Vol. 20(1), pp. 123-131, January, 2024
DOI: 10.5897/AJAR2016.12113
Article Number: 926535171782
ISSN: 1991-637X

http://www.academicjournals.org/AJAR

ACADEMIC JOURNALS
expand your knowledge

African Journal of Agricultural Research

Full Length Research Paper

Enhancing wheat productivity for small-scale farmers in the northern state of Sudan through developing a local made seed cleaner and different seeding methods

Yasir Hassan Satti[1]* and fahad Alwagaae[2]

[1]Department of Agricultural Engineering, Faculty of Agricultural Sciences, University of Dongola, Sudan.
[2]Shamaliya for Agricultural Services, Ministry of Agriculture, Northern State, Sudan.

Received 31 December, 2016; Accepted 16 March, 2017

The wheat cleaner was designed, manufactured, and tested in the workshop of the Department of Agricultural Engineering, Faculty of Agricultural Sciences, University of Dongola, and Northern State of Sudan. The purpose was to enhance productivity for small-scale farmers who traditionally plant their saved wheat seeds every season, facing risks of weed infestation and low viability. A one-season field experiment was then conducted following the Randomized Complete Block Design (RCBD) experimental design in the demonstration farm of Dongola Research Station. Clean seeds and unclean seeds of a local wheat variety (Imam) were used, and two different planting methods were adopted: Traditional seed drilling with the recommended seed rate (50 kg.feddan^{-1}) and precision seeding using half the recommended seed rate (25 kg.feddan^{-1}). The effect of seed type and planting method on field parameters was investigated, and the data were analyzed using the computer application SAS system version 9.3. The results revealed significant (P ≥ 0.05) and highly significant (P ≥ 0.01) differences between treatments. Precision seeding with clean seeds versus seed drilling with unclean seed increased the number of kernels per spike (KS), tillers per plant (TPP), one thousand kernels mass (TKM), biomass of wheat (BWT), and total yield (TOY). Meanwhile, weeds per area (WSM), biomass of weeds (BWD), and weight of weed seeds were noticeably decreased.

Key words: Wheat cleaner, precision seeding, seed drilling method, small-scale farmers.

INTRODUCTION

Wheat holds strategic importance as a field crop in Sudan, serving as the primary staple food for a significant portion of the urban population. Its cultivation along the Nile banks in the Northern region, spanning latitudes 16° to 22°N, has historical roots dating back to 3000 B.C. In recent times, wheat cultivation in Sudan has expanded to latitudes lower than 15° N, functioning as a winter crop and occupying a substantial area in Sudanese irrigated schemes. It ranks as the second most crucial cereal crop in the country after sorghum (Ishag, 1994). Despite the increasing demand for wheat due to urbanization, there exists a significant production deficit compared to consumption.

The average wheat yields in Sudan are notably low, attributed to both limatic and production factors.

To enhance wheat yields, various fertilizer forms have

*Corresponding author. E-mail: yasshiri@gmail.com. Tel: +249912172546.

been introduced in Sudan.

Currently, farmers in the northern state of Sudan often prefer using their saved wheat seed instead of cleaned seeds provided by the Ministry of Agriculture. This preference is driven by the high cost of commercial seeds and the desire to provide free feed for their animals. However, this practice overlooks the adverse impact of weeds on reducing productivity. Many farmers believe that weeds growing alongside the main crop can serve as a cost-free source of animal feed, thus saving money that would otherwise be spent on commercial forage.

As per the recommendations of the Agricultural Research Corporation of Sudan (ARC), the recommended seed rate for wheat is 50 kg/fed^{-1} (119 kg.ha^{-1}). However, Dawy et al. (2012) reported that the most widely adopted seed rate for wheat in different parts of the country is 143 kg ha^{-1} (approximately 60 kg.fed^{-1}).

The objective of this study is to introduce a simple cleaning machine designed for small-scale farmers. Additionally, the study aims to investigate the impact of cleaned seeds produced by the locally made seed cleaner, along with different sowing methods, on productivity and weed infestation in a virgin medium clay soil of the upper terrace in the Northern State of Sudan.

LITERATURE REVIEW

In an experiment assessing farmer-saved wheat seed, Kabir et al. (2007) concluded that the quality of such stored seed is suboptimal and can be enhanced through physical and chemical treatments. In a trial involving different seed rates, Boutfirass and Karrou (2004) found that a precision seeding rate of 200 plants/m2 resulted in the highest grain yield and wheat biomass, accompanied by a reduction in weed biomass.

Despite the increased demand, many producers, especially in irrigated areas, tend to plant farmer-saved seed, a practice associated with significant risks of contamination with diseases and weed seeds (Barnard and Calitz, 2011). In an investigation of 15 wheat varieties using two seed rates (320 seeds.m^{-2} and 80 seeds.m^{-2}), HGCA (2000) reported that wheat plants can produce over 20 tillers per plant, particularly when sown early. They noted that varietal differences in tillering observed at normal plant populations largely disappeared at lower densities, where there was less competition between plants, suggesting that variety has no effect on optimum plant population. Kirkland et al. (2000) concluded that seeding rate has no effect on grain yield.

