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The Influence of *Triticum asetivum* Seeding Rates and Sowing Patterns on the Vegetative Characteristics in Shambat Soil under Irrigation

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Abstract: Seeding rate and sowing patterns play an important role in the proper stand establishment of the growing crop, which ultimately affect the productivity at the end of the season. The selection of suitable planting method as well as the accurate rate of seeding for bread wheat is dependent upon several factors including the time of planting, soil characteristics, seed viability and availability of plant machinery. A study was conducted at the Demonstration Farm of the Faculty of Agriculture, University of Khartoum, Shambat to find out the effect of different seeding rates and planting techniques on the vegetative growth of bread wheat (*Triticum aestivum* L.) on the widely used cultivar *Condor*. The present study indicated the importance of putting more emphasis on the crop stand establishment in connection with various cultural practices.

Key words: Wheat (*Triticum aestivum* L.), sowing method, seeding rate, vegetative growth, cultural practices, Sudan

INTRODUCTION

Wheat (*Triticum aestivum* L.) was one of the first domesticated food crops and for 8,000 years has been the basic staple food of major civilizations in Europe, West Asia and North Africa. Today, wheat is grown on more land area over 240 million ha than any other commercial crop and continues to be the most important food grain source for humans. Annual global production exceeds 0.6 billion tons (Dixon *et al*., 2009). Wheat is a strategic field crop in Sudan, since it constitutes the main staple food for most of the urban population. Its cultivation along the Nile banks in the Northern region between latitudes 16 and 22°N dates back to 3000 B.C. Wheat cultivation in Sudan expanded recently to latitudes <15°N as a winter crop, occupying the largest area in Sudanese irrigated schemes and it is the second most important cereal crop after sorghum in the country (Ishag, 1994). The demand for wheat increased due to urbanization but there is a large deficit of production compared to consumption. Average wheat yields in Sudan are very low due to climatical and to production factors. Nowadays, many different fertilizer forms are introduced in Sudan to raise wheat yields.

Plant density; sowing methods; fertilization; weed and diseases control are among the limited factors of wheat production. Among these factors, the method of sowing and plant density are of great significance, as it not only determines the proper crop stand establishment but also the production of individual plant through balancing the plant to plant competition and facilitating the conversion of light energy to harvest yield of crop (Jan *et al*., 2001; Nakano and Morita, 2009). Growth improvements at an early stage should help to increase the crop productivity (Tanveer *et al*., 2003). Vigorous early growth has been reported to be associated with rapid and uniform seedling emergence (Kirby, 1993) and better combination of leaf size and tiller number (Regan *et al*., 1992). Since there are few studies that compare directly the vegetative characteristics of wheat plants under irrigated field conditions, the present study was conducted to investigate the effects of various seeding rates and sowing methods on the growth attributes of bread wheat.

MATERIALS AND METHODS

The objective of this experiment was to study the effects of different combinations of seeding rates and methods of sowing on the vegetative growth of bread wheat (*Triticum aestivum* L.). The experiment was carried out in the Demonstration Farm of the Faculty of Agriculture, Shambat (Latitude 15° 40' N, Longitude 30° 32' E, 380 m above sea level) on a heavy clay soil with a pH range of 7.8-8.5. The physical and chemical characteristics of the soil at the experimental site are nearly similar to those reported by Sulieman and Hago (2009). One of the most widely locally cultivated varieties, *Condor* was used in the experiment. The land was prepared according to the standard procedure followed in the demonstration farm by disking, harrowing and leveling. The crop was sown on the end of December manually by hand. A guard area of sorghum (*Sorghum bicolor*), maize (*Zea mays*) and rice (*Oryza sativa*) was grown in the northern and southern sides of the experimental area. The experiment consisted of three seeding rates and three methods of sowing. The seed rates were 50, 25 and 12.5 kg fed^{-1} designed as R1, R2 and R3, respectively. The methods of sowing applied were: sowing on ridges in rows (M1), sowing on flats by broadcasting (M2) and sowing on flats in rows (M3). The treatments were arranged in a Randomized Complete Block Design (RCBD) with four replicates. Plot size was 20 m^2 (5×4 m). A nitrogen dose was applied in the form of urea (46% N) 45 days After Sowing (DAS) at a rate of 40 kg N ha^{-1}. All parameters examined were determined at harvesting (62 DAS). Plant height was measured from the soil surface to the tip of upper most leaf, leaf number as the average number of the green ones per plant, number of tillers as the average number of both primary and secondary tillers per plant excluding the main stem. For determining the dry weights, all plants of each sample were pulled out, samples were kept in study bags and were taken to the laboratory. All samples were oven-dried at 80°C for 48 h and weights were then recorded. For determining the Leaf Area Indices (LAI), the Leaf Area (LA) of the upper most leaf was measured following the method suggested by Lal and Rao (1951) using the standard formula:

