Comparative study for the effect of different sowing techniques on wheat (Triticum aestivum L.) productivity and economic feasibility

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Abstract

Planting methods are very important in agricultural crop production and comparatively some has been found very cost effective. An experiment was conducted to examine the role of different sowing technique on the wheat productivity and economic viability. There were four sowing techniques: Direct drilling technique (T_1), drilling after land preparation (T_2), mechanical broadcasting (T_3) and minimum tillage drilling technique (T_4) and the study was laid out in Randomized Complete Block Design with three replications. Data regarding different crop characteristics showed that maximum germination count, number of fertile tillers and grain yield were found when crop was sown by adopting minimum tillage method. Among the economics analysis parameters highest fuel consumption and cost of production was recorded in drilling after land preparation and in broadcast method while lowest was in minimum tillage and direct drilling method. There was maximum benefit cost ratio in minimum till sowing due to higher gross income and lower cost of production. Over all, it is concluded that wheat crop can produce maximum grain yield and economically more profitable when sown by minimum tillage technique.

Keywords: Sowing techniques. Productivity. Economics. *Triticum aestivum* L.

1. Introduction

Agricultural productivity enhancement besides other factors depends on farm mechanization. The tube well technology and seed-fertilizer revolution doubled the labor requirement in agriculture, which resulted considerable increase in cropping intensities and increased the mechanized farming (Tahir et al., 2003). The use of various farm machines / implements and cost effective technologies in the farming system has resulted in increased crop yield, cropping intensity and ultimately improved productivity level as well as saving (Govt. of Pakistan, 2001).

Agriculture plays an important role in Pakistan's economy. It is the single largest sector and dominant driving force for growth and development of the national economy. At present, 79% of farmers having land of less or equal to 5 hectares is practicing subsistence farming under deficit and an intensive use of agricultural machinery needs to be popularized the farmers to speed up cultivation process and improve yield per hectare. The effective and efficient use of agricultural machinery saves energy, time and operational cost. Thus, transition from subsistence farming to profitable farming can only be achieved through the adoption of efficient and effective technologies (Anonymous, 2009).

Wheat (*Triticum aestivum* L.) is an important and main staple food for the people of Pakistan sown on an area of 9.06 million hectares. The production of wheat crop is provisionally estimated at 23.4 million tons, which is 11.7% more than last year crop (Govt. of Pakistan, 2010). The province of Punjab alone contributes about 80% of the total wheat production in the country. In spite of abundant land, water and human resources, the government has to import wheat every year in order to feed the ever-increasing population of Pakistan. The rapid growth of population demands a tremendous increase in food. To fulfill the requirements, modern agricultural machineries should be used (Ghafoor, 2001).

Planting equipments are used to sow the seed into the soil after seedbed preparation and choice of equipments depends on size, shape and type of seed to be sown. The real benefit of mechanical broadcasting over traditional (manual broadcasting) is the uniformity in spreading the given quantity of seed in the area. The real benefit of drilled crop is to increase in yield (particularly wheat) by about 15% over the traditional one (Tahir et al., 2003). The zero tillage technique is a win-win situation with implicit and explicit advantages of cutting down the cost of production of wheat substantially. The technique is eco-friendly; the input

use efficiency is increased and as a result of which, profitably of farmers in wheat production is increased (Hobbs et al., 1997).

Minimum tillage has been increasing interest mainly to reduce crop production cost, water requirement and improve soil conditions. Wheat planting by this technique increases the yield 15% higher as compared to conventional practice involving land preparation. It is also considered an excellent practice for wind and water erosion control and thus storage of water in soil profile (Benites, 2001).

Keeping in view the above facts the experiment was planned with the objective to compare different methods of sowing of wheat crop for its growth, production and for economic feasibility.

2. Materials and Methods

An experiment was carried out at Agronomic Research Area, Postgraduate's Agricultural Research Station Jhang Road, Faisalabad. The investigation was laid out in Randomized Complete Block Design (RCBD) with four treatments and three replications. The experiment comprised four treatments i.e. direct drilling technique (T_1), drilling after land preparation (T_2), mechanical broadcasting (T_3) and minimum tillage drilling technique (T_4). The direct drilling operation was carried out by operating Happy Seeder. The field was prepared by using the tillage implements like rotavator was operated in the field in a single pass. Three operations of a narrow tine cultivator and two operations of a planker were carried out for sowing seed with Broadcaster and Rabi drill. Minimum tillage sowing technique operation was carried out by using the Zone Disk Tiller Drill. Net plot size was 19m×31m.