Wilson et al. (1982) indicated that in barley, competition in higher seeding densities reduces yield through a decrease in the number of grains per spike. Lesznyak (1996) stated that tillers per plant decrease with an increase in sowing seed rate, a finding supported by Kumar et al. (1991) and Ahmad et al. (1999), who reported that higher sowing rates increased the number of tillers per square meter due to a greater number of seeds sown and emerged plants, but tillers per seedling decreased with an increase in seed rate. Valério et al. (2013) reported that grain yield increased while the weight of kernels per spike decreased with an increase in seeding densities for wheat genotypes with reduced tillering ability. The number of grains per spike did not affect grain yield but was highly influenced by seeding densities. In contrast, Jan et al. (2000), Baloch et al. (2010), Haile and Girma (2010) concluded that as the seeding rate increased, the number of plants emerged per unit area increased, while thousand kernels mass decreased.

Field experiments were conducted during the rabi seasons of 2006-07 and 2007-08 to assess the impact of different seeding management practices, namely manual broadcasting, seeding with an ordinary seed drill, Zero seed drill, and precision seed drill, on yield attributes, yield, and soil properties of wheat under irrigated conditions in western Uttar Pradesh. The application of precision seed drills demonstrated a significant advantage over other treatments, resulting in increased growth and yield attributes, including plant height, number of tillers per plant, number of grains per spike, straw yield, grain yield, biological yield, and harvest index of wheat (Gill and Narinder, 2016).

In an investigation of different wheat cultivars, Cox et al. (2015) observed that higher seeding rates likely contributed to a decline in grain yields for soft red winter varieties, although straw yields continued to increase. Additionally, higher seeding rates increased the risk of lodging and disease pressure. The study emphasized that growers should carefully consider the trade-off between seed cost and potential issues related to lodging and disease when planting wheat in September.

Weeds pose a significant challenge to wheat cultivation, competing for light, moisture, nutrients, and space, leading to substantial losses in both quantity and quality of the final produce (Khaliq et al., 2011; Harrem et al., 2015; Saira et al., 2015). Marwat et al. (2013) highlighted the adverse effects of weeds on wheat production, emphasizing their competition for light, nutrients, and moisture. Wheat, being a crucial cereal crop, is particularly susceptible to weed competition, resulting in significant yield losses (Abid et al., 2016). While previous studies have aimed at identifying optimal wheat cultivation densities, the results have shown variations based on experimental conditions and tested parameters (Luo et al., 2011).

MATERIALS AND METHODS

Design of wheat cleaner

The cleaner (Figures 1 and 2a) had been designed, tested and improved to meet the requirements and needs of small-scale farmers in terms of simplicity, affordability and easy use for their saved seed cleaning. As shown in Table (2) the diameter of holes of the screen was made to be 1.8 cm according to ≤ 50% size of

