Research Article

Delayed wheat (*Triticum aestivum* L.) cultivation and role of diverse seeding rates and row spacings under semiarid agro-climatic situations

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Abstract

Delayed picking of BT cotton, changing climate resulted in late sowing of wheat in cotton-wheat cropping system of Southern Punjab which have serious implications for food security in the region is always crucial for getting higher yields. If sowing is delayed, it becomes necessary to adopt certain agronomic practices to tackle this issue of lower yield. Keeping in view the above problem a field study was performed at College of Agriculture, Dera Ghazi Khan to assess the impact of seeding rates and row spacings on yield and yield components of late sown wheat. The treatments were comprised of two seeding rates i.e. 125 kg ha⁻¹ and 150 kg ha⁻¹ and three row spacings i.e. 10 cm, 15 cm and 20 cm. The treatments were laid out in randomized complete block design (RCBD) with factorial arrangements and performed in triplicate. The cultivar Aas-2011 was used as experimental material by altering row spacing and seeding rates with respect to overall performance. The results revealed that seed rate of 150 kg ha⁻¹ with row spacing of 20 cm were more efficient in influencing the yield and yield contributing traits i.e. plant population, plant height, spike length, spikelet spike⁻¹, productive tillers plant⁻¹, grains weight spike⁻¹, 1000-grain weight, biological yield, grain yield and straw yield as compared to 125 kg ha⁻¹ with any row spacing. Higher seed rate can useful to compensate yield losses due to delayed sowing of wheat.

Key words: Wheat; Late wheat sowing; Planting geometry; Planting density

Introduction

Among the cereals wheat (*Triticum aestivum* L.) is a staple food for more than 1.5 billion people in the world and is the most valuable among cereal crops in Pakistan. Being a major cereal crop in several parts of the world, it is commonly known as king of cereals and belongs to *Poaceae* family [1]. It contributes 12.5% to the value added in agriculture and 2.6% in overall GDP of Pakistan [2]. It provides around 20% of calories and the protein requirement for the population of world [3]. Agriculture is controlling the overall performance of the economy in the country but yields of most crops in Pakistan are lower as compared yield of other countries in the world [2]. As compared to many other countries wheat yield in Pakistan is still low and farmers are getting only 30-35% of yield potential of current cultivars [4]. The factors behind lower yield are the use of old varieties, sowing dates, farm size, and inappropriate rate of seeding, it may also include incomplete use of fertilizers etc [5-7].

Among all other factors, inappropriate seeding rate and row spacing are the key management factors for influencing agronomic characteristics and reducing wheat yields [8]. Grain yield cannot be increased only by the altering seeding rates but a suitable combination of seed rate and row spacing could increase grain yield of wheat [9]. Farmers are still not getting the maximum yield because of lack of knowledge and awareness related to new and improved agronomic technologies. That's why, we are facing problem of lower average yield as compared to other

countries. In current situations, our local varieties have potential to produce much higher yield than we are obtaining but there is need to focus on the management of agronomic practices [10]. In Punjab, suitable planting time for cultivation of wheat is up to 15th of November. However, due to introduction of BT cotton it is delayed till mid of December. This leads to decline in the yield with the passage of time.

Keeping in view the importance of seeding rate and row spacing and observing the late sowing of crop, it was imperative to study the influence of seeding rates and row spacings on the performance of wheat cultivar Aas-2011. Current study was carried out with following objectives; (i) to determine the effects of different seed rates and row spacings on the performance of wheat cultivar Aas-2011 under agro-climatic conditions of Dera Ghazi Khan and (ii) to explore the best seeding rate and row spacing for cultivar Aas-2011.

Materials and Methods

A field experiment was conducted at research area, College of Agriculture, D. G. Khan during Rabi season (2013-14) to investigate the response of a wheat cultivar (Aas-2011) to different sowing techniques under the agro-climatic conditions of Dera Ghazi Khan, Punjab, Pakistan. Dera Ghazi Khan lies in the arid region of the Pakistan and lies on 30.05° latitude and 70.63° altitude and 1800 m above sea level. This area comprised of relatively cold winter, however hot summer prevails during rest of the year. Soil of the experiment field had following physico-chemical properties (Table 1).