$$LA = Length_{max} \times Width_{max} \times 0.73$$

Thereafter, the LAI (The one-sided area of green leaf tissue/unit area of land occupied by that crop) was measured according to the Watson (1947). All the collected data were statistically analyzed using standard Analysis Of Variance (ANOVA) procedure. Least Significant Difference test (LSD) was used for mean separation.

RESULTS AND DISCUSSION

Plant height is an important component of straw yield. The responses of plant height to the plant density and sowing methods are depicted in Fig. 1a, b. The statistical analysis revealed no significant difference to both factors in question. Increase in the seeding rates was resulted in a slight increment in the heights of the plants. On the other hand, sowing on ridges as well as sowing on flats in rows slightly exceeded in height the plants which were sown by broadcasting due to the higher competition between the neighboring plants particularly for the light. Seed rate x method of sowing interaction had a significant increase on this parameter. In general, the highest plant height was recorded by the combination R2M1 and R3M2 produced the lowest value. Tillers calculated at 62 days from sowing were highly significantly (p<0.001) affected by different treatments. Mean values show that there were no significant differences among different seeding rates for the mean number of tillers per plant (Fig. 2a). R2 was much better than the other seeding rates. On the other hand, it is clearly evident that M2 was resulted in more tillers in comparison with M1 and M3 which gave closer values and were not significantly different from each

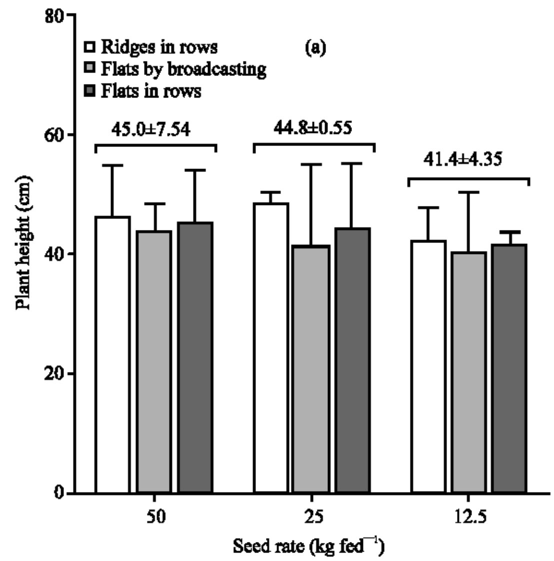

Fig. 1a: The effect of different seeding rates on the plant height (cm) of *Triticum aestivum* plants grown in the field for 62 days. Bars represent±S.E of four replicates