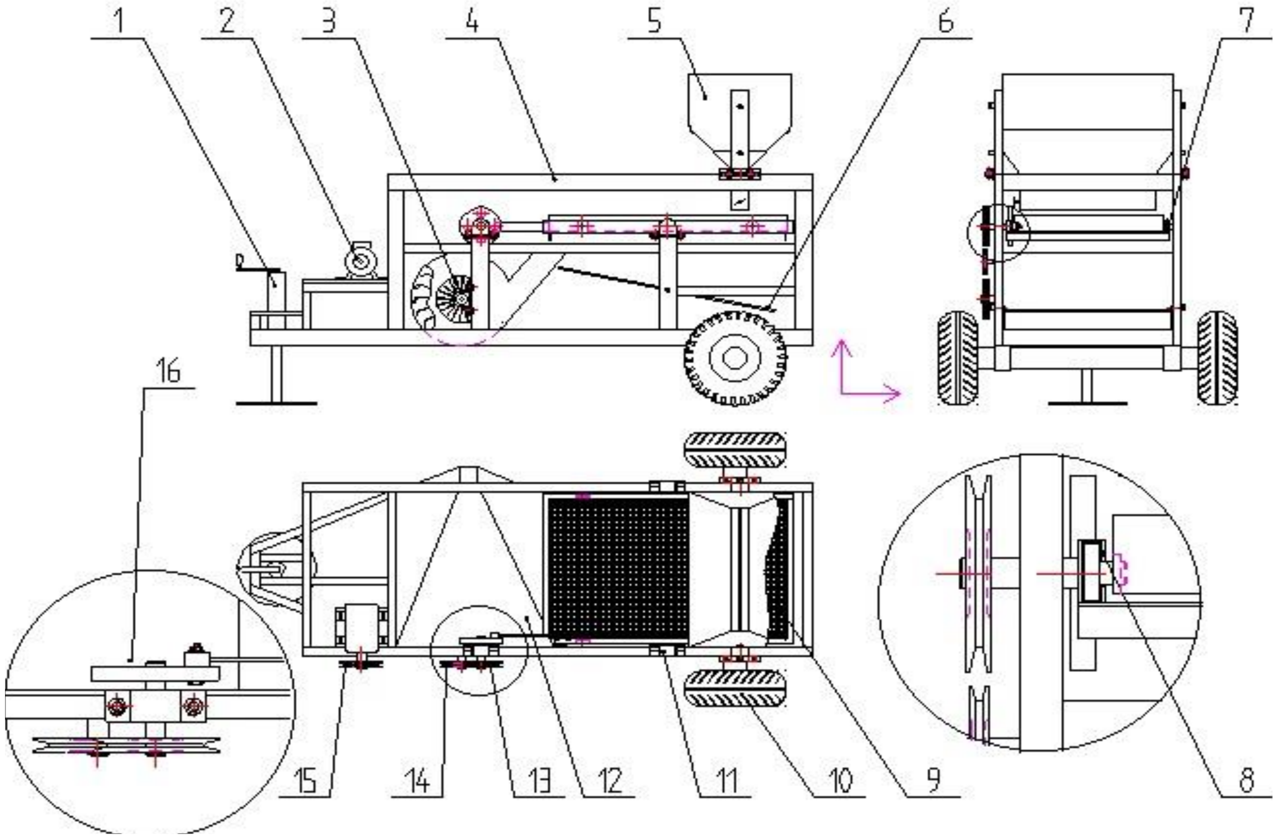

Figure 1. 1- hydraulic jack, 2- electric motor,3- high capacity fan,4- frame, 5- seed box, 6-trashes pan, 7-shaker, 8- screen, 9- bearing 10- driving wheel, 11- bearing, 12- clean kernels pan, 13-cam pulley, 14- fan pulley, 15- driving pulley, 16- cam system.

Figure 2. (a) The prototype of wheat cleaner, (2) Undesirable components, (3) Clean kernel pan.

geometric diameter of wheat kernels (Singh et al., 2005), given by the following formula.

$$ds = (lwt)^{1/3}$$

Where: *ds* is geometric mean diameter in mm; *l, w* and *t* are the mean length, width and thickness in mm, respectively.

Controlling the kernels flow from seed box to drop directly to the screen, the mixture moves forward and backward and upward and downward according to the reciprocating movement of the shaker, that allows all components smaller than the average mean diameter of healthy wheat kernels (including weed seeds, trashes and skinny small wheat kernels) to drop down to the trash pan (Figure 2b).

The trashes and components bigger than wheat kernels are left to be get rid of by means of fan air, the clean kernels are then moves forward depending on inclination provided by hydraulic jack

Table 1. Soil testing of experimental site according to Dongola Research Station.

Type	Upper-terrace	Statement
Crack	Medium cracked clay soil	
Nature	Virgin soil	Arable land
PH	7.01	Neutral
ECE	21.6	High salt content*

*Soil had been tested in a range of 30 cm depth, although salts were not exposed in the surface, however, the soil is reclaimable according to ARC experts of Dongola station

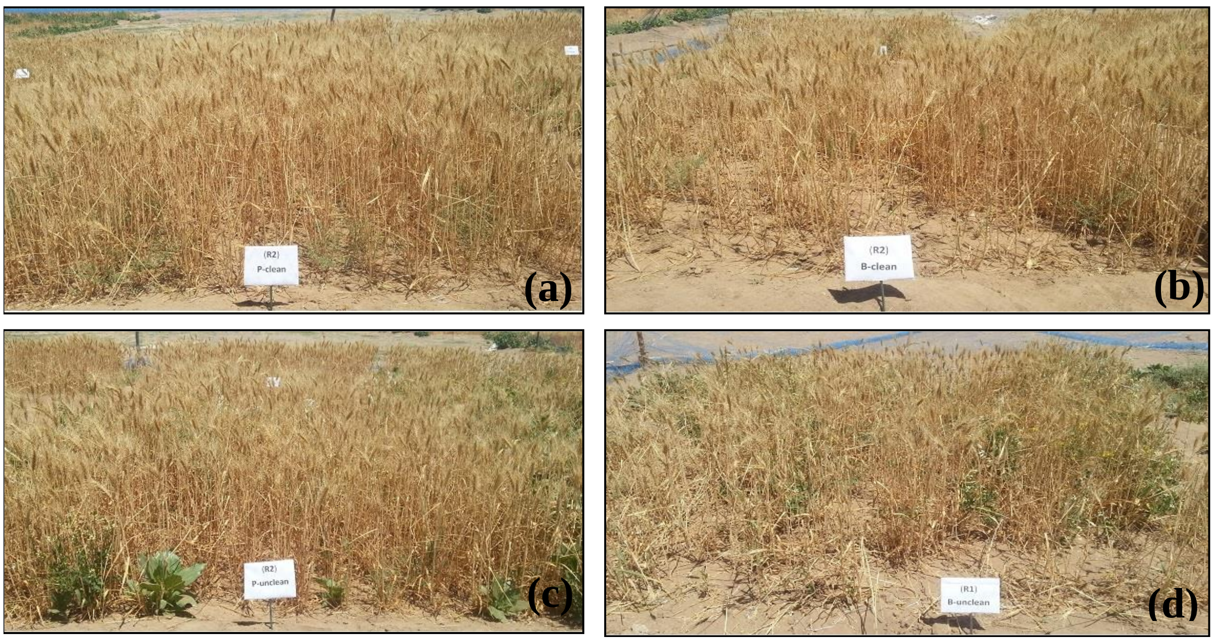

Figure 3. Wheat plant under different treatments after heading (a) Precision seeding with clean seeds, (b) mass flow seeding with clean seeds, (c) precision seeding with unclean seeds, (d) mass flow seeding with unclean seeds.

to the clean kernels pan (Figure 2c).

