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Effect of Irrigation Water on Profitability as well as Sustainability of Summer Mung bean Versus Spring Maize Cultivation in Kapurthala District of Punjab

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ABSTRACT

In the central plain zone of Punjab, the underground water level is depleting at a very rapid rate may be due to over exploitation of water resources used for raising the long duration and high water requirement crops in addition to the industrial use. Hence, a study was conducted to note the effect of application of irrigation water on profitability as well as sustainability of summer mung bean versus spring maize cultivation in Kapurthala. For this, front line demonstrations on summer mung bean were conducted on 32 ha area at farmers' field during spring 2016 season. The various parameters recorded were sowing date, per cent germination, number of irrigations and man days required for various crop management practices, number of sprays applied for control of insect pest and diseases, method of harvesting, grain yield and selling rate. The grain yield obtained in mung bean varied between 9.4 q/ha to 11.5 q/ha and average grain yield was found to be 10.65q/ha under the demonstration plots. Total irrigation water applied was calculated to be 9,850 and 1,200 m^3 /ha for spring maize and summer mung bean, respectively. If we calculate, the cost of irrigation water @ 1 paisa per 10 L, the net returns for spring maize cultivation was found to be Rs 49,421/-ha and Rs 54,600/-ha for summer mung bean, which clearly speaks that cultivation of summer mung bean is very economical compared to spring maize.

Key Words: Irrigation water, Spring Maize, Summer Mung bean, Sustainability, Water productivity.

INTRODUCTION

Punjab is the major rice- wheat producing state in the country contributing 51 per cent of Paddy (Anon, 2016a) and 18 per cent of wheat production (Anon, 2016 b). The central plain zone comprising the major part of the state is highly productive and has irrigation system, mainly through tube-wells. In order to produce 10.8 t/ha of rice and wheat (Anon, 2016 c), two natural resources *i.e.* water and soil have been depleted to a large extent. As, 145 water blocks that Punjab has been divided into, 110 have already been declared as dark zones (Anon, 2016 d) and removes 500-700 kg/ha major nutrients from the soil annually (Biswas *et al,* 2001).

In spite of this peculiar situation, the farmers of Jalandhar and Kapurthala district (Central plain zone) are not judging the consequences of unwanted situation and therefore, opting for cultivation of spring maize (*Zea mays*) during the month of Feb-June every year. Moreover, due to very high temperature during the months especially April and May, the water requirement of Maize comes out to be very high. Sharma *et al* (2014) and Manan *et al* (2016) reported that farmers in the area were cultivating maize hybrids developed from various private organizations and earning high net profits. Contrary to the fact that farmers are not calculating the cost of irrigation water applied in raising the spring season crop because state government is providing electricity free of cost to run the tubewell. Now the time has come that the net profitability is coming down and growing of crops is not being sustained because the underground water level is going down and farmers are lowering down the

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deep submersible motors. It is pertinent to mention that earlier the water level was at 60 ft. in the year 1991 which now has gone down to 110 ft. during 2016 in about 25 years of period. Hence, it becomes essential to educate the farmers about the use of irrigation water for raising short duration crops.

Mung bean (*Vigna radiata*) being a leguminous crop has a unique role in fixing atmospheric nitrogen through the process of biological nitrogen fixation (BNF). The biological nitrogen fixed by mung bean not only meets its own requirement but also leaves nitrogen after harvest, which is beneficial to the next crop by fixing 31-85 kg N/ha (Sekhon *et al*, 2002). Hence, it was planned to conduct front line demonstrations on summer moong on an area of 32 ha. with the objective to measure the effect of irrigation water on profitability as well as sustainability of summer mung bean versus spring maize cuLivation in Kapurthala

MATERIALS AND METHODS

In order to demonstrate the production potential of summer mung bean as a profitable, sustainable and viable alternative to the spring maize, front line demonstrations on summer mung bean cv. SML 668 were conducted on 32 ha area at 50 farmers' field in 2 blocks of the district i.e. SuLanpur and Kapurthala.

