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Wheat Yield Potential-Current Status and Future Strategies

Muhammad Ayyaz Khan, Iqtidar Hussain and Muhammad Safdar Baloch
Department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan-29050, Pakistan

Abstract: Yield potential of six high ranking wheat varieties was determined in the light of wisdom described in the Holy Quran, using grain yield determining formula. The grain yield calculated is seven times less than the Holy Quranic predicted wheat yield. One reason of low wheat yield might be the lack of production of predicted fertile tillers (ears) containing 100 grains in the cultivated varieties. Second reason in our opinion is lack of efficient wheat production technologies for getting the Holy Quranic predicted yield of 70 t ha^{-1}.

Key words: Current status, future strategies, wheat yield potential

Introduction

Wheat *(Triticum aestivum* L.) is the staple food for most of the people in the world. The area and yield of wheat has gradually increased in Pakistan due to favourable weather, efficient use of inputs, better storage facilities and supporting price policies by the Government. But still we import every year to supply wheat flour to our increasing population (Khawaja, 1996). Revised production target for the 1998-99 crop has been fixed at 22.5 million tones which is 17.2 percent more than last season's harvest of 19.2 million tones (Anonymous, 1998). All available indigenous resources are being exploited on war footing to achieve the target with average yield of 2.38 t ha^{-1} from 9.466 million hectares. Domestic consumption requirement for this year has been estimated at 19.5 million tones. However, the government still plans to import 2 million tones of wheat this year to avoid any crises. Last year 4.1 million tones of wheat were imported (Anonymous, 1998). Average yield of wheat is very low as compared to some developed countries (Shah, 1994). Higher wheat yield involves technology, capital, judicious use of fertilizer (NPK), irrigation, improved wheat varieties and farm implements, following of improved cultural practices. D.I.Khan lies in arid region of NWFP Pakistan. Wheat yield may be increased upto 46.2 percent by the use of fertilizer application, 27.62 percent by method of sowing, 19.25 percent by best seed and pest management factors (Anonymous, 1998). Hanif *et al*. (1986) reported that the yield of wheat can be doubled by improved management practices involving fertilizer, irrigation and sowing methods. The wheat yield potential has already been quoted in the Holy Quran "The likeness of those who spend their wealth in Allah's way is as the likeness of a grain which growth seven ears, in every ear a hundred grains-Allah giveth increase manifold to whom He will. Allah is All Embracing, All Knowledge (Albaqra, Ayah 261). This Quranic Ayah basically explains about the act of those people who spend their God-given wealth for the welfare of mankind and also points out clearly about the yield potential of a crop. Imdad (1957), Najfi (1983) and Shafi and Mufti (1984) have assumed the word "ear" and "grains" as wheat ear and wheat grains. Some evidences have been reported that wheat crop attained four thousand grains per ear due to heavy rains in "Bu" city of Iran. Those plants had tall stem, large ear accompanied by full grains (Najfi, 1983). A semi-dwarf winter wheat yielded 12.9 t ha^{-1} in Washington but was not produced regularly (Anonymous, 1966). The wheat yield calculated on the basis of Quranic prediction should be 70 t ha^{-1}, if there is 100 percent seed germination and each seed must produce seven fertile tillers with hundred grains in each ear. It means that one seed can yield 700 seeds.

To meet the need of food supply of the ever increasing population rate of the world, it is the cry of the day to produce higher yields by hybridization and modern management practices. The aims of this study are:

1. To compare the wheat yield obtained from the research so for in the light of Quranic prediction
2. To draw the attention of all wheat researchers to achieve this predicted goal through out the world

Materials and Methods

The study was undertaken to understand grain yield potential of different wheat varieties sown at different locations in D.I.Khan (NWFP), Pakistan.

The varieties understudy were Daman 98, Gomal 99, Inqilab 91, Dera 98, Punjab 96 and Bakhtawar 92. Twelve ears of each variety were collected randomly. The data were recorded on number of grains/ear, thousand grain weight (TGW) and Number of ears/m^2.