Field experiment

Al local variety (Imam) of farmer-saved wheat (*Triticum aestivum*) had been obtained, half the amount has been cleaned with the wheat cleaner.

As shown in Table 1, the soil of the experimental site had been tested in the laboratory of the Dongola research station.

The experimental layout was then made according to RCBD statistical design with four treatments and four replications.

Two planting methods were adopted with clean and unclean kernels of farmer stored seed, and then planted manually in plots of 3×3 m^2 with 15 cm row spacing in each. Precision seeding method with seed rate of 25 kg $feddan^{-1}$ (1 $g.line^{-1}$) was introduced versus mass flow seeding method (seed drilling) with seed rate of 50 $kg.feddan^{-1}$ (2 $g.line^{-1}$) as exposed in Figure 3. For singulation purposes in precision seeding method, the number of seeds per line for one-meter length was determined to be 27 kernels with seed spacing of 3.5 cm according to the one thousand kernel mass (Table 2).

The sowing date was 28th November 2015 according to the recommended planting date in the region, fertilizer and water application were constant, and the whole site was covered by net.

The data from the sowing date till harvesting were being collected at interval during the season of 2015/2016. Computer application SAS system version 9.3 was used for statistical analysis.

A germination test was conducted for both clean and unclean wheat samples, and the averages were calculated. The results revealed a germination percentage of 97.75% for clean kernels and 79.25% for unclean kernels.

RESULTS AND DISCUSSION

As described above, the prototype of the wheat cleaner was utilized to clean farmer-saved seeds obtained from a local farmer in Dongola district. Samples were taken from both clean and unclean seeds using two different

Table 2. Physical properties of tested wheat.

Physical properties	Min	Max	Mean
Length l, mm	5.40	7.20	6.26
Width w, mm	2.70	3.50	3.10
Thickness t, mm	2.20	3.40	2.79
1000 seed mass, g	36.99	38.36	37.57
Geometric mean diameter mm	3.17	4.40	3.78

Table 3. Duncan's multiple range test for selected parameters.

Parameter \ Treatments	PC	PU	BC	BU	Pr > F
Count of seedlings per square meter (SSM)	99.00^{C}	93.00^{C}	212.00^{A}	195.00^{B}	0.0001**
One thousand kernel mass (g) (TKM)	36.20^{A}	33.30^{B}	32.80^{B}	30.10^{C}	0.0001**
Count of weeds per square meter (WSM)	10.00^{C}	42.00^{B}	13.00^{C}	72.00^{A}	0.0001**
Count of kernels per spike (KS)	36.00^{A}	33.00^{AB}	35.00^{A}	29.00^{B}	0.0147*
Count of tillers per plant (TPP)	17.9^{A}	16.8^{A}	14.7^{B}	14.2^{B}	0.0001**
Biomass of wheat (BWT) (kg.fed^{-1})	2301.60^{A}	1596.00^{B}	1713.60^{B}	1108.80^{C}	0.0001**
Biomass of weeds (BWD) (kg.fed^{-1})	352.80^{C}	961.60^{B}	436.80^{C}	1394.40^{A}	0.0001**
Weight of pure wheat (WWT) (kg.fed^{-1})	1217.20^{A}	917.10^{B}	922.40^{B}	682.70^{C}	0.0001**
Weight of pure weed seed (WWD) (kg.fed^{-1})	3.60^{B}	4.50 ^{AB}	4.10^{B}	6.00^{A}	0.0480*
Total yield (TOY) (kg.fed^{-1})	1220.77	921.56	928.36	686.75	0.0001**
Weeds to wheat (WTw) %	0.30	0.49	0.61	0.62	0.0072**

Means within a group followed by same letter are not significantly different at probability P = 0.05 by Duncan's multiple range test.

methods, namely precision seeding and mass flow (seed drilling). The treatments were labeled as PC for precision seeding with clean seeds, PU for precision seeding with unclean seeds, BC for mass flow seeding with clean seeds, and BU for mass flow seeding with unclean seeds. Various field parameters were measured, including the count of seedlings per square meter (SSM), count of weeds per square meter (WSM), count of kernels per spike (KS), count of tillers per plant (TPP), one thousand kernel mass (TKM), biomass of wheat (BWT), biomass of weeds (BWD), weight of pure wheat (WWT), weight of pure weed seeds (WWD), total yield (TOY), and weed to wheat ratio (WTw %).

Effect of planting methods and type of seeds on field parameters:

The results of the analysis (Table 3) reveal that the field parameters were significantly influenced by the type of seeds and the method of planting. For SSM and TKM, the high rates in seed drilling treatments may be attributed to the high seed rate; however, it is worth mentioning that the highest rates were always observed in clean seed treatments (PC and BC). It is also evident that TKM increased in precision seeding with clean seed treatments (lower rates) compared to the seed drilling method, which is in agreement with Jan et al. (2000), Baloch et al. (2010) and Haile and Girma (2010).

For WSM, the differences among treatments were highly significant (P ≥ 0.01), as identified by Duncan's multiple range test, which revealed no significant difference between PC (10) and BC (13). This indicates that weed per square meter decreases with the use of clean seeds and a low seed rate.

