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Research Article

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Laser Leveler Maximized Chickpea's Growth and Yield Traits (*Cicer arietinum* L.)

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Abstract

Since the introduction of laser leveler for land leveling in agriculture, farming community has been discussing the comparative role of different leveling implements in enhancement of crop growth and yield. Therefore, this study was conducted to determine the performance of chickpea (*Cicer arietinum* L.) crop under three leveling implements, including planker, iron blade and laser leveler. The research was carried out at the "Students' Experimental Farm" of the Department of Agronomy, Sindh Agriculture University, Tandojam, Sindh, Pakistan, during winter season of 2021-22. The field experiment was thrice replicated in Randomized Complete Block Design (RCBD, factorial) on a net area of the plot (9 m^2) per replication of each treatment, a total of 81 m^2 per treatment. The results showed that land leveled under T_3 (Laser leveler) resulted maximum growth and yield traits such as days to 50% germination (18.0), days to 50% flowering (47.53), days to 50% pod formation (77.53), plant height (72.63 cm), pods plant^{-1} (71.8), seed index (193.33 g), biological yield (4226.66 kg ha^{-1}), grain yield (2550.0 kg ha^{-1}) and harvest index (59.64 %), followed by T_1 = Leveling with planker. While the minimum results recorded in T_2 = Leveling with iron blade for all parameters. Therefore, land should be leveled with laser leveler to achieve the higher seed (grain) yield per unit area because it ensures uniform distribution of water, fertilizer, and ease in field operations.

Keywords: Chickpea, laser leveler, Planker, Iron blade, yield.

Introduction

Gram or Chickpea (*Cicer arietinum* L.) is the 03rd highly important food legume crop after common bean and field pea, growing in more than 40 countries of the world. It began in West Asia and gradually extended to Europe and India. Since the nutritional value of the gram (chickpea), it has been popularly consumed throughout the world. Its seed contains 50-58% Carbohydrates, 12-23% Proteins, 3.8-10.2% fats, and <1% other trace (Micronutrients) (USDA, 2021). Chickpea is an important legume food crop that offers important micronutrients (1%) and oil (7%) inside the grain (Kantar *et al.*, 2007). Due to its efficient nitrogen fixation capacity, chickpea has the remarkable chance to expand and improve the nutrient-poor soils (Khaitov *et al.*, 2016). Chickpeas, like other legumes, create a nitrogen-fixing symbiosis with mycorrhizal bacteria (Hungria and Kaschuk, 2014). Many studies have shown that inoculating chickpea with beneficial bacteria improves growth indices and grain output, as well as seed quality (Pathak *et al.*, 2017).

In Pakistan, chickpea production does not satisfy the demand of the people with its domestic supply. Due to lack of chickpea production, chickpea prices in local marketplaces have risen 2 to 3 times in recent years. New chickpea varieties with great production potential and salt tolerance have certainly been introduced. However many farmers are still growing locally available old types with inadequate agronomic management approaches. Furthermore, natural and anthropogenic variables including salinity, drought, nutrient scarcity and rhizobia stresses in the soil are causing destruction on chickpea production in the world (Khaitov, 2016).

It is critical to apply new management technologies to increase the chickpea grain production and quality. The most essential biological function of the leguminous crop plants is a symbiotic Nitrogen (N) fixation system for provision of nitrogen to the crop plants, as well as to improve soil N fertility. Chickpea fixes atmospheric nitrogen higher amount when these are inoculated with rhizobium bacteria. Previous research demonstrated that when legumes were associated with rhizobia, their nodulation efficacy improved which promotes plant development and boosts grain production (Khaitov *et al*., 2016).

In Agriculture, land leveling is used to alter the land contour to create the desired surface with specific field slopes, changing water circulation on the surface of the ground, improving watering and drainage and increasing the efficiency of cultivation activities. Precision lands lowering (PLL) is a method that may be applied to leveling tools such as drag scrapers or leveled blades to achieve extremely accurate soil surface leveling. Since its introduction in the 1970s, it has had a tremendous impact on surface irrigation. Even in vast fields, PLL precision might be very good, with a mean difference of land elevation of less than 20 mm and it can be done with a lower proportion of leveling machine passes in the same spot

Precision lands lowering (PLL) is a time saving and reducing the amount of water necessary to complete the life cycle of the crop through advanced surface irrigation systems, resulting in better growth and increases water use efficiency, a larger uptake of deficit irrigation, and improved management of the leaching portion (Bai *et al*., 2017). Crop health such as germination, growth uniformity and fertilizer use efficiency continuing to maximize yields and reducing weeding, labor and energy costs; (Das *et al*., 2018).