The study area falls under semi arid climate where the temperature in the months of May to June ranges between 31-46^{o}C and the coldest months are November to February and temperature of these months ranges between 10 to 27^{o}C. Wheat variety Oofaq was used for the study and seed rate used were 55 kg per acres. Five irrigations were applied to the experiment and fertilizers i.e. nitrogen, phosphorus and potash were applied @160:100:100 kg per hectares. 1/3 N was applied at the time of sowing as side dressing with the help of single row hand drill, 1/3 N with first irrigation and remaining 1/3 N was applied at booting stage. Phosphorus and potash was applied at the time of planting. Urea, triple super phosphate and sulphate of potash were used as a source of fertilizers. All other cultural practices were standard and uniform for all treatments including control.

Following observations was recorded from the experiment during the course of study and the procedure of data collection was as under:

- Germination count (m^2): The percentage of seed germination (emerged seedling or visible seedling) in subplot from each plot was recorded three weeks after sowing time at the completion of germination. Germination count was obtained from a unit area of one square meter taken at random.
- Number of fertile tillers per square meter: Number of fertile tillers at harvest of the crop from one square meter area was counted.
- Weed density (m^2): After the completion of crop germination, one square meter was selected from each plot. The numbers of weeds were counted from one square meter area of each plot.
- Applied water applied: The amount of water (cubic feet) applied to each experimental unit was determined by using following formula: $V = Qt$
- Where, V = Amount of applied water (cubic feet), Q = Discharge at field nakka (cusec), t = Time of application (sec)
- The total amount (V′) of water applied was computed for the entire crop season in all treatments. Then, the amount of water saved was determined by the difference of water applied to the difference treatments
- Water saving = $V'_{T2} - V'_{T1}$
- Where, V'_{T2} = total amount of water applied to crop sown by using Rabi drill. V'_{T1} = total amount of water applied to crop sown by using happy seeder.
- Grain yield (kg/plot): Grain yield was estimated by harvesting an area of one square meter from plot. The plants from selected areas were harvested and threshed manually. The grains were weighted by using the balance.
- Fuel consumption (L/plot): Fuel consumption in different sowing techniques was determined by filling the tractor fuel tank to its top at the start of operation and then refilling the tank to its capacity at the end of operation. The quantity of fuel added later was considered the fuel consumed.
- Economical analysis: The experimental data was analyzed by using methodology described in CIMMYT (1988). For economic point of view, cost of production of wheat was calculated for the experiment in different sowing techniques for wheat

crop. Net income and BCR (benefit cost ratio) was computed to examine the most profitable treatment.

- Statistical analysis: The data collected from the experimental plots was analyzed using personal computer. Computer software 'MSTATC' was used to carry out the statistical analysis (MSTAT Development Team, 1989). The treatment means were compared using least significant difference test at 5% probability level (Steel et al., 1997).

3. Result and Discussion

3.1. Germination count (m^2)

Data regarding effect of different sowing techniques on the germination count of wheat is presented in Table 1. The germination count was affected significantly both by MST (Modern sowing techniques i.e. direct drilling and minimum tillage drilling) and CST (Conventional sowing techniques, i.e. drilling after land preparation and broadcast) and maximum germination was recorded in minimum tillage drilling followed by direct drilling and minimum was recorded in conventional sowing i.e. broadcasting.

The more germination count recorded for minimum tillage drilling technique might be attributed to better seed placement and better seed contact on moist soil. Younis et al. (2006) reported that zone till sowing of wheat (i.e. minimum tillage sowing technique) maintained the favorable seed to soil contact, which resulted in rapid water absorption by the seeds and faster seedling emergence.

Similar results were reported by Gupta and Hobbs (2000) that slow emergence of seedling in conventional tilled plots as compared to the direct drilling might be due to the lower moisture content and plant nutrient in the upper soil layer. Higher germination in direct drilling is due to higher water content and more water holding capacity. Zero tillage gave favorable results in the presence of surface residue, promoting high levels of seedling emergence (Chaudhry and Bakar, 1987; Sichuan (1998).

3.2. Number of fertile tillers (m^2)

Number of fertile tillers is affected by different sowing techniques is presented in Table 1. The results indicate that the maximum tiller densities i.e. 272.67 and 255.67 were

recorded in the modern sowing techniques i.e. minimum tillage drilling and direct drilling and in conventional sowing techniques i.e. drilling after land preparation and broadcasting were 234 and 221 respectively.