The number of kernels per spike (KS) was also influenced by the planting method and type of seeds, with the statistical analysis exposing a significant difference among treatments (Figure 4). The highest value of KS was in PC (36), followed by BC, PU, and BU with 35, 33, and 29 kernels per spike, respectively. From mean separation tests, it can be observed that there was no significant difference between clean seeds and unclean seeds treatments, despite different seed rates. Therefore, it can be concluded that the number of kernels per spike was not affected by different seed rates. Similar findings were reported by Khokhar et al. (1985). However, KS increased when clean seeds were used, which might be attributed to the high viability of seeds due to mechanical cleaning.

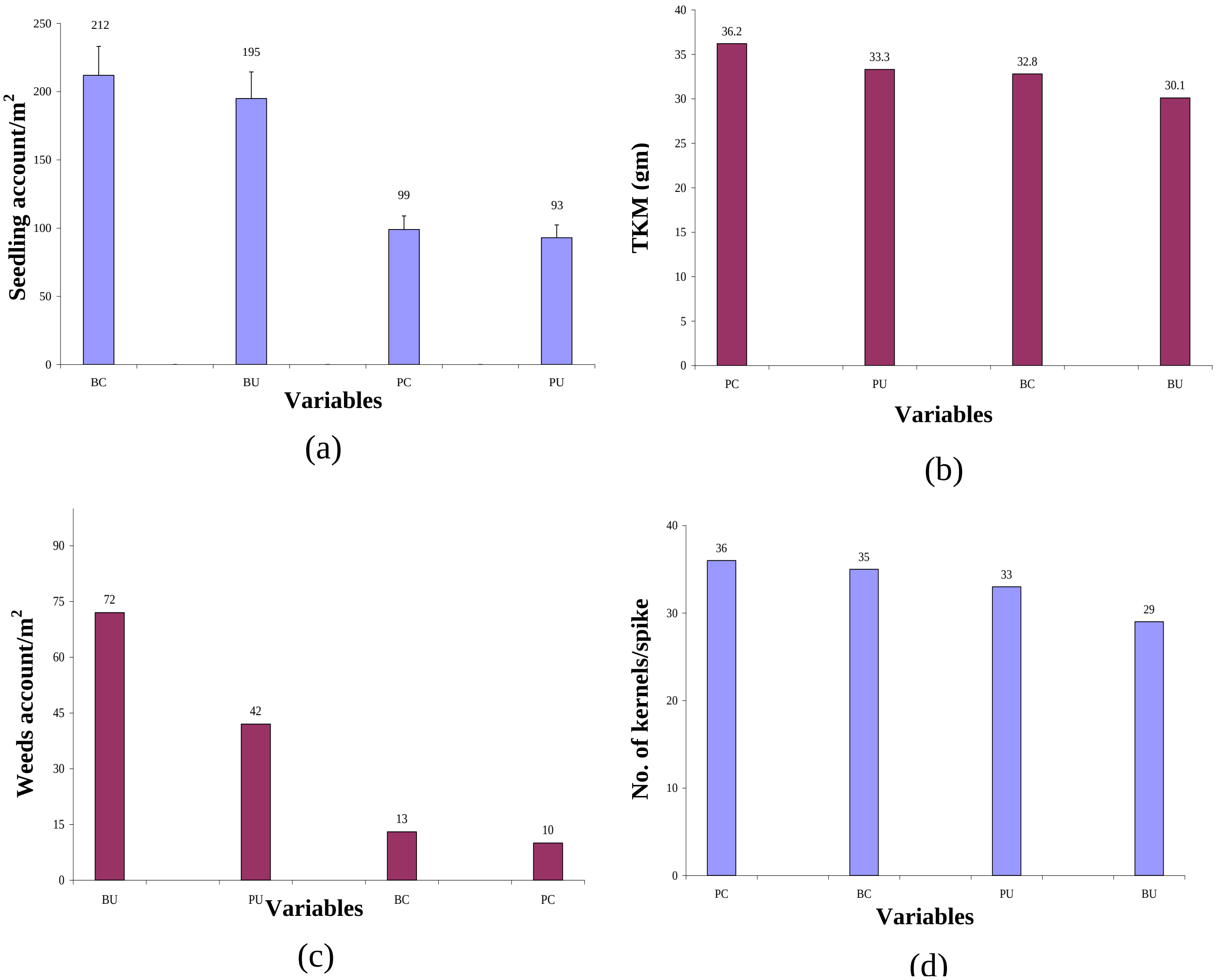

Figure 4. (a) Account of seedlings per square meter, (b) weed account per square meter, (c) account of kernels per spike, (d) weight of 1000 kernels.

A highly significant difference between treatments was also revealed in relation to the number of tillers per plant (TPP). Precision seeding treatments (PC and PU) seemed to have no significant difference according to the mean separation test, similar to seed drilling (high rate). These results confirm the findings of Kumar et al. (1991), Ahmad et al. (1999), and Lesznyak (1996), who stated that high seed rates decrease the number of tillers per plant (Figure 5).

With precision seeding treatments, wheat biomass increased, while weed biomass decreased, as highlighted in Table 3 and Figure 6. Similar findings were reported by Boutfirass and Karrou (2004), who concluded that lower rates produced the highest grain yield and wheat biomass, while weed biomass reduced.