Selection of farmers

In two blocks, farmers were made aware about the utility of pulse crops through trainings, seminars and lectures organized by the Krishi Vigyan scientists during the months of January and February, 2016. During these programmes, farmers were asked to give their requirement to go for mung bean cultivation at their fields. Only those farmers, who were willing to sow the crop as per the guidelines of the KVK experts were selected. Farmers were supplied 37.5 kg seed/ha costing Rs. 7,500/- free of cost.

Selection of site

It was made mandatory to the farmers that demonstration plot should be along the road side so that maximum number of visitors can see the performance of mung bean crop sown in place of spring maize. The participating farmer had also sown spring maize and therefore, it became easy to make comparison between pulse and cereal crop.

Package of practices followed

All the package of practices recommended by the Punjab Agricultural University, Ludhiana (Table 1) were followed (Anon, 2016c). However, KVK provided only seed of SML 668 and all other inputs were applied by the farmer himself at his own level as per the advice of the KVK scientist.

Observation recorded

Since this crop takes about 60 to 65 days from sowing to maturity, therefore, regular and frequent visits were made to note down growing status of mung bean as well spring maize crops, in order to increase the level of confidence of both the scientist as well as participating farmer. The various parameters recorded were sowing date, per cent germination, number of irrigations applied, number of sprays applied for control of insect pest and diseases, method of harvesting, grain yield and selling rate. Based on the data, calculations were made in order to draw the inference about the comparative performance of summer mung bean with spring maize.

Calculations

The economical parameters were calculated using following formulae:

- Gross income (Rs) = Yield (q/ha) X Selling price (Rs/q)
- Gross returns per day (Rs) = Gross income (Rs) / Crop duration (No. of days)
- Irrigation water applied (m^3/ha) = Number of irrigations x depth of irrigation (5cm) x 10x 10
- Net returns (Rs) = Gross returns– Cost of production
- Water productivity (kg/m^3/ha) = Yield (kg/ha) / Total irrigation water used (m^3)

Table 1. Package of practices followed for raising mung bean crop under front line demonstration.

Sr. No.	Parameter	Quantity	Purpose
1.	Variety	SML 668	It is a short duration variety which matures in 60 to 65 days after sowing. The potential yield of this variety is 11.5 q/ha.
2	Seed	37.5 kg/ha	Grains are bold in size and therefore seed rate is 37.5 kg/ha whereas for small size varieties, it is 30 kg/ha.
3	Seed treatment	*Rhizobium spp*	Seed must be treated with *Rhizobium spp* cuLure as it will help in more root nodulation which will help in fixing of atmospheric nitrogen in the soils.
4	Time of sowing	20th March to 10th April	The seed can be sown after potato harvesting in the month of end February or 1st week of March. However, the recommended time is 20th March to 10th April.
5.	Application of weedicide	Stomp @ 2.5 L/ha.	In order to control all type of weeds, pre emergence weedicide is required to be applied within 48 hr of sowing.
6.	Control of insect pest and diseases	1250 ml of Ekalux 25 EC (quinalphos) or 500ml of Nuvan 100(dichlorvos)	These insecticides need to be sprayed after mixing in 80-100 L of water with a manually operated knapsack sprayer.
7.	Harvesting	Stop irrigation after 55 days after sowing and spray Gramaxone @ 2.0 L/ha before harvesting with combine harvestor.	It will be better to go for manual harvesting because quality of produce becomes better than combine harvesting.

The data were analyzed using mean values.

RESULTS AND DISCUSSION

Grain Yield

The grain yield in mung bean varied between 9.4 q/ha to 11.5 q/ha and average grain yield was found to be 10.65 q/ha under the demonstration plots (Table 2), whereas, in the farmer's practice, the average yield obtained was 6.5 q/ha. However, the potential yield of the variety (SML 668) was 11.25 q/ha. This might probably be due to difference in the soil type and management practices followed by the farmers as well as effect of preceding crop on the yield of mung bean.

Average yield of mung bean of the district was found to be 5.24 q/ha and the state average was 6.69 q/ha, both these values were lower than the average yield of 10.65 q/ha obtained under FLD conducted by the KVK scientists. These values showed that average yield of FLD's have a yield gap of (- 59.2

Table 2. Comparative performance of spring maize versus summer mung bean.

