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Impact of seed rate, organic and inorganic fertilizer management on wheat yield

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Abstract
A set of two experiments were conducted to evaluate the potential of wheat grain yield against seed rate and integrated use of fertilizer (organic and inorganic). The study was carried out during 2016-18 in the field area of Faculty of Agriculture, Gomal University, Dera Ismail Khan, Khyberpakhtun Khwan-Pakistan. Both the experiments were laid out in randomized complete block design with seven treatments (T_1 to T_7) under four replications. The results of first experiment (impact of seed rate on grain yield) indicated that there was a negative correlation between seed rate and no of tillers. As seed rate increased, no of tillers decreased. Although, grain yield increased with an increase in seed rates but 1000 grain weight and grain yield exhibited non-significant differences during both the years. Maximum grain yield was obtained, with integrated use of chemical fertilizer and farm yard manure (Experiment No.2), at 20 t ha^{-1} FYM + 138 kg P_2O_5 and 120kg ha^{-1} N during consecutive years.

Keywords: Wheat, seed rate, nutrient management, grain yield and yield components

1. Introduction
Soil is considered as a key natural resource and its quality is a cumulative effect of management on soil that determine the production and sustainability of crop. Good quality of soil is not only the key indiactor of achieving high yield but also maintains quality of environment. Intensive farming, salinization, water and soil erosion has deprived the soil from essential nutrients. Fertility of soil has declined due to cultivation of crops without any consideration to total nutrient requirement [10] Evaluation of quality of soil is an essential tool for soil sustainability and crop productivity [12]
Wheat potential in yield can be exploited by required seed rate, balance use of fertilizers, proper cultural practices with required irrigation at critical stages. Integrated application of organic fertilizer with inorganic, gave high yield than chemical fertilizer [24]**.** High concentration of organic matter in the soil showed in uplifting the yield of cereals and also improve the water holding capacity of soil [26]. Reemergence and importance of organic manure pave the way for scientists to establish agricultural system which can lower production cost with conservation of natural resources.
In Pakistan wheat crop is cultivated on an area of 8734 thousand hectares with production 25.29 million tons [18]. With increasing population, the demand of wheat consumption is increasing every year. Soil of Paksitan generally have less organic matter (<1%) because of arid climatic condition and little addition of organic matter in the soil during crop cultivation. Nitrogen and phosphorus are major nutrients for wheat. Imbalance use of these fertilizers results in lower wheat production [4]. Application of nitrogen @ 128 kg ha^{-1} gave maximum grain yield but yield and yield components of wheat are greatly increased by increasing nitrogen level [7]. Under recent practice in Pakistan, wheat is sown after rice and cotton which normally delays the sowing time of crop, reducing the yield to considerable extent. Late sowing reduced number of plants and tiller production, thus increased the seed rate during cultivation [18]. Maximum grain yield (3101 kg/ha) was obtained when wheat was sown with seed rate 150kg than 100kg seed rate [17].
The recent study was to ascertain the effect of integrated organic and inorganic farming with different seed rates on morphological and yield attributes of wheat crop.

2. Materials and Methods
Two field experiments were conducted to estimated the effect of seed rate, organic and inorganic fertilizer on wheat yield during 2016-17 and 2017-18, at Agronomic Department of Gomal University, Dera Ismail (D.I) Khan-Pakistan. The soil of experimental site was clayey in nature with 10 to 12% sand, 35 to 37% silt, 50 to 55% clay, 8.5 PH, 7ppm P_2O_5, 0.45 to 0.77% organic matter, 0.023 to 0.034% N_2 and 95 to 100ppm K_2O. Climate was arid to semi arid with recorded rainfall (59.50 mm) and temperature range (77^0C to 40^0C from Dec to April).

Experiment 1: Impact of sowing seed rates on the grain yield of wheat during 2016-18
Wheat variety "Daman 98" was sown under 10 different seed rates/m^2 (120, 240, 360, 480, 600, 720, 840, 960, 1080 and 1200) in Randomized Complete Block Design (RCBD). Seed was drilled with 30 cm line to line distance and plot size 2 × 2 m^2.
The fertilizer (NPK) was applied @ 135-55-55 kg ha^{-1} at the time of sowing. Half Nitrogen was applied with 1st irrigation while remaining dose was broadcasted at 2nd irrigation. The

data of no of tillers per seedling, 1000 grain weight (g) and grain yield (t ha^{-1}) was recorded.