There spike bearing tillers in minimum tillage drilling treatment followed by direct drilling, drilling after land preparation and broadcast. The maximum spike bearing tillers recorded in the minimum tillage drilling might be due to more seedling emergence, tiller density and available moisture. Younis et al. (2006) reported that higher plant population per unit area was recorded in the minimum tilled plots as compared to slot planting and conventional sowing techniques due to more moisture content and faster seedling emergence.

Increase in productive tiller density recorded in the direct drilling as compared to conventional sowing techniques (Ghafoor, 2001).

3.3. Weed density (m^2)

Weed density was affected by different tillage treatments as shown in Table 1 and found that maximum weed densities were recorded in drilling after land preparation (21.00) and broadcast and (22.67) respectively. The population densities of weeds recorded in direct drilling and in minimum tillage drilling was 17.67 and 18.33 respectively.

There was lowest weed density in minimum tillage drilling treatment followed by direct drilling, drilling after land preparation and broadcast in ascending order. Overall, weed growth per unit area was more in tilled plots compared with direct drilling technique. These results are in conformity with Ghafoor (2001) who concluded that minimum weeds were recorded for direct drilling as compared to tilled plots. It was also observed that weed plants in direct drilling were weaker than those in other seedling techniques and were easy to control by weedicide application.

3.4. Amount of water applied (Cubic feet/plot)

The depth of applied water was affected significantly both by MST (Modern sowing techniques, direct drilling and minimum tillage drilling) and CST (Conventional sowing techniques, i.e. drilling after land preparation and broadcast). The data presented in Table 1 maximum amounts of water (cubic feet/plot) i.e. 8371 and 8345, were recorded in conventional sowing techniques i.e. drilling after land preparation and broadcast respectively.

The amount of water (cubic feet /plot) recorded in modern sowing techniques i.e. direct drilling and minimum tillage drilling were 5821 and 6652 respectively. There was minimum amount of water in direct drilling treatment followed by minimum tillage drilling, broadcast and drilling after land preparation.

The only reason for greater amount of water applied to tilled plots was slow water movement and high infiltration rate in cultivated fields. Hence, the farmers are forced to apply more water than the requirement. While in the direct drilling water moves rapidly to the other end of field due to low infiltration rate and therefore, direct drilling results in the saving both time and quantity.

Anonymous (2001) and IMMI (1999) reported that more water saving in direct drilling as compared to sowing after land preparation. The reason is that the amount of water was low in the minimum tillage drilling as compared to the conventional sowing techniques due to the rapid movement of water and low infiltration rate.

3.5. Grain yield (kg/plot)

The grain yield per unit area has a direct dependence on the accumulative effect of various parameters of yield that are influenced differently by the soil, climate conditions and management practices.

The results presented in Table 1 indicate that the maximum grain yields (kg/plot) i.e. 279.70 and 270.70 were recorded in modern sowing techniques i.e. minimum tillage drilling and direct drilling respectively. The grain yields recorded in conventional sowing techniques i.e. drilling after land preparation and broadcast were 252.93 and 246.89 respectively.

There was maximum grain yield in minimum tillage drilling treatment followed by direct drilling, drilling after land preparation and broadcast in descending order. The results of the study are quite in line with Directorate of Wheat Research (1999) and it was observed that number tillers per square meter at direct drilling was 10-15% higher than those recorded in other seedling techniques.

3.6. Fuel consumption (L/plot)

The fuel consumption per plot has a direct dependence on the farm operations involved in different sowing techniques. The fuel consumption was affected significantly both by modern sowing techniques and conventional sowing techniques.

The results in Table 1 show that maximum fuel consumption (L/plot) i.e. 2.44 were recorded in drilling after land preparation and followed by broadcast (2.30) and minimum (0.44) was recorded in direct drilling. It may be inferred from this data that direct drilling technique proved much economical than tilled techniques. Higher fuel consumption in other treatments was due to more number of tractor operations required for land preparation.

Arshad and Ahmad (1989) reported that sowing of wheat with direct drilling/zero tillage was introduced to improve wheat productivity by reducing tillage cost. It was concluded from the results that on average farmers benefits were increased through low cost technology because it reduced tillage cost.

3.7. Cost of production

The cost of production and grain yield in different sowing techniques affected net income per plot. The data pertaining to economic analysis of different sowing techniques is presented in Table 1 indicate that the maximum costs of production (Rs. 4436) were recorded in broadcast method of sowing followed by drilling after land preparation.