Sr. No.	Parameter	Spring Maize	Mung bean
1	Days to maturity (Days)	118.5	63.4
2	Yield (q/ha)	94.0	10.65 (9.4 to 11.5)
3	Selling price (Rs/q)	958/-	7,000/-

Table 3. Water use efficiency in spring maize and mung bean

Sr. No.	Parameter	Spring Maize	Mung bean
1	Number of irrigations during crop season	19.7	2.4
2	Total irrigation water applied (Cubic m/ha)	9850	1200
3	Water productivity (kg/m^3/ha)	0.95	0.89
4	Cost of irrigation water (Rs/ha)	9,850/-	1,200/-

%) with respect to state yield and (- 103 %) to the district yield, whereas, only 5.3 per cent lower as compared to the potential yield of the variety. Hence, cultivation of pulse crops demand a regular visit to the field followed by timely operations particularly weed control during first 25 days and control of tobacco caterpillar and American boll worm during first 45 days and later on at flowering and pod formation stages. It was noticed during this season that there was heavy infestation of tobacco caterpillar and American boll worm on mung bean crop, that was controlled effectively in FLD but farmers could not take precautionary measures and thus obtained lower yield as compared to potential yield of the variety. The yield losses caused by pod borer varied from 30-50 % in different rotations.

Water productivity

The cropping season of both spring maize and summer mung bean starts from February to June months, when the ambient temperature starts rising and was found to be maximum during the months of April and May. The duration of growing period for maize and summer mung bean is 118 days and 63 days, respectively. The data regarding number of irrigation applied during crop season varied significantly because spring maize required 19.7 irrigations as compared to 2.4 irrigations for summer mung bean. Likewise, total irrigation water applied was calculated to be 9,850 and 1,200 m^3/ha for spring maize and summer mung bean, respectively (Table 3).

This indicates that cultivation of spring maize is highly unsustainable due to higher water requirement which has led to more underground water depletion as evident from lowering of water table @ 60-70 cm per year in the central plain zone of Punjab and if this situation continues to prevail, the whole district will be declared as dark zone. Hence it is imperative to discourage cultivation of spring maize and farmers must be advised to go for short duration water efficient and sustainable crop such as summer mung bean.

Cost of irrigation water

Although Government of Punjab is providing electricity free of cost to the farming sector, as a result of which farmers do not consider the cost of irrigation water applied for growing crops. If we calculate, the cost of irrigation water @ 1 paisa per 10 L then, the cost of irrigation water for spring maize cultivation during the season was calculated to be Rs 9,850/-ha and for summer mung bean it was Rs 1,200/-ha, which clearly speaks that cultivation of summer mung bean is very economical compared to spring maize. This fact needs to be further propagated among the farming community while calculating the gross profit or net profit earned per unit area.

Cost of inputs used for raising crops

The values in Table 4 clearly showed that there was a huge difference in the cost of production for spring maize (Rs 30,800/-) and summer mung bean (Rs 18,750/-). The major difference was due to the fertilizer application because summer mung bean was grown mostly after potato harvesting which requires no fertilizer whereas, for growing spring maize there was a need for 300 kg of urea, 187.5 kg of DAP and 50 kg of MOP per hectare, which cost Rs 6,875/- per ha. Similarly, for providing 19 irrigations to the spring maize, during the growing period starting from February to June at least 19

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Table 4. Cost of inputs used for growing spring maize and summer mung bean per hectare.

Sr. No.	Parameter	Spring Maize	Mung bean
1	Land Preparation	3,750/-	3,750/-
2	Seed cost	4,000/-	7,500/-
3	Seed treatment	350/-	50/-
4	Labour cost for sowing	1,750/-	1,000/-
5	Watch and ward cost during germination and grain filling	2,325/-	0
6	Weedicide used	1,625/-	1,000/-
7	Insecticides used	1,000/-	1,200/-
8	Fertilizers used	6,875/-	0
9	Earthing up	625/-	0
10	Labour cost for harvesting	3,750/-	2,750/-
11	Labour cost for threshing	0	1,000/-
12	Labour for irrigation	4,750/-	500/-
	Total Cost	**30,800/-**	**18,750/-**

man days @Rs. 250/man day were required thus costing Rs 4,750/- , which is Rs 500/- in case of summer mung bean.