Laser leveling is a process that uses laser-equipped drag buckets to attain the necessary level of accuracy. It also encourages stronger crop stands and uniform seed/seedling positioning, which leads to improved crop yields. A uniform field enhances irrigation efficiency by improving water distribution and minimizes the risk of nitrogen loss by improving runoff control, resulting in more fertilizer productivity and greater harvests (Naresh *et al*., 2014).

In general, laser land leveling machinery could be compared with the corresponding farmland leveling, improving overall the segments and sub conditions of farmland, sets the groundwork for precision seeding and thus improves crop yield, fertilizer and water productivity and thus boosts up financial returns (Ashraf *et al*., 2017). Because some soil is lifted from the crest and transported to the channel during laser land leveling, some agriculturists are concerned that it would alter the soil conditions and fertility. According to Ashraf *et al*. (2017), there was on significant difference between level and unlevel fields in terms of accessible nitrogen, phosphorus, potassium and organic matter.

Laser land leveling (LLL) is a different land leveling method with the major benefit of reducing irrigation water loss caused by extremely undulating land. As a result, using LLL but instead of traditional land leveling (TLL) could assist to reduce irrigation water use and save energy by reducing irrigation duration (Jat *et al*., 2011).

Traditional land leveling (TLL) and lasers land leveling are now used by farmers in Pakistan to level land with laser (LLL). In the case of very undulated soil, the TLL, which uses scrapers or leveled boards driven by horses, trucks, or even bulldozers, lacks the precision and therefore is less likely to reduce irrigation asymmetry. (Jat *et al*., 2006).

Laser land flattening is a process that uses laser-equipped drag buckets to attain the necessary level of accuracy. It also makes seed/seedling placement more uniform and encourages healthier crop stands, all of which contribute to improved crop yields. A uniform field enhances irrigation efficiency by improving water distribution and minimizes the risk of nitrogen loss by improving runoff control, resulting in more fertilizer efficiency and greater yields (Jat *et al*., 2011).

Therefore, the present study was conducted to assess and compare the impact of laser leveling with that of planking and commonly used iron blade pulled by tractor on the growth and yield of chickpea

Materials and Methods

The field experiment had been laid down at the Students' Experimental Farm of the Department of Agronomy @ SA University, Tandojam during winter season of 2021-22, to assess the impact of laser leveling on the growth and yield of chickpea (*Cicer arietinum* L.). The sowing of chickpea was done on 11^{th} November, 2021 and harvested on 7^{th} of April, 2022. The chickpea was planted with distance of 10 cm from plant to plant and 30 cm between row to row. The details of the experiment are as below:

Variety tested: Dokri Gram-92 (DG-92)

Design of the experiment: Randomized complete block design (RCBD) Factorial, with 03 replications, net plot size 3m x 3m (9 m^2) per replication of each treatment, (9X9=81 m^2).

Treatments (T) 03; T_1 = Leveling with Planker (Pulled by tractor), T_2 = Leveling with common iron blade (pulled by tractor), T_3 = Laser leveler (pulled by tractor)

Observations recorded:

Agronomic observations: Days to 50% germination, days to 50% flowering, days to 50% pod formation, plant height (cm), pods plant^{-1}, seed index (1000-seed weight, g), biological yield (kg ha^{-1}), grain yield (kg ha^{-1}), harvest index (%).

Meteorological observations: High temperature (ºC), low temperature (ºC), rainfall (mm), humidity (%).

Procedures for recording observations:

Days to 50% germination: These were counted in each treatment and average was calculated.

Days to 50% flowering: The days were recorded in each treatment to calculate the average for 50% flowering.

Days to 50% pod formation: These were noted in each treatment and average days to 50% pod formation was calculated.

Plant height (cm): It was recorded with measuring tap and after taking the averages of five randomly selected plants were calculated.

Pods plant^{-1}: This data was recorded at the crop maturity of 05 randomly selected plants of each replication and the average was calculated.

Seed index (1000-seeds weight, g): It was calculated for 1000 seeds for every treatment manually to weigh its weight in grams.

Biological yield (kg ha^{-1}): It was calculated by using the formula as given below:

Biological Yield per plot X 1000
Plot size (m^2)

Grain yield (kg ha^{-1}): The seed yield (kg ha^{-1}) was calculated using the following formula:

Grain Yield kg per plot X1000
Area of plot

Statistical analysis: The Statistics 8.1 version was used to analyze the data statistically (Satatix, 2006). The least significant difference (LSD) 0.5% test was used to compare the treatments.