The effect of the type of seeds and the method of planting on the weight of pure wheat, weight of pure weed, and total yield is demonstrated in Table 3 and Figure 7. It is evident that grain yield increased, whereas weed seeds decreased with lower seed rates and clean seeds, and vice versa with high rates and unclean seeds. It can also be observed that precision seeding with clean seeds minimized the weed seeds to almost 50%, as shown in the results of the weed-to-wheat percentage in Table 3.

Conclusion

The wheat cleaner is a simple, effective, and affordable machine that can be locally manufactured, owned, and used by small-scale farmers. Its purpose is to enhance productivity by reducing weed seeds and eliminating undesired trashes, such as skinny, small, and broken kernels with low viability, as revealed by the germination test results.

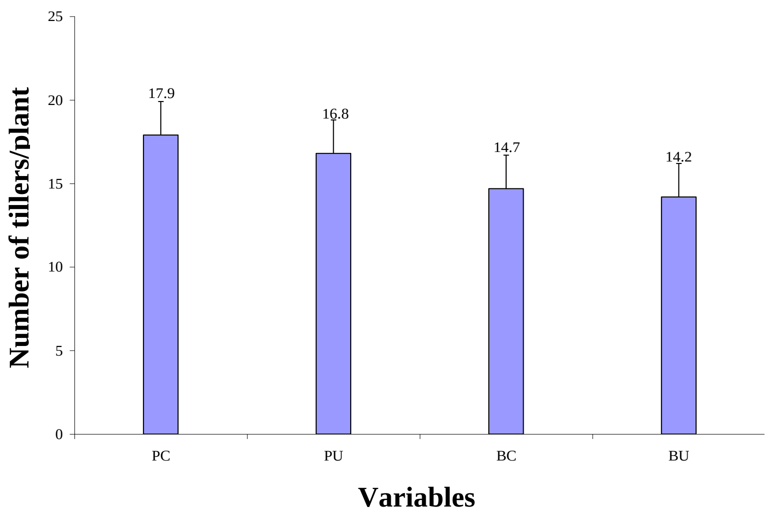

Figure 5. Number of tillers per plant.

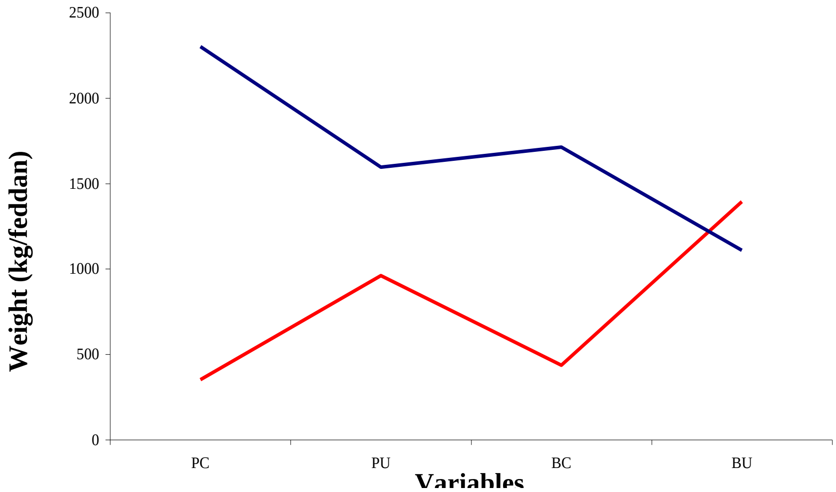

Figure 6. Biomass of wheat (BWT) and wheat (BWD) per fedaan.

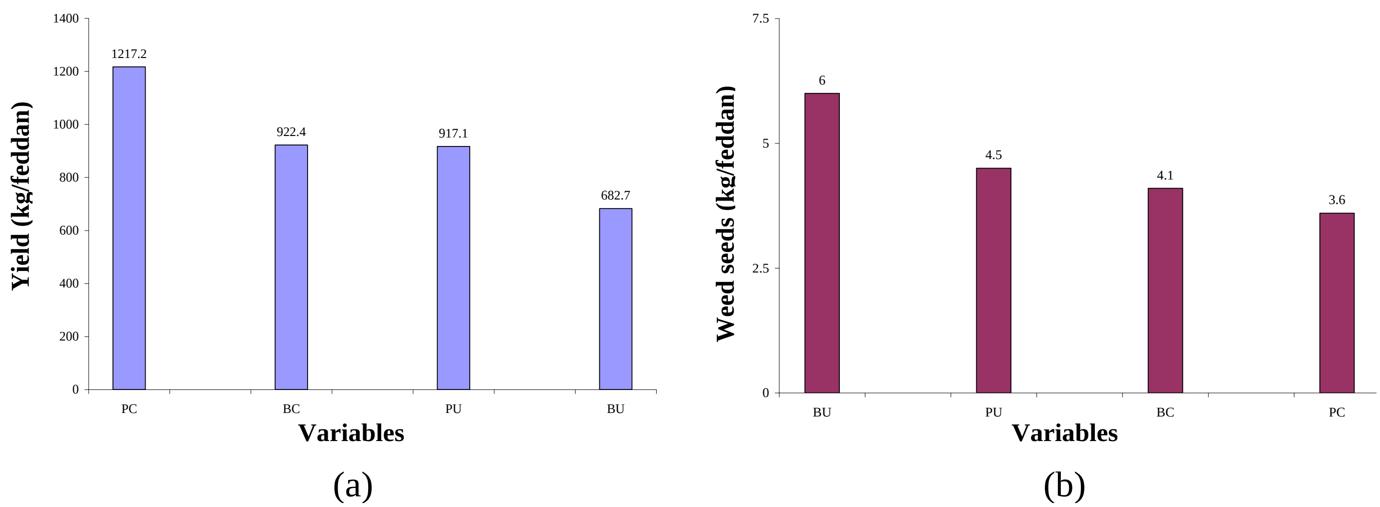

Figure 7. (a) weight of pure yield per feddan, (b) weight of pure weed seeds per feddan.