Additionally, an amount of Rs 2325/- was required to deploy a person for taking care of watch and ward especially at the time of germination and after filling up of grains in spring maize (Table 4). As far as, harvesting cost is concerned maize crop was harvested with the help of combine harvester @ Rs 3750/- per ha, whereas, moong crop was harvested and threshed manually. No fertilizer was applied to the summer Mung bean as *Rhizobium spp.* which supplies about 20-40 kg N/ha. can be considered as a complementary source of plant nutrients as inoculation of *Rhizobium* enhances nodulation, nitrogen fixation, and grain yield.

Gross Returns

The average selling price of mung bean observed during the year 2016-17 was between Rs. 6500/- to Rs. 7500/-q and so the average was Rs. 7,000/-q then gross income comes out to be Rs. 74,550/-ha (Table 5). On the other hand, spring maize yielded an average of 94.0 q/ha @ Rs. 958/-q which comes out to be Rs. 90,052/ha and was more by Rs. 15,502/ha.

This was the main reason that farmers were increasing area under spring maize day by day in order to harvest maximum gross income and not paying any attention toward cultivation of short duration, more resource efficient crops like summer mung bean and spring groundnut etc. Contrary to the fact that if we calculate gross returns on per day basis then summer mung bean gives an amount of Rs. 1,176/-ha as compared to spring maize (Rs.760/-ha). This indicated that farmers can earn more per unit area in per unit time but it requires an exhaustive effort to be made by the extension agencies in order to make the farmer understandable about this philosophy.

Net Returns

The study clearly indicated that the net profitability is totally dependent upon the cost of irrigation water applied, which is considered free by the farmers and if taken into consideration, cultivation of spring maize, in any case is not at all profitable (Table 5). In one case, when irrigation water cost was excluded, spring maize gave a net profit of Rs 59,271/- per ha compared to 55,800/- with summer mung bean, showing that it is economical to go for cultivation of spring maize.

Table 5. Net returns in spring maize and mung bean.

Sr. No.	Parameter	Spring Maize	Mung bean
1	Gross income (Rs/ha)	90,052/-	74,550/-
2	Gross returns per day (Rs/ha/day)	760/-	1,176/-
4	Cost of production including irrigation cost (Rs/ha)	40,650/-	19,950/-
5	Net returns excluding irrigation cost (Rs/ha)	59,271/-	55,800/-
6	Net Returns including irrigation cost (Rs/ha)	49,421/-	54,600/-

In second case, when cost of irrigation water @ 1 paisa per 10 L was taken into account cultivation of spring maize became less remunerative (Rs 49,421/-) than the summer mung bean (Rs 54,600/-). Therefore, it can be said that farmers must take into account the cost of irrigation water required to irrigate the crop, while calculating the total cost of production as well as the profitability of the crop.

CONCLUSION

The average grain yield of mung bean was 10.65 q/ha under the demonstration plots whereas average yield of spring maize was 94q/ha. On the contrary, total irrigation water applied was 9,850 and 1,200 m^3 /ha. for spring maize and summer mung bean, respectively. This indicated that spring maize requires 8.2 times more quantity of irrigation water than summer mung bean. Similarly, irrigation to spring maize and summer mung bean costs about 24.3 and 6.0 per cent of the total cost of production, respectively. The average selling price of mung bean during the year 2016-17 was Rs. 7,000/-q and thus, gross income comes out to be Rs. 74,550/-ha whereas selling price of spring maize was Rs. 958/-q. so gross income comes out to be Rs. 90,052/ha which was more by Rs. 15,502/ha than summer Mung bean. On calculating the cost of irrigation water @ 1 paisa per 10 L, the net returns for spring maize cultivation was Rs 49,421/-ha and Rs 54,600/-ha for summer mung bean. Hence it is imperative to discourage cultivation of spring maize and farmers must be advised to go for short duration water efficient and sustainable crop such as summer mung bean.

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