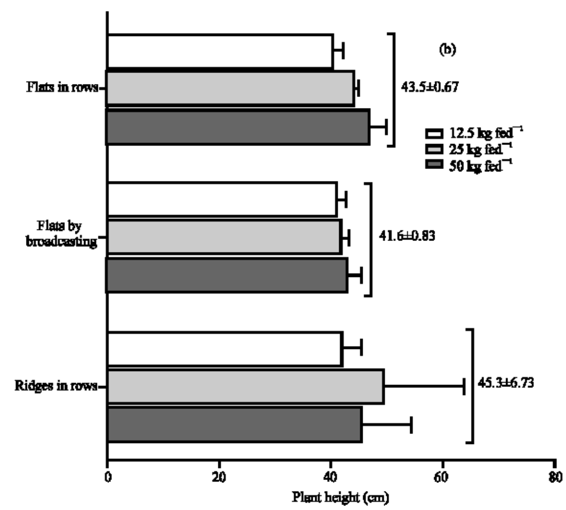

Fig. 1b: The effect of different planting patterns on the plant height (cm) of *Triticum aestivum* plants grown in the field for 62 days. Bars represent±S.E of four replicates

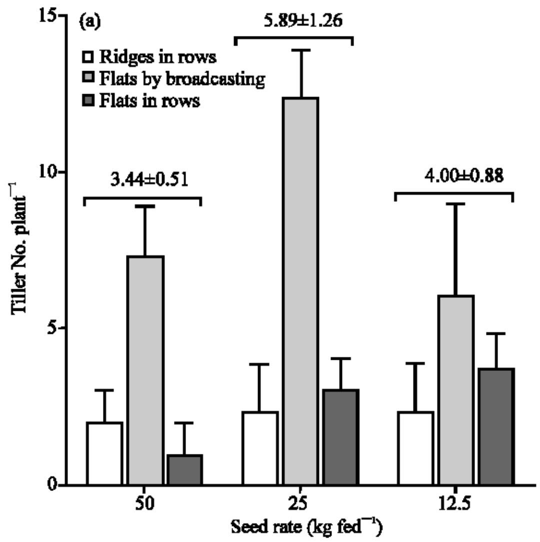

Fig. 2a: The effect of different seeding rates on the number of tillers per plant for *Triticum aestivum* grown in the field for 62 days. Bars represent±S.E of four replicates

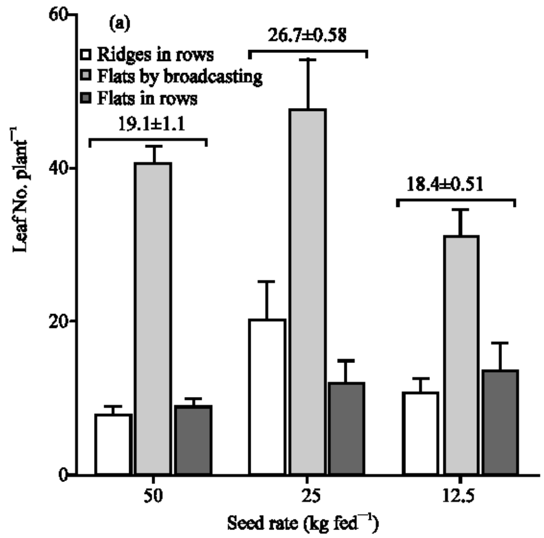

Fig. 3a: The effect of different seeding rates on the number of leaves per plant for *Triticum aestivum* grown in the field for 62 days. Bars represent±S.E of four replicates

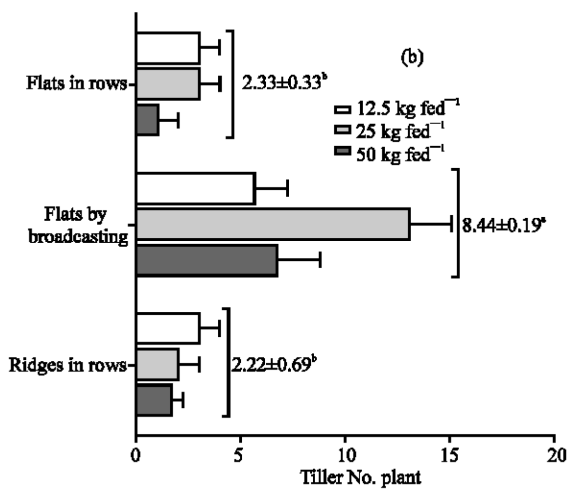

Fig. 2b: The effect of different planting patterns on the number of tillers per plant for *Triticum aestivum* grown in the field for 62 days. Bars represent±S.E of four replicates. Different letters indicate a statistically significant difference between planting patterns (LSD)