Results

Days to 50% germination: The results regarding mean days to 50% germination of DG-92 chickpea genotype affected by different levelers are showed in figure.1 The ANOVA revealed that genotype was significantly affected by different levelers at (p<0.0.5). It is revealed in the findings of the experiment presented in Figure 1 that 50% germination was recorded at a maximum of 18.0 days in T3 = Laser leveling, followed by T1 = Leveling with planker (17.53) days in and T2 = Leveling with iron blade. (17.2) days.

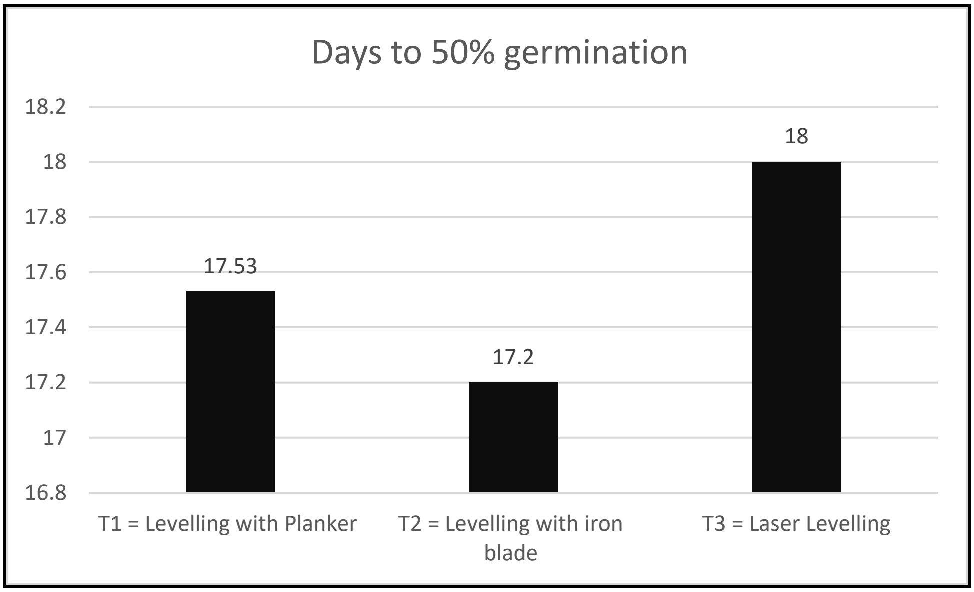

Figure .1. Effect of different levelers on days to 50% germination of chickpea variety DG-92

Days to 50% flowering: The results regarding mean days to 50% flowering of chickpea variety DG-92 as affected by different leveling are shown in Figure 2. Analyses of variance proved that chickpea variety by different leveling were effect significant at (p<0.0.5).

The findings in Figure .2 reveal that the maximum days to 50% flowering were recorded (47.53) in T3 = laser leveling, followed by days to 50% flowering (47.27) in T1 = Leveling with planker, while the minimum days to 50% flowering were recorded in ironT_2 = Leveling with iron blade (47.0).

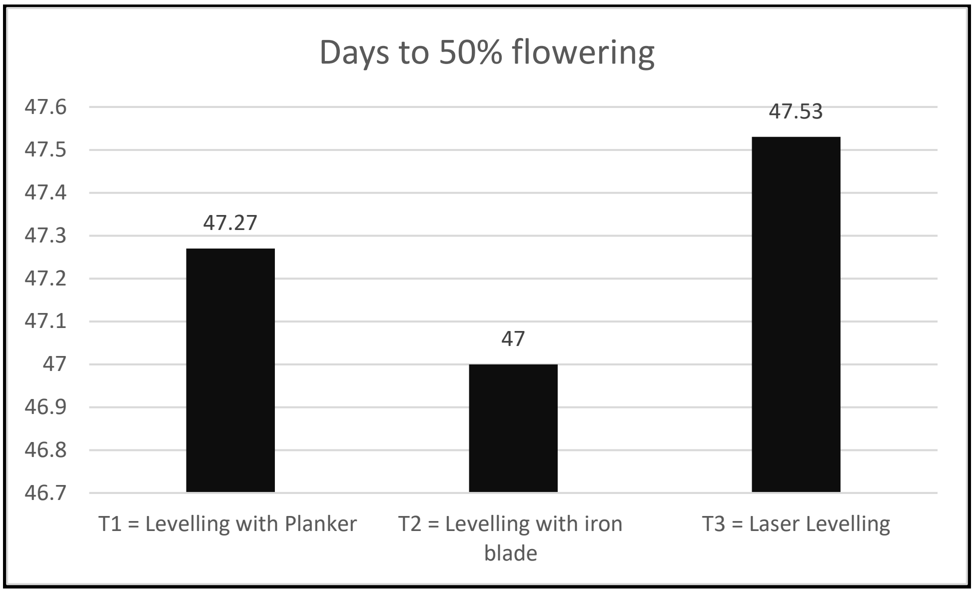

Figure 2. Days to 50% flowering of chickpea variety DG-92 as affected by different levelers