Experiment 2: Organic and Inorganic fertilizer management effect on the grain yield of wheat during 2016-18

The experiment was designed in a Randomized Complete Block Design (R.C.B.D) with four replications. "Daman-98" with plot size 2x5 m^2 was drilled with seed rate 320 seeds m^{-2}. Full dose of phosphorus and half dose of nitrogen were applied at sowing, while the remaining nitrogen was applied at first irrigation. Weeds were controlled manually. Seven treatments were used in the experiment: -

T_1: Control, T_2: 20t ha^{-1} FYM, T_3: 138kgN + 60kg P_2O_5 ha^{-1},T4: 20t FYM+138kg N + 60kg P_2O_5 ha^{-1},T_5: 20 t FYM + 138 kg N+120kg P_2O_5 ha^{-1},T_6: 20t FYM + 200kg N+ 120 kg P_2O_5 ha^{-1},T_7: 20 t FYM + 250 kg N + 180 kg P_2O_5 ha^{-1}

The data were analyzed by using the analysis of variance as described by [27] and treatment means were compared following Duncan New Multiple Ranges Test [9]

3. Results and Discussion

3.1. No of tillers m^{-2}

The data for no of tiller indicated significant but constant decrease in the numbers of tiller/m^2, with an increase in the sowing rate during 2016 to 2018 (table 1 & 2). The lowest seed rate (120 m^{-2} and 128 seeds m^{-2}) produced the highest number of tiller (3.41 & 3.53) per emerged seedling during consecutive years. Minimum no of tillers (0.52 and 0.68) were recorded against the maximum seed rate 1200m^{-2} and 1280m^{-2}. High seed rate act as a catalyst in plant population which results in plant competition and ultimately decreased no of tillers and no of spikes [22].

Fertilizer application greatly affects the tillering character of the plant. Effect of fertilizer application on tiller was shown in table 3 and 4. The data revealed that no of tiller/m^{-2} during 2016-17 and 2017-18, increased with increasing rates of Nitrogen and Phosphorous up to T5 (FYM 20 + N 138 +P_2O_5 120) and remained static at T6 (FYM 20 t ha^{-1} + N 200 kg ha^{-1} +P_2O_5 120 kg ha^{-1}) and then declined in T_7 (FYM 20 t ha^{-1} + N 138 kg ha^{-1} +P_2O_5 180 kg ha^{-1}). Non-significant results were recorded for Plot no 1(T_1 control) at no application of organic and inorganic fertilizer combination. During the year 2016-17, combination of organic and inorganic fertilizer gave remarkably results with maximum no of tillers (1.60) in plot no 6 followed by plot no 5 in which recorded data was 1.50. These results indicated that FYM in combination with chemical fertilizer not only increased no of tillers but also increased yield. These results were in harmony with findings of scientists [23, 25].

Table 1. Effects of seed rates on no of tillers m^{-2} against "Daman-98" variety during growing season 2016-17

No. Seed sown m^{-2}	No. Tillers m^{-2}
120	3.41a
240	1.82ab
360	1. 33ab
480	1.20b
600	1.00b
720	0.85b
840	0.80b
960	0.75bc
1080	0.68c
1200	0.52c

Means not sharing a letter in common differ significantly at 5% level.

Table 2. Effects of seed rates on no of tillers m^{-2} against "Daman-98" variety during growing season 2017-18.

No. Seed sown m^{-2}	No. Tillers m^{-2}
128	3.53a
256	1.78ab
384	1.44ab
512	1.34b
640	1.08b
786	0.95c
896	0.83c
1024	0.81c
1152	0.73c
1280	0.68c

Means not sharing a letter in common differ significantly at 5% level of significance.

Table 3. Impact of nutrient management on no of tillers m^{-2} against "Daman-98" variety during growing season 2016-17.

Treatments				No. Tillers m^{-2}
	FYM ($t\ ha^{-1}$)	N ($kg\ ha^{-1}$)	P_2O_5 (Kg ha-1)	
T_1	0	0	0	0.8^{NS}
T_2	20	0	0	1.10
T_3	0	138	60	1.40
T_4	20	138	60	1.52
T_5	20	138	120	1.70
T_6	20	200	120	1.65
T_7	20	250	180	1.54

Means not sharing a letter in common differ significantly at 5% level of significance.
T= Treatment.