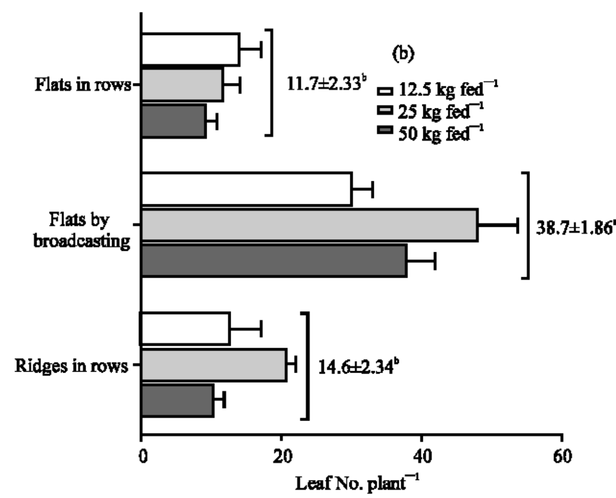

Fig. 3b: The effect of different planting patterns on the number of leaves per plant for *Triticum aestivum* plants grown in the field for 62 days. Bars represent±S.E of four replicates. Different letters indicate a statistically significant difference between planting patterns (LSD)

other (Fig. 2b). Interaction of seeding rates and sowing methods had a significant increase on this parameter. The highest value was obtained at the combination R2M2. The data showed highly significant effects ($p<0.001$) of seeding rate and sowing method on number of leaves (Fig. 3a, b). Mean values show that there were no significant differences among different seeding rates for the mean number of leaves per plant (Fig. 3a). For the sowing method, the highest mean number of leaves was obtained under M2. M1 and M3 gave relatively similar number of leaves and were not significantly different from each other. M2 was significantly higher than M1 and M2 (Fig. 3b). The interaction of both factors revealed a significant increase on this parameter. The highest number of leaves was given by the combination R2M2. The analysis of variance has revealed that there was significant difference ($p<0.05$) among various treatments for the dry matter accumulation. Moreover, no significant different was detected between the three seeding rates for the whole dry matter production of the plants. Relatively, R2 was better than R1 as well as R3 (Fig. 4a, b). The method of sowing significantly affected the mean weight of dry matter per plant. The difference between M1 and M3 was not significant but the two planting methods differ significantly from M2. It is evident that the seeding rate by method of sowing interaction was significant on dry weight. The highest value was obtained at the combination R2M2. Highly significant effect ($p<0.001$) was detected between the different treatments concerning the LAI of the plants. Contrary with above mentioned insignificant effect of the seeding rates on the other parameters, the mean values in Fig. 5a show a remarkable significant effect on the LAI. R1 was the only significantly higher than R3. In harmony with the effects on the other mentioned parameters, the sowing method had also revealed a significant effect on this parameter. Only M2 was significantly different from the other two planting methods and the highest index was obtained by the same sowing method (Fig. 5b). Interaction of both factors showed a significant increase on this parameter. The highest value was obtained at the combination R1M2. Very few experiments attempted to study the effects of different seeding rates and sowing methods on the vegetative attributes of bread wheat. Most of the attention was basically paid towards the grain yields and ield components (Dawelbeit and Babiker, 1997; Akbar *et al*., 2006). From an agronomic point of view, a key factor which would be reflected in high wheat production is the well understanding of early crop establishment factors (Soomro *et al*., 2009). The growth