Table 1. Physico-chemical properties of experimental soil

Soil Parameters	Values
EC	4.74 Ms cm ⁻¹
Soil pH	7.7
Organic Matter	0.52%
Available Phosphorus	8 ppm
Available Potassium	150 ppm
Saturation Percentage	44%
Texture	Sandy Loam
Remarks	Saline Soil

Seeds of wheat cultivar Aas-2011 were obtained from Ayyub Agricultural Research Institute, Faisalabad. The treatments comprised of two seeding rates i.e. 125 kg ha⁻¹ (S₁) and 150 kg ha⁻¹ (S₂) and three row spacings were utilized i.e. 10 cm (R₁), 15 cm (R₂) and 20 cm (R₃). The field was divided in to 18 experimental units each of 12 m² with dimension of 4.0 m × 3.0 m, experiment was conducted in triplicate. The treatments were allotted randomly to each experimental unit by using random number table. Soil was prepared by three ploughings followed by planking. Based on local recommendation, fertilizer was calculated for each experimental unit and applied as described below. Sowing was performed in the first week of December, 2013 (on 5th Dec.) using single row hand drill and different row spacings were maintained by using rope with desired spacings marked. Nitrogen (N), phosphorus (P₂O₅) and potassium (K₂O) were applied as urea, diammonium phosphate (DAP) and sulphate of potash (SOP). Total P (115 kg ha⁻¹) and K (65 kg ha⁻¹) and one third of N (130 kg ha⁻¹) were applied just before sowing and incorporated in the soil. While remaining urea was applied at first and third irrigation. First irrigation was applied after 25 days after sowing (DAS); second irrigation was applied at booting stage (85 DAS) and third irrigation. All other agronomic practices were kept uniform for all the treatments. Standard plant protection measures were implemented to protect crop from diseases and insect-pests. The treatments were:

S₁R₁ = 125 kg ha⁻¹ seed rate and 10 cm row spacing

S₁R₂ = 125 kg ha⁻¹ seed rate and 15 cm row spacing

S₁R₃ = 125 kg ha⁻¹ seed rate and 20 cm row spacing

S₂R₁ = 150 kg ha⁻¹ seed rate and 10 cm row spacing

S₂R₂ = 150 kg ha⁻¹ seed rate and 15 cm row spacing

S₂R₃ = 150 kg ha⁻¹ seed rate and 20 cm row spacing

Data regarding plant population (m⁻²), plant height at maturity (cm), total number of tillers plant⁻¹, number of fertile tillers plant⁻¹, spike length (cm), spikelet spike⁻¹, grains spike⁻¹, grain weight spike⁻¹ (g), 1000-grain weight (g), biological yield (t ha⁻¹), grain yield (t ha⁻¹) and straw yield (t ha⁻¹) was recorded as reported earlier [7]. Collected data was analyzed statistically by using Fisher's analysis of variance technique and DMR test was applied at 0.05 probability level to compare the significance of differences among treatment means [11].

Results

Plant population is an important aspect for depicting the planting density of a crop. In the current experiment seed rate and row spacings individually influenced the plant population while the interaction of seed rate × row spacing remained non-significant (Fig. 1). Among the seed rates application of 150 kg ha⁻¹ increased the plant population (173.22 plants m⁻²) as a result of it. On the other hand individual impact of row spacing depicted that only 10 cm wider rows were efficient in providing higher plant population (175.5 plants m⁻²) as compared to 15 cm and 20 cm wider rows.

Plant height at maturity was significantly influenced by seed rate, row spacing and their interactions (Fig. 2). Plant height was increased by increasing the seeding rates as 150 kg ha⁻¹ of seeding rate caused highest plant height (88.28 cm) while 20 cm wider row space provided tallest plants with average height of 88.44 cm. The results clearly demonstrated the influence of different seeding rates and row spacings on plant height of late sown wheat cultivar Aas-2011. With increasing seeding rate and spacing between the rows, plant height showed increasing trend.

Figure 3 depicts that productive tillers were significantly influenced by seeding rate and row spacings individually. While interaction between seeding rate and row spacing was non-significant. It can be observed that higher seeding rate i.e. 150 kg ha⁻¹ produced more productive tillers (11.35) as compared

to 125 kg ha⁻¹ (10.73). Among different row spacings, only 10 cm wider row produced higher number of productive tillers (11.94). Generally with increasing seed rate and narrow row spacing higher number of productive tillers were produced.