The costs of production (Rs. 4105 and Rs. 4046) were recorded in modern sowing techniques i.e. minimum tillage drilling and direct drilling respectively. The higher costs of production in conventional sowing techniques are due to proper seedbed preparation.

The seedbed preparation consists of 3-4 tillage operations along with planking operation. Gill (2001) narrated that direct drilling saved expenditure involved in seedbed preparation by eliminating plowing and planking cost.

3.8. Gross income

The data pertaining to gross income of different sowing techniques is presented in Table 1 indicate that the maximum gross incomes (Rs./plot) i.e. 6501 minimum tillage drilling

followed by direct drilling. The minimum gross income (Rs./plot) i.e. 5740 was recorded in broadcasting.

There was maximum gross income in minimum till drilling sowing technique treatment. In this way, adoption of minimum till drilling sowing technique saved 11.70%, 9.5% and 3.18% higher gross income as compared to broadcast, drilling after land preparation and direct drilling techniques respectively.

The lower gross incomes in conventional sowing techniques are due to less grain yield. Younis et al. (2006) and Ghafoor (2001) also found that on an average, the productivity of wheat was higher for zero tillage as compared to conventionally tilled fields.

3.9. Net income

The net income in different sowing techniques is dependence on grain yield and cost of production of wheat per plot. The data pertaining to net income of different sowing techniques is presented in Table 1 affected significantly both by different sowing techniques.

There was maximum net income in minimum till drilling sowing technique treatment. In this way, adoption of minimum till drilling sowing technique saved 45%, 39% and 6% higher net income as compared to broadcast, drilling after land preparation and direct drilling techniques respectively.

The lower net incomes in conventional sowing techniques are due to lower grain yield and higher cost of production. Similar results were obtained by Younis et al. (2006). They concluded from their three-year research that average grain yield with the zone till sowing machine higher as compared conventional sowing techniques respectively. Ghafoor (2001) also described that on an average zero tillage enhanced net income by increasing the productivity of wheat and reducing cost of production.

3.10. Benefit cost ratio

The benefit cost ratio in different sowing techniques is dependence on gross income and cost of production of wheat per plot. The data regarding benefit cost ratio of different sowing techniques is shown in Table 1. The benefit cost ratios i.e. 1.33 and 1.30 were recorded in drilling after land preparation and in broadcast method respectively.

There was maximum benefit cost ratio in minimum till drilling sowing technique treatment due to higher gross income and lower cost of production. Younis et al. (2006) concluded from their research that average gross income with the zone till sowing machine higher as compared to conventional sowing techniques respectively. They also reported that minimum till drilling reduces the cost of production by saving in diesel fuel consumption, labor, and irrigation water.

4. Conclusions

The emergence count, productive tillers were higher in the minimum tillage drilling as compared to other sowing techniques as drilling after land preparation and broadcasting that contribute toward higher grain yield. Overall, less amount of water applied per plot and maximum benefit cost ratio in minimum till drilling sowing technique was found due to higher gross income and lower cost of production.

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Table 1: Effect of different sowing techniques on emergence count, number of fertile tillers, weed density, amount of water applied, grain yield, fuel consumption, cost of production, gross income and benefit cost ratio (BCR) on wheat

Means sharing the same letters in a column do not differ significantly from each other at p 0.05 NS = Non significant

Treatment	Germination count (m^2)	Number of fertile tillers (tiller/m^2)	Weed density (plant/m^2)	Amount of water applied (cu ft / plot)	Grain yield (Kg/plot)	Fuel consumption (L/plot)	Cost of production (L/plot)	Gross income (Rs/plot)	Net income (Rs/plot)	BCR
Direct drilling	163.33 b	255.67 b	17.67	5821.00^{c}	270.70^{b}	0.43^{c}	4046^{c}	6294^{b}	2248^{b}	1.55^{b}
Drilling after land preparation	147.67 c	234.00 c	21.00	8370.67^{a}	252.93^{c}	2.44^{a}	4430^{a}	5881^{c}	1451^{c}	1.33^{c}
Broadcasting	132.67 d	221.00 d	22.67	8370.33^{a}	246.89^{d}	2.30^{a}	4426^{a}	5740^{d}	1314^{d}	1.30^{d}
Minimum tillage drilling	172.33 a	272.67 a	18.33	6652.33^{b}	279.59^{a}	0.78^{b}	4105^{b}	6501^{a}	2396^{a}	1.59^{a}
LSD at 5%	5.95	5.95	NS	432.8	0.50	0.22	28.00	11.12	30.35	0.0063