Days to 50% pod formation: The results regarding mean days to 50% pod formation of chickpea variety DG92 as affected by different leveling are showed in figure.3 Analyses of variance proved that chickpea variety by different leveling were effect significant at (p<0.0.5). It is revealed in the findings in figure .3 that the maximum days to 50% pod formation were recorded (77.53) in T_3 = Laser leveling, followed by days to 50% pod formation were recorded (76.17) in T_1 = Leveling with planker, while the minimum days to 50% pod formation were recorded (71.83) in T_2 = Leveling with iron blade

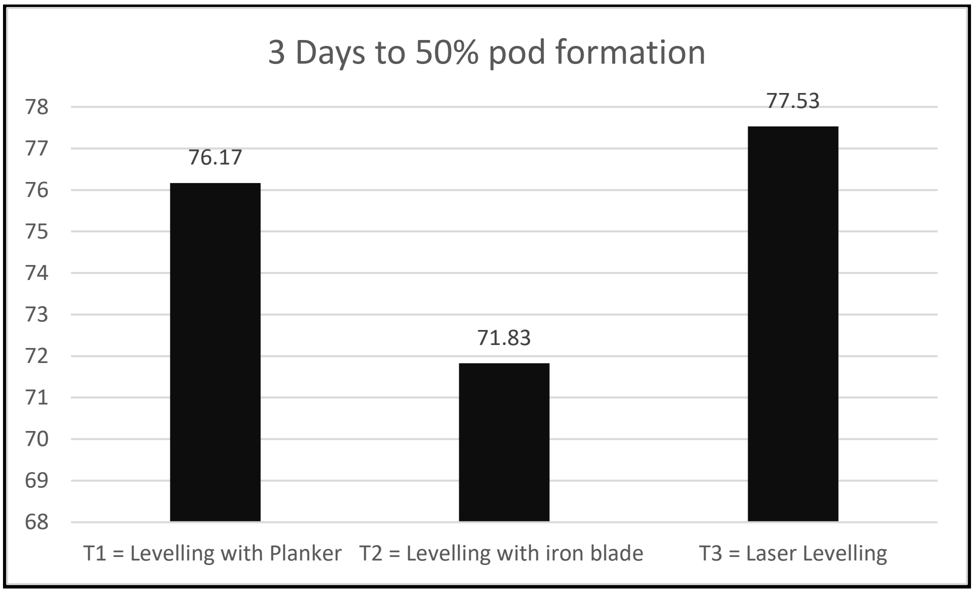

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Figure. 3. Days to 50% pod formation of chickpea variety DG-92 as affected by different levelers

Plant height (cm): The results regarding mean plant height (cm) of chickpea variety DG-92 as affected by different leveling are shown in Figure .4. Analyses of variance proved that chickpea variety by different leveling was effect significant at (p<0.0.5). It is revealed in the findings in figure 4 that the maximum plant height was recorded (72.63 cm) in T_3 = Laser leveling, followed by plant height was recorded (71.8 cm) in T_1 = Leveling with planker, while the minimum plant height was recorded (70.93 cm) in T_2 = Leveling with iron blade