The study, along with similar research, strongly recommends the use of lower seed rates combined with clean seeds to minimize weed infestation and maximize wheat productivity. It is noteworthy that nearly 50% of the seeds could be saved for human consumption instead of being planted without making a profitable contribution to either food security or farmers' outcomes.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

ACKNOWLEDGEMENTS

The researchers would like to express their gratitude to the Sudanese Agricultural Research Corporation (ARC), represented at the Dongola Research Station, as well as Al-Shamaliya for Agricultural Services, for providing the experimental site, conducting soil testing, and offering manufacturing facilities.

NOTATION

SSM, Count of seedlings per square meter; **WSM**, count of weeds per square meter; **KS,** count of kernels per spike; **TPP,** Count of tillers per plant; **TKM**, one thousand kernel mass (g); **BWT,** biomass of wheat ($kg.fed^{-1}$); **BWD,** biomass of weeds ($kg.fed^{-1}$); **WWT,** weight of pure wheat ($kg.fed^{-1}$); **WWD,** weight of pure weed seeds ($kg.fed^{-1}$); **TOY,** total yield ($kg.fed^{-1}$; **WTw %,** weed to wheat ratio; **Fed,** (Which is abbreviation for the word Feddan, is a local agricultural area unit commonly used in agricultural sector (one Feddan = 4200 m^2).

REFERENCES

Abid MS, Safdar A, Gul Z, Muhammad SJ, Muhammad A, Ali YK, Muhammad A, Ishrat R (2016) Weed population dynamics associated with wheat productivity under different sowing techniques & herbicides: An overview, Agriculture and Biology Journal of North America pp. 2151-7525. doi:10.5251/abjna.2016.7.5.200.206.

Ahmad B, Muhammad I, Shafi M, Akbar H, Khan H, Raziq A (1999). Effect of row spacing's on the yield and yield components of wheat. Sarhad Journal of Agriculture 15(2):103-106.

Baloch MS, Shah ITH, Nadim MA, Khan MI, Khakwani AA (2010). Effect of seeding density and planting time on growth and yield attributes of wheat. Journal of Animal and Plant Sciences 20(4):239-242.

Barnard A, Calitz FJ (2011). The effect of poor-quality seed and various levels of grading factors on the germination, emergence and yield of wheat. South African Journal of Plant and Soil 28(1).

Boutfirass M, Karrou M (2004). Optimizing Plant Population, Crop emergence, Establishment and Sowing Rate, guideline on Explore on Farm: Adoption of GAP for Wheat in North Africa issued by FAO and ICARDA.

Cox Bill, Eric S, Phil A (2015). A Newsletter for New York. Field Crops and Soils 25(4).

Dawy I, Elfatih E, Awad E (2012). Effect of seed rate and method of sowing on wheat grain yield and yield components, at New Hamdab, in Northern Sudan) National Collegiate Honors Council (NCHC) annual conference pp. 11-19.

Gill MS, Narinder P (2016). Studies on precision seeding compare traditional seeding in wheat, International Journal of Science, Environment and Technology 5(5):2966-2971.

Haile D, Girma F (2010). Integrated Effect of Seeding Rate, Herbicide Dosage and Application Timing on Durum Wheat (*Triticum Turgidum L. Var Durum*) Yield, Yield Components and Wild Oat (Avena Fatua L.) Control in South Eastern Ethiopia 2(2):12-26.

Harrem K, Ali Q, Sadia A, Mobeen A, Ali A, Arfan A, Tayyab H (2015). Biodiversity and correlation studies among various traits of Digeria arvensis, *Cyperus rotundus*, *Digitaria adescendense* and *Sorghum halepense*. New York Science Journal 8(4):37-42.

Home-Grown Cereals Authority (HGCA) (2000). Research and Development Caledonia House 223, Pentonville Road London N1 9HY.

Ishag HM (1994). Genotype differences in heat stress in wheat in Gezira Scheme. In: DA Saunders and GP Hettel eds. Wheat in Heat-Stressed Environment, Irrigated, Dry Areas and Rice-Wheat Farming Systems. Mexico, D.F.: CIMMYT.

Jan A, Hamid I, Muhammad TJ (2000). Yield and yield component of wheat as influenced by seeding rates and sowing dates. Pakistan Journal of Biological Sciences 3(2):323-325.

Kabir MH, Aminuzzaman FM, Islam MR, Chowdhuiy MM (2007). Effect of Physical and Chemical Seed Treatments on Leaf Spot (Bipolaris sorokiniana) and Yield of Wheat, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh. World Journal of Agricultural Sciences 3(3):306-315.