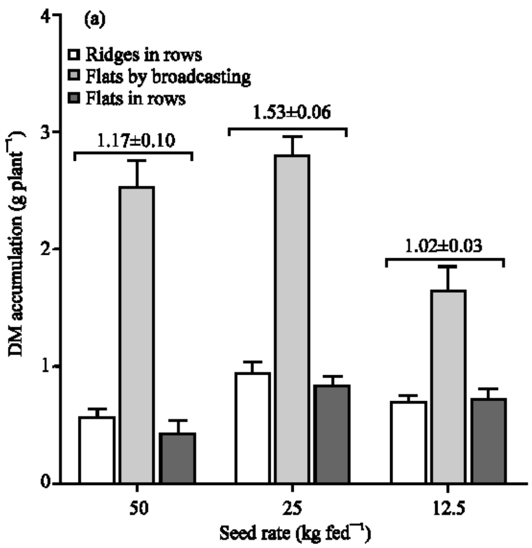

Fig. 4a: The effect of different seeding rates on the dry matter accumulation per plant for *Triticum aestivum* grown in the field for 62 days. Bars represent±S.E of four replicates

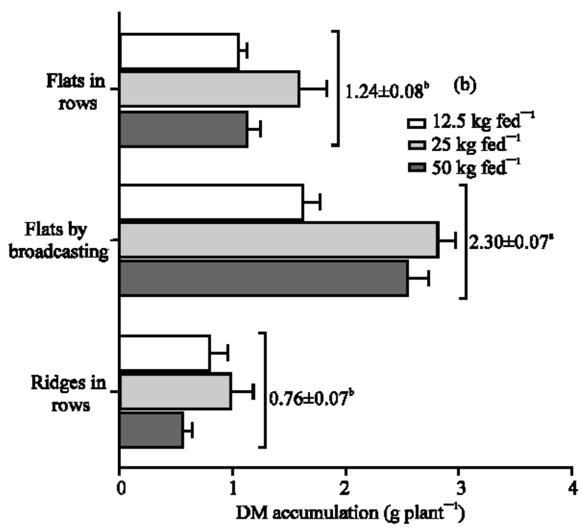

Fig. 4b: The effect of different planting patterns on the dry matter accumulation per plant for *Triticum aestivum* grown in the field for 62 days. Bars represent±S.E of four replicates. Different letters indicate a statistically significant difference between planting patterns (LSD)

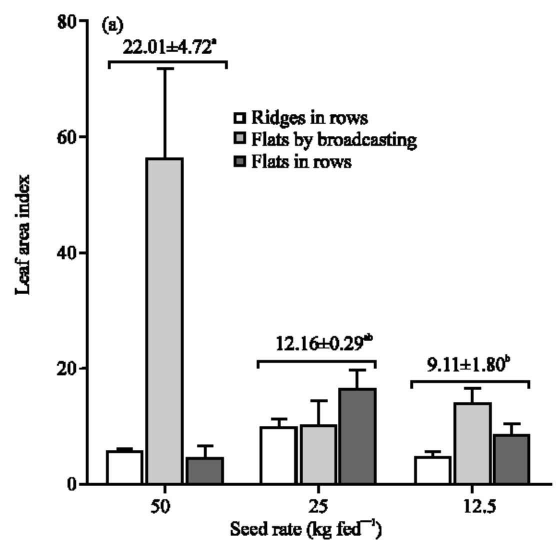

Fig. 5a: The effect of different seeding rates on the Leaf Area Index (LAI) for *Triticum aestivum* plants grown in the field for 62 days. Bars represent±S.E of four replicates. Different letters indicate a statistically significant difference between planting patterns (LSD)