These varieties were sown at the normal seed rate of 100 kg (Shah, 1994). The number of fertile tillers/m^2 was 126 as calculated by unitary method from 60 percent establishment through 100 kg seed/ha. The total number of ears/ha for each variety was determined by multiplying 10,000 m^2 with 126 ears/m^2. The yield was calculated by the following formula:

Yield = Number of ears/m^2 × Number of grains/ear x Grain weight

The accuracy of formula was tested by putting the yield components data of different research studies in the formula and by comparing the formula grain yield with recorded grain yield.

The fact mentioned in Ayah 261 of Sure Albaqra about the potential yield of wheat can be used for understanding current yield level by keeping 21×10^5 plants ha^{-1} with average 1000-grain weight of 48 g (Lockhart and Wiseman, 1988).

Results and Discussion

Wheat yield can be determined by $y = a \times b \times c$
Where y = grain yield
a = ears/m^2
b — grains/ear
c = grain weight

Wheat yield calculated by applying this formula is given in column 7. Table 1. The data has been gathered to elaborate the previous research findings and check the accuracy of some recorded yield with the formula yield. This table shows that maximum grain yield of wheat variety Ingalab 91 was reported by Chaudhary and Mehmood (1998). When the yield contributing components of this variety were put in the formula, it resulted grain yield which was found at par with the recorded grain yield. This indicates that the formula yield calculation is too accurate to apply for grain yield determination, especially in the cereal crops. These three yield components are inter-related i.e by increasing the number of ears (e.g by denser the plant population or more tillering), the number of grains per ear may be reduced and also the size of the grain (Lockhart and Wiseman, 1988). The calculated grain yield will be 13 t ha^{-1} if we put the number of ears/m^2 (372) of Chaudhary and Mehmood (1998), grains/ear and 1000-grain weight 62 and 49 respectively, of Sadiq and Khan, 1994. This yield is much lower than the grain yield calculated on the basis of the Holy Quranic prediction i.e 70 t ha^{-1}. As far as development of these yield components is concerned, production of more ears per unit area depend on heredity, environmental factors, favourable temperature, ample soil moisture, high level of nitrogen and thin plant stand (Arnon, 1972).

Awns of ears and flag leaves of plants play important role due to photosynthetic activity. The importance of awns for grain filling has been reported by McDonough and Gauch (1959) and Anonymous (1975). The contribution of flag leaves towards grain filling is about 60-70 percent (Watanabe *et al.*, 1994). Grain weight is controlled by environment, genetic make-up, soil fertility specially soil nitrogen and phosphorus (Kandera, 1988; Rajput *et al.*, 1989; Shafi *et al.*, 1992). Arnon (1972) has pointed out that when production is not limited by moisture and nutrient supply and maximum interception of available light is achieved by an optimum plant population, the only means of increasing productivity is to use genotypes with a greater adaptation to high plant densities. Evidently, hybrids can produce more grain yield than open pollinated varieties of crops. Hybrids have been found to require more plants per hectare than open pollinated varieties, in order to reach the point of maximum yield per unit area (Stinson and Moss, 1960). The wheat grain yield obtained by some of the researchers did not coincide with formula yield (Table 2). There is a big gap between recorded and formula yield. This might be attributed to the mismanagement, fecticious data, wrong interpretation, small sampling and ill-measurement (Erwin *et al.*, 1980). It is evident from Table 2 that both recorded and formula yield of different varieties of wheat is still lesser than the predicted grain yield of wheat by the Holy Quran.