Figure 1. Plant population (m⁻²) as influenced by various seeding rates (SR) and row spacings (RS). Means sharing different letter are significantly different from each others.

Figure 2. Plant height (cm) as influenced by various seeding rates and row spacings.

Spike length is very essential parameter which is directly associated with the grains number and it has been observed that longer spikes leads to more number of grains. Figure 4 displays that only seeding rate and row spacing influenced the spike length but their interaction was non-significant. Averages of different row spacings showed that maximum and significantly higher spike

length (9.85 cm) was achieved when sowing was done at seed rate of 150 kg ha⁻¹ than 9.46 cm at seed rate of 125 kg ha⁻¹. Whereas, row spacing of 20 cm produced maximum spike length of 10.06 cm while 10 cm and 15 cm row spacing were statistically similar with values i.e. 9.35 cm and 9.55 cm respectively. In case of interaction which was non-significant, it was observed that

highest value of spike length i.e., 10.23 cm was found where 150 kg ha⁻¹ seed was sown at 20 cm wider rows, however, shortest

spikes (9.12 cm) were acquired when wheat was sown at 10 cm spacing row spacing and 125 kg ha⁻¹ seed rate.

Figure 3. Productive tillers as influenced by various seeding rates and row spacings.

Figure 4. Spike length (cm) as influenced by various seeding rates and row spacings.

The plants sown at higher seeding rate (150 kg ha⁻¹) gave more spikelets i.e. 18.18 while row spacing of 20 cm produced higher spikelets spike⁻¹ i.e. 18.55. Figure 5 revealed that a mixture of higher seeding rate and wider row space (150 kg ha⁻¹ and 20 cm) produced more spikelets i.e. 18.94 spike⁻¹. Grains weight spike⁻¹, an important aspect of yield, was significantly influenced by seeding rates, row spacings and their interaction (Fig. 6). Higher seeding rate (150 kg ha⁻¹) produced heavier spikes (1.40 g) as

compared to 125 kg ha⁻¹ seeding rate (1.34 g). Row spacing also played vital role and wider rows 20 cm produced more weight (1.41 g) however, lowest grains weight spike⁻¹ was found in narrow spacing between the rows (10 cm). Figure 6 clearly displayed that a combination of increased seed rate (150 kg ha⁻¹) and wider row spacing (20 cm) was more effective in producing higher values of grains weight spike⁻¹ (1.40 g).

Both seed rate and row spacing had a significant influence on 1000-grain weight but their interaction remained non-significant (Fig. 7). Main effects of seeding rate was prominent in enhancing overall 1000-grain weight as an increased seed rate (150 kg ha^{-1}) produced higher average value

i.e. 39.33 g. While 20 cm wider rows produced higher value of 1000-grain weight i.e., 39.39 g. A suitable combination of seed rate and row spacing i.e. 150 kg ha^{-1} and sown at 20 cm produced maximum 1000-grain weight (40.29 g).

Figure 5. Spikelet Spike⁻¹ as influenced by various seeding rates and row spacings.

Figure 6. Grains weight spike⁻¹ (g) as influenced by various seeding rates and row spacings.

Biological yield represents the total performance and growth information and is an essential tool regarding the yield of a crop, therefore it is an important component of study. There was a significant effect of seed rate, row space and their interaction was recorded in case of biological yield (Fig. 8). Maximum biological yield (11.64 t ha^{-1}) was obtained at enhanced sowing rate (150 kg ha^{-1}) sown at wider rows of 20 cm respectively. While individual impacts of seeding rate depicted that only 150 kg ha^{-1}

was prominent in enhancing the average biological yield (10.55 t ha^{-1}). In case of row spacing, higher values (10.75 t ha^{-1}) were recorded at 20 cm wider row.

Grain yield is very important parameter with respect to its economical point of view. It is determined by the cumulative influence of different yield traits. In this study, maximum average of grain yield (4.43 t ha^{-1}) was acquired by utilizing enhanced rate of seed (150 kg ha^{-1}) while row spacings had a non-significant impact on overall grain yield.

Results were statistically similar in case of all row spacing treatments i.e. 10, 15 and 20 cm (Fig. 9). Interaction revealed that higher

grain yield (4.88 t ha^{-1}) was achieved when 150 kg ha^{-1} (seed rate) and 20 cm wider row space was used.