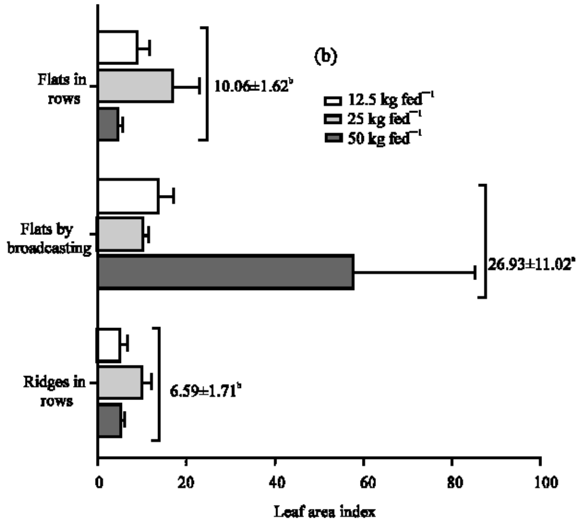

Fig.5b: The effect of different planting patterns on the Leaf Area Index (LAI) for *Triticum aestivum* plants grown in the field for 62 days. Bars represent±S.E of four replicates. Different letters indicate a statistically significant difference between planting patterns (LSD)

attributes of bread wheat *Triticum aestivum* L. cv. *Condor*, which were examined in the present study included plant height, number of leaves, number of tillers, LAI and total plant dry matter accumulation. The effect of increasing the applied seeding rate was not enough to reach the significance level for all the parameters examined except for LAI. Increasing in the seed rates slightly increased the vegetative growth of the plants and 25 kg fed^{-1} (60 kg ha^{-1}) showed the best results. These finding is in line with Akasha (1966), who found no significant difference between sowing rates ranging from 48-190 kg ha^{-1}. Ageeb (1974) at Hudeiba Research Station conducted nine rates ranged between 11.9 and 190.4 kg ha^{-1} and results of the trial did not reveal any significant differences. In another season Ageeb (1975), tested the effect of four seeding rates (33.3, 66.7, 100.0 and 133.3 kg ha^{-1}) and four sowing methods (drilling, broadcasting, broadcasting + ridging and hills) on wheat yield.

The results showed that on average there was no significant difference between the four methods of sowing and there was no significant interaction the two factors. The best results were obtained when the seeds were broadcasted and followed by ridging the soil. Such behavior was attributed to the improvement of soil/plant moisture relationship that usually results from sowing plants on ridges in heavy clay soils. In contrary, Ali (1979) carried experiments on sowing rates and found 15% increment when the seeding rate was increased from 41-95 kg ha^{-1}. Mahmoud and Osman (1981) noted that plants grown at higher seed rates attained their maximum numbers of shoots at an earlier date. The number of shoot m^{-2} was increased with an increasing in seed rate however, the number of fertile shoots per plant at harvest decreased with an increase in seed rate and composed mostly of main shoots i.e., reduce tillering. Increase in the seeding rates slightly increased plant height. Such increment in the plant height could be due to the reduction in the number of tillers per plant. Similar results were stated by Nazir *et al.* (1987), who demonstrated that the reduction in plant height was caused by low density of planting. Number of both tillers and leaves were found highly significant. The applied dose of nitrogen which was supplied 45 DAS is expected to affect positively for that result (Olsen and Weiner, 2007). The effect of seeding rates on the number of tillers per plant was not significant during the study. However, the tiller number is influenced significantly by the method of sowing.

Rather observed that an increase in seed rates resulted in less tillering while Kinra observed more tillers following an increase in seeding rates. More recently, the study conducted by Chen *et al.* (2008) revealed that tillers formed by hard red spring wheat at higher seeding rates of had larger phyllochrons and greater mortalities. Sowing on flat by broadcasting showed a significant increase on all vegetative characteristics examined including the total dry matter formation (Prashar *et al.*, 2004). This might be attributed to the fact that sowing on flat by broadcasting decreased the influence of competition between the neighboring in the same plot. This result is in line with the earlier report for Hattab *et al.* (1970) and a recent one by Soomro *et al.* (2009) for bread wheat. The significant increase in number of tillers per plant might be fully reflected in a corresponding significant increase in the number of leaves per plant.