Impact of nitrogen, phosphorus and potassium on the grain yield of wheat shown in Table 3 indicates that application of major plant nutrients has an enormous effect on boosting up the wheat production. Especially, nitrogen application at higher rate produces increased grain yield. It might be due to more chlorophyll development in wheat plants. Another reason of higher grain yield might be the ample availability of major plant nutrients at all growth stages. For instance, Pearman *et al*. (1979) observed that the application of 180 kg N/ha increased the photosynthetic productivity of flag leaves of wheat by a factor of 2.3 while the increase in grain yield was only 1.8 times. Wheat is the major food grain crop of Pakistan to which weeds pose a serious threat by depriving the crop plants of nutrients, moisture, light and CO_2 (Anderson, 1983). Weeds controlled by two herbicides (Banvel-M and Buctril-M) evidently increased the grain yield of wheat over control (Table 3). Irrigation is also a key factor for getting more crop produce. Irrigation is considered crucial operation for continued nutrient supply without which higher wheat production seems difficult. The importance of moisture supply for getting high wheat production have been emphasized by Bajwa *et al*. (1993) who recorded high grain yield by applying three irrigations over control. Findings of Cheema *et al*. (1973) and Mandal *et al*. (1985) also confirmed the effect of 3 irrigations to increase wheat yield over control. However, Jamal *et al*. (1987) advocated four irrigations for wheat. It can be concluded from this discussion that irrigation is unavoidable factor to boost the grain yield of wheat favourably. Keeping in view the prediction of the Holy Quran for wheat production, although improved management practices and crop varieties have increased the grain yield but still ten times less than the Holy Quranic predicted target.

Grain Yield of Wheat (t ha^{-1}) in D.I.Khan: Six high yielding wheat varieties were sown at three different locations in D.I.Khan to explore their yield potential under prevailing climatic conditions. Daman 98 ranked first among all testing varieties by producing grain yield of 12.50 t ha^{-1} (Fig. 1). It might be due to the high number of ears/m^2 (253), maximum grains/ear (95) and 1000-grain weight (52) as compared to other varieties. All the varieties understudy produced higher grain yield than our average national grain yield of wheat (2.38 t ha^{-1}). The difference in the grain yield of these varieties might be due to the difference in their genetic potential and soil fertility.

Table 1: Results of experiments of grain yield of wheat which coincide with y = a×b×c

Source	Variety	Ear/m^2	Grain/ear	1000-GW (g)	Actual G.yield t ha^{-1}	Formula G.yield t ha^{-1}	Accuracy (%)
Khan (1992)	Pirsabak-85	266	52	40	5	5.53	90
Sadiq *et al*. (1994)	Pak-81	229	62	49	7	6.95	99
Shah (1996)	Incjilab-91	209	52	45	5	4.90	98
Chaudhary and Mehmood (1998)	Ingilab-91	372	45	45	7	7.53	95
Khan *et al.* (1999)	Pirsabak-85	263	38	44	4	4.39	98

Table 2: Results of experiments of grain yield of wheat different from y = a×b×c

Source	Variety	Ear/m^2	Grain/ear	1000-GW (g)	Actual G.yield t ha^{-1}	Formula G.yield t ha^{-1}	Accuracy (%)
Khan *et al*. (1990)	Pirsabak-85	231	30	38	3.53	2.72	70
Khan (1992)	Pak-81	374	53	38	4.57	7.58	60
Chaudhary (1998)	Incjilab91	423	61	48	4.50	12.38	37
Salarzai *et al*. (1999)	Ingilab91	428	62	46	5.00	12_20	40
Ghazanfar (1999)	Punjab96	304	72	43	7.00	9.43	74

Table 3: Impact of fertilizer, herbicides and irrigation on the grain yield of wheat