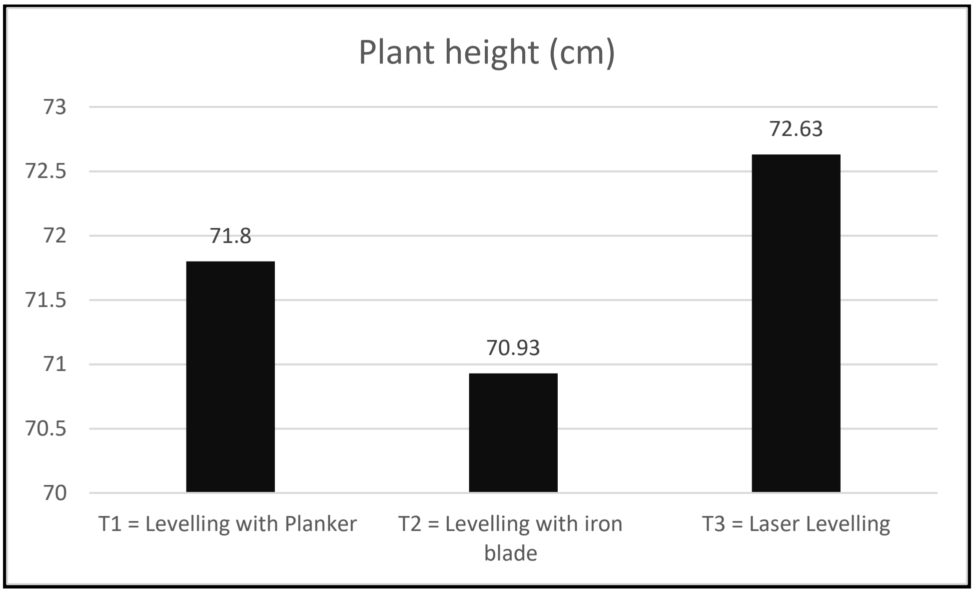

Figure .4. Plant height (cm) of chickpea variety DG-92 as affected by different levelers

Pods plant^{-1}: The results regarding mean pods plant^{-1} of chickpea variety DG-92 as affected by different leveling are shown in Figure .5, and analyses of variance in Appendix 5. Analyses of variance proved that chickpea variety by different leveling were effect significant at (p<0.0.5). It is revealed in the findings in Figure 5 that the maximum number of pods plant-1 were recorded (71.8) in T3 = Laser leveling followed by pods plant-1 were recorded (63.6) in T1 = Leveling with planked, while the minimum number of pods plant^{-1} were recorded (61.67) in T_2 = Leveling with iron blade

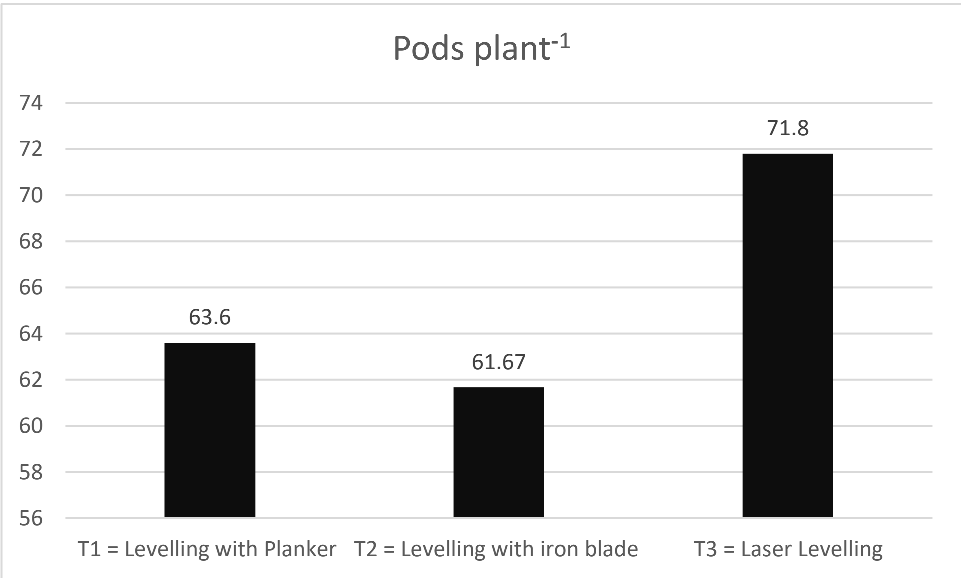

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Figure .5. Pods plant^{-1} of chickpea variety DG-92 as affected by different levelers

Seed index (1000-grain weight, g): The results regarding mean seed index (g) of chickpea variety DG-92 as affected by different leveling are showed in figure 6. Analyses of variance proved that chickpea variety by different leveling were effect significant at (p<0.0.5). It is revealed in the findings in figure 6 that the maximum seed index was recorded (193.33 g) in T_3 = Laser leveling, followed by seed index was recorded (190.0 g) in T_1 = Leveling with planker while the minimum seed index was recorded (180.0 g) in T_2 = Leveling with iron blade.