Figure 7. 1000-grain weight (g) as influenced by various seeding rates and row spacings.

Figure 8. Biological yield (t ha^{-1}) as influenced by various seeding rates and row spacings.

Figure 9. Grain yield (t ha^{-1}) as influenced by various seeding rates and row spacings.

It was observed from Figure 10 that maximum straw yield (6.11 t ha^{-1}) was achieved when increased seeding rate (150 kg ha^{-1}) was used whereas 20 cm wider rows also produced 6.35 t ha^{-1} of maximal straw

yield. But it was recorded that average values of straw yield at 10 and 15 cm were statistically similar to each other. However, interaction between seed rate and row spacing was completely non-significant.

Figure 10. Straw yield (t ha^{-1}) as influenced by various seeding rates and row spacings.

Discussion

Wheat is an important cereal crop of the world and plays crucial role in human diet. Due to recent increase in population, its demand is increasing with the passage of time. Seeding rates and row spacings are major agronomic factors which directly influence the crop yield. A suitable combination of seeding rate and row spacing is always important for getting valuable yield from wheat crop.

Plant population of wheat crop reflects the yield directly. With the increase in plant population, more yield can be expected. Here in Figure 1, 150 kg ha^{-1} seeding rate with 10 cm narrow spacing between the rows gave higher plant population. Malik *et al.* [12] also found the similar trend and explained that maximum germination count was obtained with the subsequent increase in the seed rates due to higher seed rates. This increase in the sowing rate can also be helpful in the compensation of late sowing of crop. The results of Iqbal *et al.* [13] were also similar to current findings, they used four seeding rates i.e. 125 kg ha^{-1} , 150 kg ha^{-1} , 175 kg ha^{-1} and 200 kg ha^{-1} and

found that 200 kg ha^{-1} , higher seed rate gave more germination count m^{-2} while lowest plant population was acquired at lower seeding rate of 125 kg ha^{-1} . While in case of row spacing, narrow row spacing of 11.25 produced more number of plants which leads to similar current result trend. The wider row spacing of 22.50 cm gave lower plant population as compared to any other row spacing treatments. Geleta *et al.* [14] also reported that with the increment in seeding density increased plant population was observed. They further reported that higher seed rate had a significant influence on plant population percentage which an important agronomic component for any variety. It was recorded that maximum plant population percentage achieved at 130 kg ha^{-1} . While if seed rate is reduced then it totally relies on ability of genotype to reimburse for fewer plants. Tanveer *et al.* [15] evaluated the performance of various wheat varieties and under different sowing dates and seed rates and reported the varieties versus seeding rate integration. It was depicted that maximum number of plants m^{-2} were recorded when higher

seeding rate of 140 kg ha⁻¹ was utilized as compared to others i.e. 80 kg ha⁻¹, 100 kg ha⁻¹ and 120 kg ha⁻¹. These results were also in line with current findings.

Plant height was significantly influenced by 20 cm spacing between the rows along with 150 kg ha⁻¹ of higher seeding rate. Even the interaction effect for seed rate and row spacing was significant as depicted in Figure 2. These results were in agreement with Soomro *et al.* [16] who showed that drilling method with increasing seed rate was more efficient in producing taller plants of wheat. While Iqbal *et al.* [13] also described the similar trend in case of plant height and reported that maximum plant height was achieved when wheat sown at 150 kg ha⁻¹ while minimum height was recorded when further increase in the seed rate was done i.e. 175 kg ha⁻¹. While they also suggested that use of nitrogen fertilizer as a factor responsible for taller plants. Tanveer *et al.* [15] depicted increase in plant height by using higher seeding rate of 140 kg ha⁻¹ in a variety against seeding rate analysis. Ayaz *et al.* [17] depicted the same development that with the increase in seeding rate plant height was increased.

Greater numbers of productive tillers were recorded in Aas-2011 wheat variety when a seeding rate of 150 kg ha⁻¹ and row spacing of 10 cm was used. But the productive tillers ratio was decreased by further extension in row spacing. Findings of Hussain *et al.* [18] were also in line with the results achieved in this study as they reported that crop sown at 10 cm and 20 cm showed better performance with respect to productive tillers in tall and low tillering varieties and in medium stature and with higher tillering capacity. While in those varieties with dwarf stature and having lower tillering capacity, 10 cm spacing between the rows gave more number of productive tillers. Chaudhary *et al.* [19] also reported the similar findings

and conveyed that seeding rate of 150 kg ha⁻¹ reduces the number of fertile tillers.