Source	Fertilizer kg ha^{-1}			Grain Yield (t ha^{-1})	Grain Yield (t ha^{-1}) Control
	N	P	K		
Gurmani and Rehman (1985)	138	90	67	5.76	2.00
Amanullah and Bakhsh (1994)	120	90	60	6.00	1.28
Chaudhary and Mehmood (1998)	250	115	0	7.10	4.35
	Herbicides				
Chaudhary (1998)	Buctril-M 1.25 l/ha			4.50	3.31
Khan (1992)	Buctril-M 1.75 l/ha			4.86	3.83
Salarzai *et al.* (1999)	Banvel-M 0.175 l/ha			5.00	4.20
	Irrigation				
Jamal *et al.* (1987)	4 irrigations			4.48	3.17
Bajwa *et al.* (1993)	4 irrigations			6.57	2.50

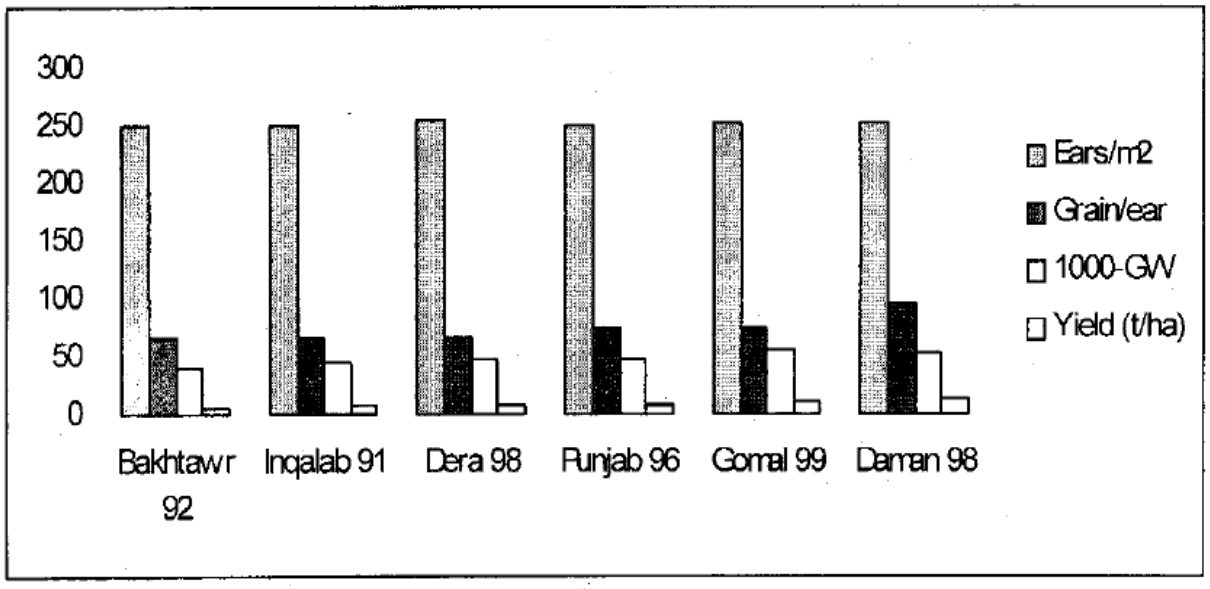

Fig. 1: Grain Yield of wheat determined by formula y = axbxc of six varieties of wheat

