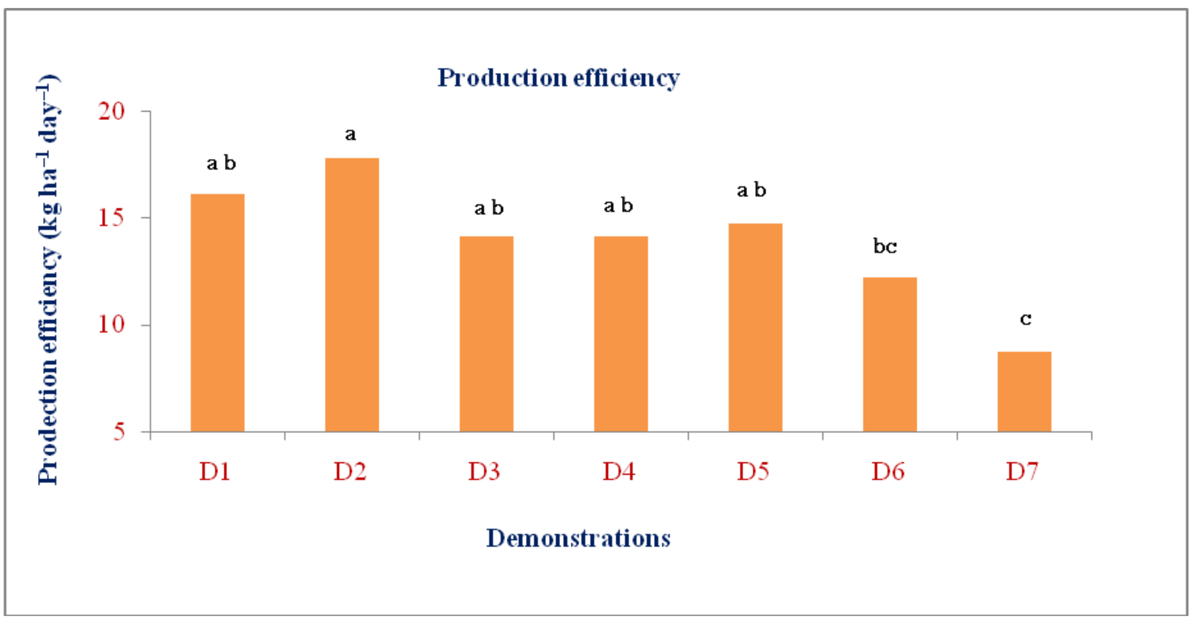
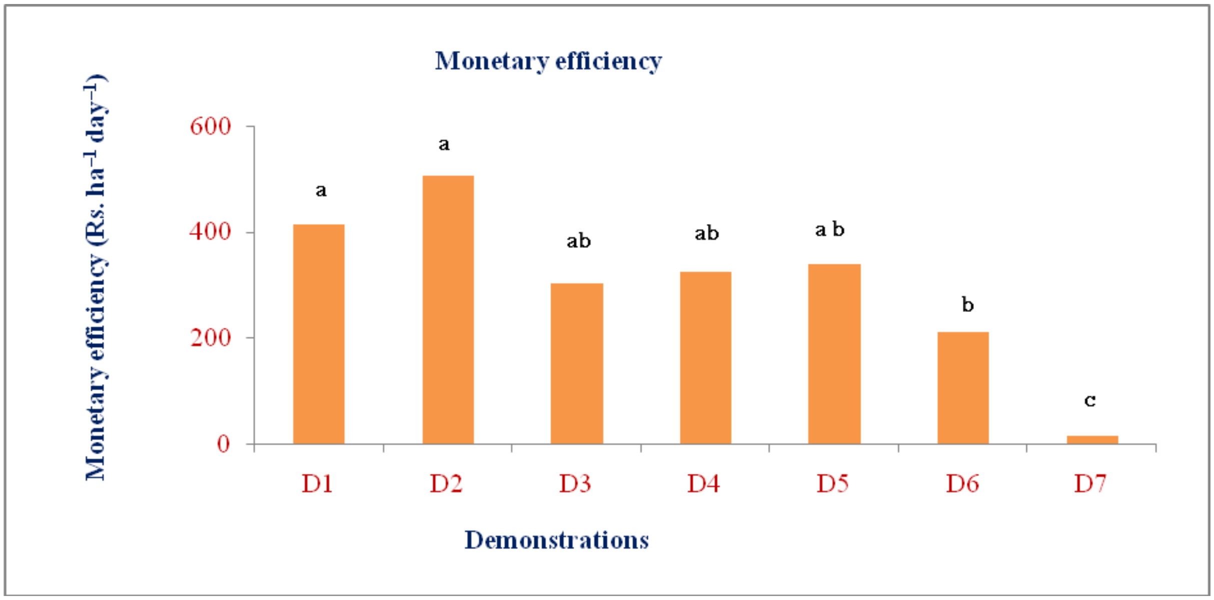


Fig.2 Monetary efficiency of summer mungbean with different time of sowing (Means with different letters above bars are significantly different at the 0.05 level of significance)



In conclusion, results on demonstrations indicated maximum production and economic benefit to summer mungbean grower when crop was sown between 11th March and 14th April. Summer mungbean sowing during this period also gave maximum production and monetary returns to the farmers. The benefits from the crop in term of production and monetary efficiency, however, decreased drastically as the sowing time is delayed. Overall, demonstrations sown during above time spell gave best performance in term of productivity and profitability to the farmers. Delayed sowing (after April 14) led to infestation of whitefly and transmission of yellow mosaic virus disease resulting lesser seed yield. Moreover, crop's maturity period coincide with early monsoon, which may result in significant loss of crop yield and economic returns.

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