Table 4. **Impact of nutrient management on no of tillers m^{-2} against "Daman-98" variety during growing season 2017-18.**

Treatments				No. Tillers m^{-2}
	FYM ($t\ ha^{-1}$)	N ($kg\ ha^{-1}$)	P_2O_5 ($Kg\ ha^{-1}$)	
T_1	0	0	0	10.2^{NS}
T_2	20	0	0	1.07
T_3	0	138	60	1.29
T_4	20	138	60	1.44
T_5	20	138	120	1.50
T_6	20	200	120	1.60
T_7	20	250	180	1.45

Means not sharing a letter in common differ significantly at 5% level of significance.
T= Treatment

3.2. Thousand (1000) grain weight (g)

Results pertaining to 1000-grain weight recorded during years (2014-16) was been shown in table 1&2, indicating that all sowing rates had non-significant effects on grain weight. Highest grain weight (45.93g) was observed when wheat was sown with seed rate $600m^{-2}$ followed by 46.43g at the rate of seed $1200m^{-2}$. During the year 2015-16, maximum grain weight (46.2g) was recorded against seed rate $120m^{-2}$ followed by 45.4g. Results proved that 1000-grain weight is not affected by any change in sowing rates either low or high. These results were in agreement with findings of [14] and [13] who reported that 1000-grain weight was not much affected by sowing rates [2]. studied the effect of population density on yield and yield components of wheat and reported that grain weight was not significantly affected by seed rate. Grain weight of wheat is purely genetic character; it is rarely influenced by changes in plant density [28].

Table 1. Effects of seed rates on thousand grain weight (g) against "Daman-98" variety during growing season 2016-17.

No. Seed sown m^{-2}	1000-grain weight (g)
120	45.85^{NS}
240	43.41
360	45.44
480	45.13
600	45.93
720	45.54
840	44.81
960	46.27
1080	46.27
1200	46.43

Means not sharing a letter in common differ significantly at 5% level.

Table 2. Effects of seed rates on thousand grain weight (g) against "Daman-98" variety during growing season 2017-18.

No. Seed sown m^{-2}	1000-grain weight (g)
128	46.2^{NS}
256	43.9
384	44.5
512	43.3
640	45.4
786	42.8
896	43.0
1024	41.3
1152	42.2
1280	42.0

Means not sharing a letter in common differ significantly at 5% level of significance.

The combine effect of FYM and NP fertilizer, during 2014-15 and 2016-17, on the studied trait was shown in table 3&4. Results revealed that FYM +NP levels significantly increased the grain weight over control. The maximum 1000-grain weight (38.6 g) was observed in T_5 (20t ha^{-1} FYM +135,110 kg NP ha^{-1}),followed by T_6 (37.7 g), T_7 (37.4g), T_4 (37.4 g),T_3 (37.3 g), T_2 (34.3g) and T_1 (33.4g) during the year 2014-2015.But in next year, T_7 (FYM 20 t ha^{-1} + N 250 kg ha^{-1} +P_2O_5 180 kg ha^{-1}) produced heavier grains. This difference in this parameter might be due to climatic change and as well as nutrients availability to crop during year to year. This increase in 1000- grain weight might be due to enhanced crop growth which means more translocation of photosynthates towards grains consequently resulting in increased 1000-grain weight. Similar indications were reported by [8].

Table 3. Impact of nutrient management on thousand grain weight (g) against "Daman-98" variety during growing season 2016-17.

	Treatments			1000 grain wt (g)
	FYM (t ha^{-1})	N (kg ha^{-1})	P_2O_5 (Kg ha-1)	
T_1	0	0	0	33.4c
T_2	20	0	0	34.3c
T_3	0	138	60	37.3ab
T_4	20	138	60	37.4ab
T_5	20	138	120	38.6a
T_6	20	200	120	37.7ab
T_7	20	250	180	37.7ab

Means not sharing a letter in common differ significantly at 5% level of significance.
T= Treatment

Table 4. **Impact of nutrient management on thousand grain weight (g) against "Daman-98" variety during growing season 2017-18.**

	Treatments			1000 grain wt (g)
	FYM (t ha^{-1})	N (kg ha^{-1})	P_2O_5 (Kg ha^{-1})	
T_1	0	0	0	32.0d
T_2	20	0	0	36.0c
T_3	0	138	60	36.2c
T_4	20	138	60	38.4ab
T_5	20	138	120	40.4ab
T_6	20	200	120	41.5ab
T_7	20	250	180	43.2a

Means not sharing a letter in common differ significantly at 5% level of significance.
T= Treatment

3.3. Grain yield (t ha^{-1})

The grain yield is the final product of wheat plant bearing spikes and grains per spike. Results of experiment 1 (Table 1 and Table 2) exhibited non-significant differences among treatments means during both years. However, seeds sown at 640 seeds m^{-2} and 512 seeds m^{-2} produced numerically maximum grain yield 7.19 t ha^{-1} in year 2014-2015 and 6.25 t ha^{-1} in year 2015-16 against minimum grain yield (5.32 t ha^{-1} and 4.75 t ha^{-1}) produced by sowing seed at 128 m^{-2} respectively in two years. The grain yield of seeds sown at