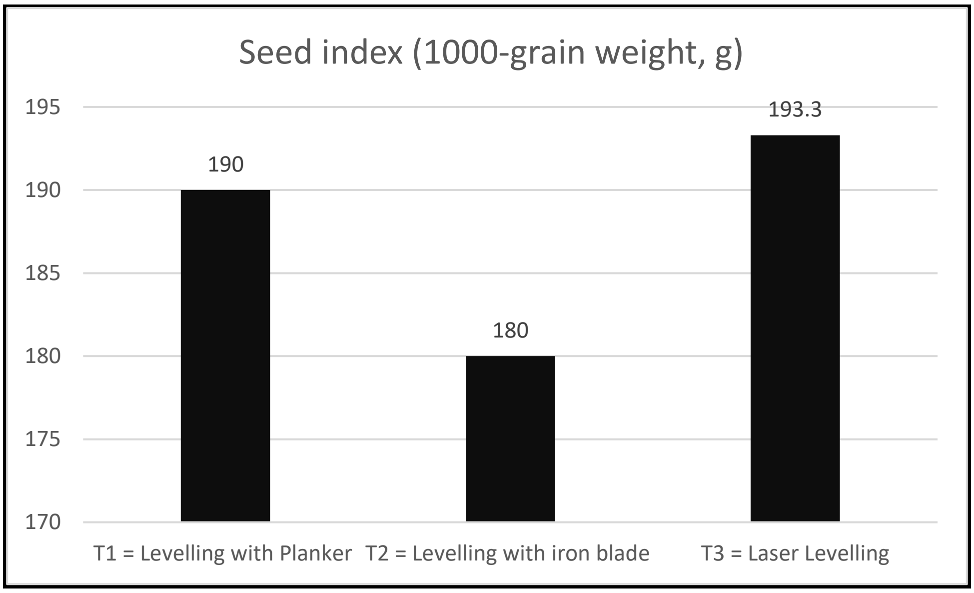

Figure .6. Seed index (1000-grain weight, g) of chickpea variety DG-92 as affected by different levelers

Biological yield (kg ha^{-1}): The results regarding mean biological yield (kg ha^{-1}) of chickpea variety DG-92 as affected by different leveling are shown in Figure .7. Analyses of variance proved that chickpea variety by different leveling was significantly affected at (p<0.0.5). It is revealed in the findings in figure .7 that the highest biological yield (kg ha^{1}) was observed (4226.66) in T_3 = Laser leveling followed by biological yield (kg ha^{-1}) was observed (3636.66) in T_1 = Leveling with planker while the lowest biological yield (kg ha^{-1}) was observed (3215.0) in T_2 = leveling with iron blade

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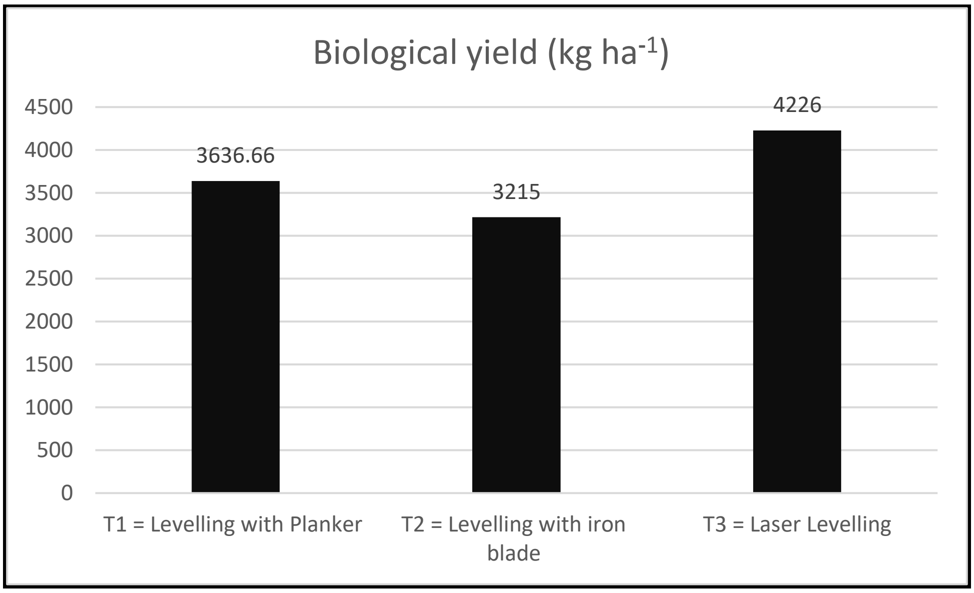

Figure .7. Biological yield (kg ha^{-1}) of chickpea variety DG-92 as affected by different levelers