Increase in the seeding rates only significantly increased LAI. This might be related to the high plant density resulting from high seeding rate. In wheat plant, LAI formation was known to be obtained by tillering (Evers *et al.*, 2005) and by number of leaves per plant (Frederick and Camberato, 1995; Heidmann *et al.*, 2000, Sharma *et al.*, 1994). High LAI of the crops during the vegetative growth is normally connected with high yield in the end of the season. Additionally, there are also many advantages for increasing LAI, including decreases light interception and net assimilation rate (Karimi and Siddique, 1991; Sharma *et al.*, 1994). These advantages are especially important for the crop/weed competition (Champion *et al.*, 1998; Lemerle *et al.*, 2004; Olsen *et al.*, 2006). This implies that increased crop density had strong and consistent negative effects on weed biomass and positive effects on grain and straw yield (Jhala *et al.*, 2008).

CONCLUSION

The outcome of the present study indicates that higher increasing in the seeding rates is not beneficial in increasing wheat vegetative growth. Generally, sowing on flats by broadcasting showed the best results in comparison with the other tested patterns.

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REFERENCES

Ageeb, O.A.A., 1974. Annual report of Hudeiba research station, Sudan. Agricultural Research Corp, Sudan.

Ageeb, O.A.A., 1975. Annual report of Hudeiba research station, Sudan. Agricultural Research Corp, Sudan.

Akasha, M.H., 1966. Annual report of Gezira research station, Sudan. Agricultural Research Corp, Sudan.

Akbar, H., M. Idrees, M.F. Ahmad, M. Arif and M. Zakirullah, 2006. Dry weight of spike at anthesis determines grain weight of spike at maturity. J. Agric. Biol. Sci., 1: 55-61.

Ali, F.M., 1979. Annual report of Gezira research station, Sudan. Agricultural Research Corp, Sudan.

Champion, G.T., R.J. Froud-Williams and J.M. Holland, 1998. Interactions between wheat (*Triticum aestivum* L.) cultivar, row spacing and density and the effect on weed suppression and crop yield. Ann. Appl. Biol., 133: 443-453.

Chen, C., K. Neill, D. Wichman and M. Westcott, 2008. Hard red spring wheat response to row spacing, seeding rate and nitrogen. Agron. J., 100: 1296-1302.

Dawelbeit, M.I. and E.A. Babiker, 1997. Effect of tillage and method of sowing on wheat yield in irrigated Vertisols of Rahad, Sudan. Soil Till. Res., 42: 127-132.

Dixon, J., H.J. Braun, P. Kosina and J. Crouch, 2009. Wheat Facts and Futures 2009. CIMMYT, Mexico, ISBN: 978-970-648-170-2.

Evers, J.B., J. Vos, C. Fournier, B. Andrieu, M. Chelle and P.C. Struik, 2005. Towards a generic architectural model of tillering in Gramineae, as exemplified by spring wheat (*Triticum aestivum*). New Phytol., 166: 801-812.

Frederick, J.R. and J.J. Camberato, 1995. Water and nitrogen effects on winter wheat in the Southeastern coastal plain: II. Physiological responses. Agron. J., 87: 527-533.

Hattab, E.H.S., M.S. Kamal and A.A. Galil, 1970. The effects of the rate of seeding and the number of irrigation on the wheat yield and its components. Field Crop Abstr., 26: 474-474.

Heidmann, T., A. Thomsen and K. Schelde, 2000. Modelling soil water dynamics in winter wheat using different estimates of canopy development. Ecol. Model, 129: 229-243.

Ishag, H.M., 1994. Genotype Differences in Heat Stress in Wheat in Gezira Scheme. In: Wheat in Heat-Stressed Environment, Irrigated, Dry Areas and Rice-Wheat Farming Systems, Saunders, D.A. and G.P. Hettel (Eds.). CIMMYT, Mexico, ISBN: 968-6127-87-9.