Khaliq A, Matloob A, Tanveer A, Areeb A, Aslam F, Abbas N (2011). Reduced doses of a sulfonylurea herbicide for weed management in wheat fields of Punjab, Pakistan. Chilean Journal of Agricultural Research 71(3):424-429.

Kirkland KJ, Holm FA, Stevenson FC (2000). Appropriate crop seeding rate when herbicide rate is reduced. Weed Technology 14(10):692-698.

Kumar A, Sinha AK, Sinha BP, Singh KM, Thakur SS (1991). Response of wheat genotypes to seed rate and row spacing. Indian Journal of Agronomy 36(1):78-82.

Lesznyak CM (1996). Grain yield and plant population relationships in hard red spring wheat. Crop Science 25(3):521-525.

Luo LP, Yu ZW, Wang D, Zhang YL, Shi Y (2011). Effects of Plant Density and Soil Moisture on Photosynthetic Characteristics of Flag Leaf and Accumulation and Distribution of Dry Matter in Wheat. Acta Agronomica Sinica 37(6):1049-1059.

Marwat SK, Usman K, Khan N, Khan MU, Khan EA, Khan MA, ur Rehman A (2013). Weeds of Wheat Crop and Their Control Strategies in DeraIsmail Khan District, Khyber Pakhtun Khwa, Pakistan. American Journal of Plant Sciences 4(1):66-76

Saira M, AQ, Yusra B, Ali A, Arfan A, Samiullah TR, Rao AQ (2015). Estimation of correlation among various morphological traits of *Carthamus oxycantha*, *Cirsium arvense*, *Cleome viscose* and *Convolvulus arvensis*. World Rural Observations 7(2).

Valério P, Carvalho FIF, Benin G, Silveira G, da Silva JAG, Nornberg R, Hagemann T, Luche HS, de Oliveira AC (2013). Seeding density in wheat: the more, the merrier. Scientia Agricola 70(3):176-184

Wilson BJ, Peters NCB (1982). Studies of competition between Avena fatua and spring barley. I. Influence of Avena fatua on yield of barley. Weed Research 22(3):143-148.

APPENDIX

Appendix 1. Summary showing weights collected at product and reject receptacles at 208.5rpm cam speed and the corresponding separation efficiencies for wheat variety imam.

	Stopwatch	Feed,g	G,g	MOG,g	GP,g	BP,g	GR,g	BR,g	ξG,%	ξMOG,%	ξT,%	%Pp
Trial 1	00:14:20.86	10000	9514.83	485.17	9503.59	52.69	11.24	432.48	99.88	89.13	89.02	99.44
Trial 2	00:13:57.30	10000	9550.98	449.02	9536.72	69.16	14.26	379.86	99.85	84.59	84.46	99.28
Trial 3	00:14:18.62	10000	9460.87	449.02	9452.09	39.52	08.78	499.61	99.90	92.66	92.56	99.58
Average	00:14:12.39	10000	9508.89	461.07	9497.46	53.79	11.42	437.31	99.87	88.79	88.68	99.43

Appendix 2. Cost estimation.

Item	Quantity	Rate (SDG)	Cost (SDG)
Angle iron (2’’ × 2’’ and 3 mm thick)	6 lengths each of about 1.2 m	75	450
Angle iron (1’’ × 1’’ and 1 mm thick)	2 lengths each of about 6 m	65	130
Steel tubes (80 mm × 40 mm and 2.5 mm thick)	3 lengths each of about 6 m	300	900
Steel tubes (50 mm × 50 mm and 3 mm thick)	2 lengths each of about 2 m	150	300
Steel tubes (40 mm × 40 mm and 2.5 mm thick)	3 lengths each of about 2 m	120	360
Shaft (25 mm in diameter and 1 m long)	2 length	150	300
Steel sheet metal (1 mm thick)	3 sheet	92	276
Steel sheet metal (2 mm thick)	1 sheet	178	178
Steel sheet metal (2 mm thick with Ø1.9 mm opening)	1 sheet	678	678
Pillow block with size 25 mm	6 pcs	100	600
Bearings with size 25 mm	8 pcs	50	400
Bearings with size 17 mm	4 pcs	25	100
Cam (Ø150 mm)	1 unit	150	150
Pulley (Ø285 mm)	1 unit	150	150
Pulley (Ø45 mm)	2 units	150	300
V-Belts (A-types)	1 pcs	50	50
Bolts and Nuts (10 mm)	135 pcs	1	135
Bolts and Nuts (14 mm)	31 pcs	3	93
Bolts and Nuts (16 mm)	4 pcs	10	40
Bolts and Nuts (19 mm)	9 pcs	12	108
Bolts and Nuts (2 2mm)	14 pcs	15	210
Bolts (19 mm)	10 pcs	5	50
Bolts (24 mm)	4 pcs	8	32
Nuts (21 mm)	1 pcs	4	4
Nuts (24 mm)	1 pcs	5	5
Wheel (Ø500 mm)	2 units	1000	2000
Wheel hub	2 units	500	1000
Hydraulic jack	1 units	500	500
Hook	1 units	200	200
Electric motor (0.6 hp, 1390 rpm)	1 unit	1000	1000
Miscellaneous	-	-	3000
Total	-	-	13699