Grain yield (kg ha^{-1}): The results regarding mean grain yield (kg ha^{-1}) of chickpea variety DG-92 as affected by different leveling are shown in Figure.8, proving that chickpea variety by different leveling was effect significant at (p<0.0.5). The findings in Figure 8.8 reveal that the highest grain yield (2550.0 kg ha-1) was observed in T3 = Laser leveling, followed by grain yield (1916.66 kg ha-1) in T1 = Leveling with planker, while the lowest grain yield (1900.0 kg ha-1) was observed in T_2 = Leveling with iron blade

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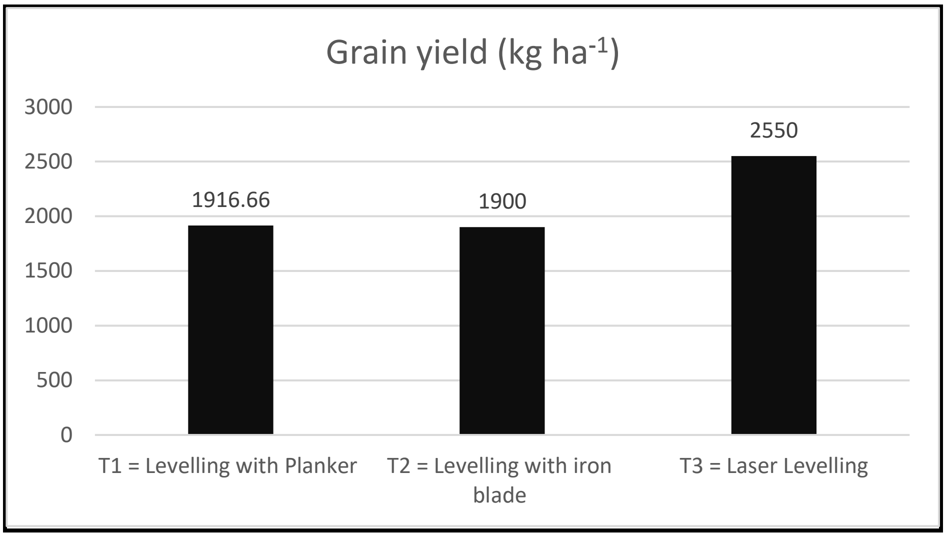

Figure. 8. Grain yield (kg ha^{-1}) of chickpea variety DG-92 as affected by different levelers

Harvest index (%): The results regarding mean harvest index (%) of chickpea variety DG-92 as affected by different leveling are showed in Analyses of variance proved that chickpea variety by different leveling were effect significant at (p<0.0.5). It is revealed in the findings in figure .9 that the maximum harvest index was recorded (59.64 %) in T3 = Laser leveling followed by harvest index was observed (51.14 %) in T1 = Leveling with planker, while the lowest harvest index was observed (46.11 %) in T_2 = Leveling with iron blade

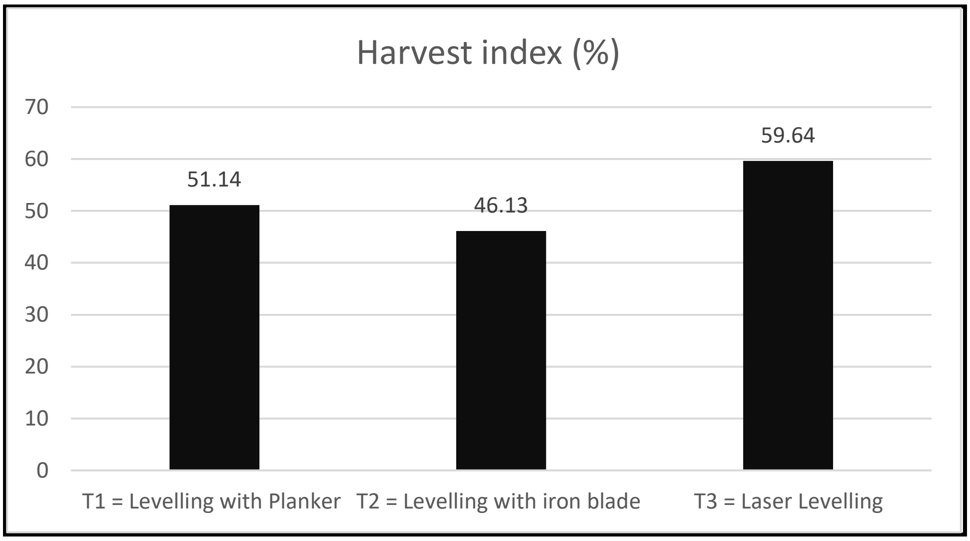

Figure .9. Harvest index (%) of chickpea variety DG-92 as affected by different levelers