Jan, M.T., H. Ali and A. Jan, 2001. Influence of sowing methods and mulching on yield and yield components of wheat. Pak. J. Biol. Sci., 4: 657-659.

Jhala, A.J., S.C. Shah, P.H. Rathod and H. Bhatt, 2008. Integrated effect of seed rates and weed management treatments in wheat (*Triticum aestivum* L.). Res. J. Agric. Biol. Sci., 4: 704-711.

Karimi, M.M. and K.H.M. Siddique, 1991. Crop growth and relative growth rate of old and modern wheat cultivars. Aust. J. Agric. Res., 42: 13-20.

Kirby, E.J.M., 1993. Effect of sowing depth on seedling emergence, growth and development in barley and wheat. Field Crop Res., 35: 101-111.

Lal, K.N. and M.S.S. Rao, 1951. A rapid method of leaf area determination. Nature, 167: 72-72.

Lemerle, D., R.D. Cousens, G.S. Gill, J.S. Peltzer and M. Moerkerk *et al.*, 2004. Reliability of higher seeding rates of wheat for increased competitiveness with weeds in low rainfall environments. J. Agric. Sci., 142: 395-409.

Mahmoud, Z.M. and A.M. Osman, 1981. Tillering of wheat as influenced by nitrogen and seed rate in Sudan. J. Agroc. Sci., 97: 619-627.

Nakano, H. and S. Morita, 2009. Effects of seeding rate and nitrogen application rate on grain yield and protein content of the bread wheat cultivar Minaminokaori in Southwestern Japan. Plant Prod. Sci., 12: 109-115.

Nazir, M.S., M. Ahmed, M. Siddiq and R. Ahmed, 1987. Wheat productivity as affected by seeding density and geometry of planting. Sarhad J. Agric., 3: 409-415.

Olsen, J. and J. Weiner, 2007. The influence of *Triticum aestivum* density, sowing pattern and nitrogen fertilization on leaf area index and its spatial variation. Basic Applied Ecol., 8: 252-257.

Olsen, J., L. Kristensen and J. Winer, 2006. Influence of sowing density and spatial pattern of spring wheat (*Triticum aestivum*) on the suppression of different weed species. Weed Biol. Manage., 6: 165-173.

Prashar, A., S. Thaman, A. Nayyar, E. Humphreys and S.S. Dhillon *et al*., 2004. Performance of wheat on beds and flats in Punjab, India. Proceedings of the 4th International Crop Science Congress Brisbane, Sept. 26-Oct. 1, Australia, pp: 89-89.

Regan, K.L., K.H.M. Siddique, N.C. Turner and B.R. Whan, 1992. Potential for increasing early vigour and total biomass in spring wheat. II. Characteristics associated with early vigour. Aust. J. Agric. Res., 43: 541-553.

Sharma, K., K.K. Dhingra and M.S. Dhillon, 1994. Physiological indices for high yield potential in different genotypes of wheat. Environ. Ecol., 12: 717-719.

Soomro, U.A., M.U. Rahman, E.A. Odhano, S. Gul and A. Tareen, 2009. Effects of sowing method and seed rate on growth and yield of wheat (*Triticum aestivum*). World J. Agric. Sci., 5: 159-162.

Sulieman, S.A. and T.E.M. Hago, 2009. The effects of phosphorus and farmyard manure on nodulation and growth attributes of common bean (*Phaseolus vulgaris* L.) in Shambat soil under irrigation. Res. J. Agric. Biol. Sci., 5: 458-464.

Tanveer, S.K., I. Hussain, M. Sohail, N.S. Kissana and S.G. Abbas, 2003. Effects of different planting mrthods on yield and yield components of wheat. Asian J. Plant Sci., 2: 811-813.

Watson, D.J., 1947. Comparative physiological studies on the growth of field crops: I. Variation in net assimilation rate and leaf area between species and varieties and within and between years. Ann. Bot., 11: 41-76.