Spike length is an important character that depicts the grain yield in light of grain number. As the length of spike increases, more grain number can be expected. Figure 4 clearly explained the fact that higher seeding rate with wider row spacing created a difference in spike length of this crop. Seeding rate of 150 kg ha⁻¹ and 20 cm row spacing produced maximum spike length. These results were in agreement with Khan *et al.* [20] they also concluded that some varieties can develop long spikes while some have the quality to produce short spike so in this way, varieties have diverse genetic potential according to their spike length. Baloch *et al.* [21] reported that spike length plays crucial role in the crop production as it leads towards the grain spike⁻¹. Iqbal *et al.* [13] also reported the similar findings that with the increased seed rates and wider row distances spike length gave maximum values.

Spikelet spike⁻¹ were less when a lower seeding rate (125 kg ha⁻¹) was used while higher seeding rate (150 kg ha⁻¹) useful in enhancing the number of spikelet spike⁻¹. Jan *et al.* [22] explained that environmental factors have slight influence on the inherent characters of a variety. Although Iqbal *et al.* [13] observed non-significant influence of seeding rate on spikelets spike⁻¹ but it was reported that spikelets spike⁻¹ were more at seeding rate of 150 kg ha⁻¹ than 125 kg ha⁻¹ and with further increase in the seeding rate i.e. 175 kg ha⁻¹, spikelets spike⁻¹ were reduced. They also described the importance of plant nutrition as nitrogen fertilizer was a component of study and had a significant impact on the spikelets spike⁻¹. Khaliq *et al.* [23] also suggested that by increasing seeding density, spikelets spike⁻¹ can be increased.

In case of grains weight spike⁻¹, 20 cm of row spacing was more prominent along with

150 kg ha⁻¹ of higher seeding rate. As grains weight is linked with grains spike⁻¹, therefore, the results were found to be following similar trend with the findings of Iqbal *et al.* [13] and Ali *et al.* [24] whom reported that this parameter contributes to yield directly and increase in the number of grains with the increment in seeding rate and using wider spacings between the rows. While Iqbal *et al.* [25] reported different results and supported the use of wider row spacing but opposed the increase in the seed rate. If there are more number of grains spike⁻¹, it directly highlights that there will higher grain weight and Ghaffar *et al.* [10] also reported that at 125 kg ha⁻¹ seeding rate higher number of grains spike⁻¹ were recorded and row spacings also directly involved in this scenario.

1000-grain weight has a great role in determining the overall yield trend of crop. If 1000-grain weight will be more, yield will be more. Here in Figure 7, maximum 1000-grain weight was found at 150 kg ha⁻¹ while 20 cm individually influenced the weight. The results were in line with outcomes of Ali *et al.* [24], they reported that 1000-grain weight was more at 150 kg ha⁻¹ than at 125 kg ha⁻¹ whereas further increase in the seed rate lead to decline in the grain weight. Iqbal *et al.* [13] also reported the similar trend and showed that higher 1000-grain weight was achieved at 150 kg ha⁻¹ and 175 kg ha⁻¹ of higher seed rates while lower seed rate of 125 kg ha⁻¹ depicted lower weight of grains. They also focused the use of nitrogen for enhancing the grain weight as the experiment was also based on plant nutrition along with seeding rates. Ghaffar *et al.* [10] reported non-significant effect of seeding rates and supported that 15 cm row spacing produced higher 1000-grain weight. They found that 10 cm and 20 cm row spacing were statistically similar with respect to 1000-grain weight. Ultimately, they found that better environmental conditions had a

great role behind increase in grain weight. Hussain *et al.* [18] reported that cultivars with low tillering traits may show more 1000-grains weight with wider row spacings.