512 and 640 seeds m^{-2} produced almost equal grain yield during both years. Sowing rates above normal sowing rates (256 m^{-2}) did not show any visible increase in the grain yield [21]. Concluded that optimum seeding should be higher in high rainfall zones and irrigated environments. Increase in seed rate above optimum level may only enhance production cost without any increase in grain yield. These results also agree with findings of [3, 13]. They reported that increase in population rate up to a certain limit increase the grain yield in wheat crop [15]. Concluded that the higher grain yield of wheat can be achieved by utilizing management system based on higher sowing rates. The adverse effect of higher seed rates on growth and yield of crops may attributed to the fact that plants complete with each other for important factors such as nutrients, water, light and space for their growth and reproduction as described by [26].

The grain yield data of experiment 2 (Table 3&4) elucidated that all chemical fertilizer dozes applied alone or in combination with FYM differed significantly from control during both years where no organic or synthetic fertilizer was applied. There was an increase of 0.8 t ha^{-1} (T_4-T_3) in the grain yield by adding farmyard manure @ 20 t ha^{-1} with synthetic fertilizer during the year 2014-15. Obviously phosphors application from 60 kg ha^{-1} to 120 kg ha^{-1} fertilizer resulted increase of 0.5 t ha^{-1} in the grain yield during the year 2014-2015 The maximum grain yield of 5.5 t ha^{-1} and 5.8 t ha^{-1} was obtained by applying synthetic NP@ 138 and 120 kg ha^{-1} respectively during the both years. These results also showed a decrease in the grain yield beyond 138 kg ha^{-1} N+120 kg ha^{-1} P_2O_5. This reduction in the grain yield mainly due to decrease in number of ears m^{-2} in (T_7) during both years. It can be concluded from these results that wheat variety Ghaznavi produced the highest grain yield with optimum fertilizer 138 kg ha^{-1}N and 120 kg ha^{-1} P_2O_5 along with FYM @ 20 t ha^{-1}. Higher doses of manures (T_6 & T_7) did not increase the grain yield. These results confirmed the results of [20, 19]. Argued that improved efficiency of N fertilizer increased wheat grain yield by improving all the growth parameters.

Table 1. Effects of seed rates on grain yield (t h^{-1}) against "Daman-98" variety during growing season 2016-17 .

No. Seed sown m^{-2}	Grain yield (t ha^{-1})
120	5.32^{NS}
240	5.63
360	6.25
480	7.13
600	7.19
720	6.63
840	6.13
960	5.44
1080	6.32
1200	5.63

Means not sharing a letter in common differ significantly at 5% level.

Table 2. Effects of seed rates on grain yield (t h^{-1}) against "Daman-98" variety during growing season 2017-18

No. Seed sown m^{-2}	Grain yield (t ha^{-1})
128	4.75^{NS}
256	5.16
384	5.68
512	6.25
640	6.00
786	5.65
896	5.00
1024	4.89
1152	5.12
1280	5.72

Means not sharing a letter in common differ significantly at 5% level of significance.

Table 3. Impact of nutrient management on grain yield (t h^{-1}) against "Daman-98" variety during growing season 2016-17.

	Treatments			Grain yield (t ha^{-1})
	FYM (t ha^{-1})	N (kg ha^{-1})	P_2O_5 (Kg ha-1)	
T_1	0	0	0	3.0c
T_2	20	0	0	3.2c
T_3	0	138	60	4.2b
T_4	20	138	60	5ab
T_5	20	138	120	5.5a
T_6	20	200	120	5.2a
T_7	20	250	180	5.1a

Means not sharing a letter in common differ significantly at 5% level of significance.

T= Treatment

Table 4. Impact of nutrient management on grain yield (t h^{-1}) against "Daman-98" variety during growing season 2017- 18.

	Treatments			Grain yield (t ha^{-1})
	FYM (t ha^{-1})	N (kg ha^{-1})	P_2O_5 (Kg ha^{-1})	
T_1	0	0	0	3.5c
T_2	20	0	0	3.8c
T_3	0	138	60	4.5b
T_4	20	138	60	5.2ab
T_5	20	138	120	5.8a
T_6	20	200	120	5.4a
T_7	20	250	180	5.4a

Means not sharing a letter in common differ significantly at 5% level of significance.
T= Treatment

4. Conclusion

Recent study concluded that optimum seed rates with proper organic and inorganic fertilizer management enhance the wheat grain yield by using any improved wheat variety. All the agricultural intellectuals are suggested to evolve varieties having potential to produce maximum spikes and spike bearing tillers. Emphasis should to integrate and utilize all modern crop production techniques to get yield potential up to the mark.

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