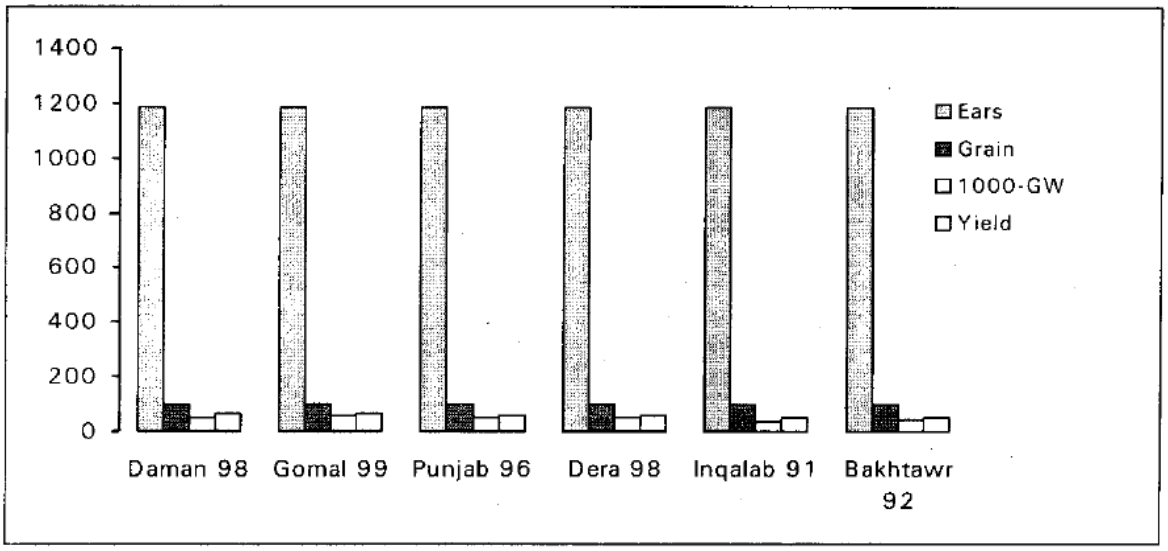

Fig. 2: Grain Yield of wheat determined by the Holy Quranic prediction i.e one wheat seedling produces seven ears with 100 grain

The Holy Quranic Predicted Wheat Grain Yield: All wheat varieties mentioned throughout the manuscript were sown at recommended seed rate of 100 kg/ha. According to Lockhart and Wiseman (1988) sowing of 100 kg of wheat means sowing of 210000 plants/ha or 210 plants/m^2. Plant establishment under field conditions is usually 126 plants/m^2 (60 percent of the sown seed). Plant mortality rate of 40 percent reported by Arnon (1972) has now been confirmed by Ghazanfar (1999). According to the Quranic injection, a single seed of wheat must produce 7 ears containing 100 grains each (Albaqra, Ayah 261).

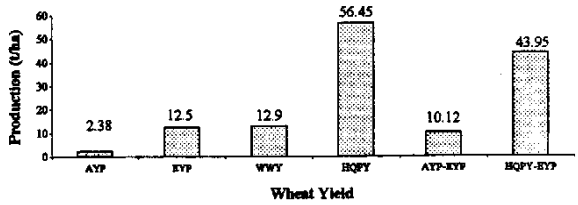

Fig. 3: Comparative study of Grain wheat.
Key; AYP = Average wheat yield of Pakistan
EYP = Experimental yield of Pakistan
WWY = World wheat yield
HQPY = Holy Quranic predicted yield

Multiplying 126 established seedlings with 7, results 1182 ears/m^2. If number of ears/m^2 (1182), grains/ear (100) and grain weight of Daman 98, Gomel 99, Punjab 96, Dera 98, Inqalab 91 and Bakhtawar 92 are put in the wheat yield determining formula i.e. $y = a \times b \times c$, the calculated yield comes very high (Fig. 2). There is no doubt that the current wheat yield per hectare throughout the world lies much below the predicted wheat yield level (Fig. 3). In our opinion, this low yield may be attributed to low fertile ears production per established seedling of wheat varieties under cultivation. It is also clear from the results quoted in this manuscript that modern crop production technologies also seems inefficient for producing 1182 ears per establish seedlings as predicted in the Holy Quran. So, it is suggested for all the agricultural intellectuals to evolve varieties which should produce 7 ears at least per established wheat seedling. Emphases should also be laid down to integrate and utilize all modern crop production technologies to get the wheat yield potential upto the mark.

It is suggested to all wheat breeders to evolve such varieties with traits as mentioned in the Holy Quran ($y = a \times b$). It is further suggested to agronomists to develop such agronomic techniques to get the Holy Quranic predicted yield from the existing wheat varieties using $y = a \times b \times c$.

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