Biological yield was significantly influenced by both seeding rate and row spacing. Moreover interaction between the seeding rate and row spacing was also significant. It can be observed from Figure 8 that highest biological yield was recorded at higher seeding rate and wider row spacing. The findings were similar to the results described by Iqbal *et al.* [13]. They reported that 150 kg ha⁻¹ gave maximum biological yield as compared to 125 kg ha⁻¹ but further increase in seeding rate i.e. 175 kg ha⁻¹ caused decline in biological yield. The results presented here are also in agreement with the findings of Otteson *et al.* [26]. Different combinations of seeding rates influence the overall performance of wheat crop differently. Biomass and other yield attributes are influenced by planting geometry. While Ghaffar *et al.* [10] reported non-significant influence of both seeding rates i.e. 125 kg ha⁻¹ and 150 kg ha⁻¹ but the value of biological yield was higher at 150 kg ha⁻¹ than 125 kg ha⁻¹. They further depicted that biological yield is interrelated with the plant height and different varieties had different traits with respect to yield attributes. They recorded minimum yield at higher seeding rate and wider spacing between the rows.

Grain yield is top priority of any agronomic trial and a common goal of all the research experiments is to develop such techniques by which maximum grain yield could be achieved. Figure 9 reflects that maximal grain yield was obtained when a set of higher seeding rate with wider spacing between the rows was utilized. Ali *et al.* [24] observed the similar trend of grain yield when comparing seed rates of 125 kg ha⁻¹, 150 kg ha⁻¹, 175 kg ha⁻¹, 200 kg ha⁻¹. Iqbal

et al. [13] and Iqbal *et al.* [25] reported that grain yield is a distinctive factor and most focusing component in any research regarding wheat. They also calculated maximum grain yield at 150 kg ha⁻¹. However, Ghaffar *et al.* [10] opposed the result trend and reported a non-significant influence of divergent seeding rates and reported that genotypes and row spacing can cause significant effect on grain yield. They observed higher grain yield at 15 cm row spacing and lower grain yield at 20 cm. Khan and Makhdum [27] focusing on the tillering potential of a variety named Punjab-81 suggested the use of higher seed rate. Ayaz *et al.* [17] also supported the use of higher seed rates to obtain maximum grain yield. Ahmed *et al.* [28] reported that maximal grain yield and harvest index of wheat can be achieved with row space of 20 cm. Bakht *et al.* [29] reported that wider but moderate row spacings can enhance the grain yield. But Hussain *et al.* [30] reported different results with respect to use of wider row spacings. Baloch *et al.* [21] and Arif *et al.* [31] also suggested higher seed rate with wider row spacing for highest yield. Hussain *et al.* [32] concluded that for achieving maximum growth and yield potential 20 cm row spacing could be helpful. In this way, it supports the current findings.

Straw yield also followed the grain yield trend and it be easily seen in Figure 10. The findings were in agreement with Ali *et al.* [24] whom described that straw yield is the economic yield and a final aim behind all crop production systems. After conducting three year research based on the effects of altered seeding rates and row spacings on wheat yield, they reported the similar findings that with the increase in seeding rate straw yield was increased. Ayaz *et al.* [17] also pointed out the similar trend and revealed that 150 kg ha⁻¹ seeding rate produced significantly higher straw yield. However, Soomro *et al.* [16] contradicted

that maximum grain and straw weight was recorded at 125 kg ha⁻¹.

Conclusion

It is concluded from the current study that both seeding rates and row spacings can play important role in influencing the yield and yield attributes i.e. plant population, plant height, spike length, productive tillers plant⁻¹, spikelet spike⁻¹, grains weight spike⁻¹, 1000-grain weight, biological yield, grain yield and straw yield of wheat crop. As the wheat sowing delays, there are certain chances that yield decrease to some extent per day. So, it is necessary to compensate this yield loss and for this purpose augmentation in the seeding rates and row spacing is crucial. Although not only agronomic but there are so many other factors i.e. genetic, environmental and certain management factors which are also contributing towards the final yield and by keeping in view all of them the current study suggests the use of higher seed rate i.e. 150 kg ha⁻¹ with wider row spacing of 20 cm in case if late sowing of wheat is done.

Authors' contributions

Envisioned the project and designed the experiment: MIA Rehmani, MF Fareed & N Hussain Performed Experiment: MIA Rehmani, MF Fareed, AM Alvi & M Ibrahim, Analyzed the Data: MIA Rehmani, MF Fareed, S Hussain, J Iqbal & H Nawaz, Wrote the Paper: MIA Rehmani H Nawaz, N Hussain & MA Bashir, Reviewed and edited later version of draft: MIA Rehmani, AM Alvi & J Iqbal.

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