Net profit: The table for net profit shows that the chickpea field where land was levelled with 'laser leveler 'produced highest yield @ 63 monds per hectare. Its market value was PKR 428400/-and total expenditure was PKR.40,750 /- Therefore, the farming community could earn nine time higher benefit as per total expenditure and also greater than using other leveling methods

Table. Net profits

	Factor/treatment	Production mon's ha^{-1}	Market Value (PKR)	Expenditure (PKR)	Net profits (PKR)
1	Leveling with Planker	48	326,400	40,000	286,400
2	Leveling with iron blade	47	319,600	38,250	281,350
3	Laser Leveling	63	428,400	40,750	387,650

Discussion

The results showed that T_3 = Laser leveling resulted maximum in all values with days to 50% germination (18.0), days to 50% flowering (47.53), days to 50% pod formation (77.53), plant height (72.63 cm), pods plant^{-1} (71.8), seed index (193.33 g), biological yield (4226.66 kg ha^{-1}), grain yield (2550.0 kg ha^{-1}) and harvest index (59.64 %), followed by T_1 = Leveling with planker recorded days to 50% germination (17.53), days to 50% flowering (47.27), days to 50% pod formation (76.17), plant height (71.8 cm), pods plant^{-1} (63.6), seed index (190.0 g), biological yield (3636.66 kg ha^{-1}), grain yield (1916.66 kg ha^{-1}) and harvest index (51.14 %) while minimum resulted recorded in T_2 = Leveling with iron blade were days to 50% germination (17.20), days to 50% flowering (47.0), days to 50% pod formation (71.83), plant height (70.93 cm), pods plant^{-1}(61.67), seed index (180.0 g), biological yield (3215.0 kg ha^{-1}), grain yield (1900.0 kg ha^{1}) and harvest index (46.13 %). These findings are like that of Chen *et al*, 2022 and Singh *et al*, 2021 in which they all observed that laser leveling as a one of the steps towards precision agriculture, proved better for enhancing soil conditions and crop growth and yield parameters.

Precision land leveling, simply means by using laser lever, resulted in a significantly greater yield of chickpea because it ensures near uniformity through cut and fill and tillage (Jat *et al*., 2003). Fragipan and duripan development are two significant diagnostic phases for the formation of hard cake tins on the soil layers of semi-arid zones, such as our experimental site, due to salt accumulation. Extensive tillage and subsequent leveling aid in the removal of such hard sub-surface layers, as does precision field leveling. Laser leveling also eliminates the frequent micro-relief that is a common feature of saline-alkaline soils like those found at the study site. Precision field leveling aids in regular water distribution even when water is applied at a shallow depth (approximately 5 cm), facilitating good crop establishment in sodic soils (Tyagi, 1984), resulting in increased yields. When compared to traditional leveling, precision land leveling reduces within-field yield variability, resulting in uniform germination, crop establishment, and greater crop yields (Jat *et al*., 2006). Significantly greater productive pods per plant, branches per plant, and plant height were related to the considerable increase in crop output on raised in optical leveled plots compared to the conventional tillage.

However, the results of this study have also been found supporting to the results of other crop scientists in which they also suggested that the bulk density did not change considerably as a result of field leveling, but planting techniques did, and it was significantly lower under raised bed planting compared to flat sowing, regardless of land leveling. More pore spaces were produced in the beds as a result of altered land layout caused by topsoil accumulations. By restricting traffic to the trench bottoms, bed planting provides a natural way to decrease compaction (Govaerts *et al*., 2006). Because of localized deposition of much more fertile top soil over beds under altered field layout than flat planting, the organic carbon store in top soil (0-15 cm) rose significantly when compared to typical tillage (Walker *et al*., 2003).

Conclusions

In the light of the findings of this study, it could be concluded that maximum grain yield was recorded (2550.0 kg ha^{-1}) in treatment 3 (T_3) where land was leveled with "Laser leveler" followed by in T_1 (Leveling with planker) where grain yield was recorded (1916.66 kg ha^{-1}); while the minimum grain yield was recorded (1900.0 kg ha^{-1}) in T_2 (Leveling with iron blade). Therefore it is recommended that land should be leveled with Laser leveler pulled by tractor because plants can g*et al*l the inputs equally which may result higher yield.

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