Research in
ISSN : P-2409-0603, E-2409-9325
AGRICULTURE, LIVESTOCK and FISHERIES
An Open Access Peer-Reviewed International Journal

Article Code: 407/2023/RALF
Article Type: Research Article

Res. Agric. Livest. Fish.
Vol. 10, No. 2, August 2023: 133-145.

PHENOLOGY AND YIELD RESPONSE OF WHEAT VARIETIES AS INFLUENCED BY SOWING DATES AT GONDE AND ARDAYITA SEED PRODUCTION FARM, ETHIOPIA

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ARTICLE INFO

Received
15 July, 2023

Revised
22 August, 2023

Accepted
29 August, 2023

Online
September, 2023

Key words:
Wheat
Sowing date
Varieties
Location
Interaction
Phenology
Yield

ABSTRACT

Wheat is one of Ethiopia's main foods, contributing to daily caloric consumption. Due to environmental conditions such as distribution and length of the rainy season shifting from time to time elsewhere, particularly at Gode and Ardayita seed production farm, sowing timing and varietal selection are key factors for low yield of wheat crop. This Experiment was designed in a randomized complete block design with three-replications which contain four sowing dates, ranging from June 17 to July 18 at ten-day intervals, and four wheat varieties namely Kingbird, Hidase, Picaflor, and Ogolcho combined to form 16 treatments. According to the result, on days to heading, there was a significant interaction effect of variety and location and the highest number of days (70.42) was obtained at the Ardayita location on Kingbird variety. On the day of heading, there is also a substantial interaction effect of location and sowing date, the maximum days (72.00) were observed at Ardayita on the early sowing date (June-17). The maturity dates of the two locations varied significantly, the longer (116.17) days were recorded at Ardayita. The effect of variations on days to maturity of varieties also significant, Ogolcho variety had the highest maturity (120.04) days. Date of sowing also has a significant effect on maturity date; the highest number of days (116.96) was recorded on June 17 sowing date. The grain filling period significantly vary among the varieties, the Ogolcho variety had the highest number of days (53.25). Grain filling period also had significant variation on date of sowing; the earliest sowing date (June 17) has the longest date (49.96). On the other hand, location had no effect on the grain-filling period, plant height and seed yield. Sowing date and location significantly interact on grain yield of wheat. The maximum (6.38 ton ha^{-1}) seed yield was recorded at Gonde location on second (June 28) sowing date and Ardayita place obtained highest yield at first sowing date (June 17). There was a significant interaction between sowing date and varieties on yield of wheat. From the result Hidasse variety obtained highest yield (6.58 ton ha^{-1}) on the second sowing date (June 28) whereas the Ogolch variety recorded highest (6.28 ton ha^{-1}) at the first sowing date (June 17).

To cite this article: Tamiru T., G. Gemedi, B. Debelu and H. Tesfaye, 2023. Phenology and yield response of wheat varieties as influenced by sowing dates at gonde and ardayita seed production farm, Ethiopia. Res. Agric. Livest. Fish. 10(2): 133-145.

DOI: https://doi.org/10.3329/ralf.v10i2.68763

INTRODUCTION

Wheat (*Triticumaestivum* L.) is the most important cereal crop in the Poaceae (Gramineae) family and the world's second most important staple food crop after rice. It is grown in 89 nations with temperate, subtropical, and tropical climates. It was grown on more than 221 million hectares of land, yielding 728.9 million tonnes of food grains with productivity of 3.62 ton ha^{-1} worldwide (FAO, 2014). Ethiopia is the leading producer of wheat in East Africa, followed by Sudan and Kenya, and second in Sub-Saharan Africa after South Africa (FAO, 2015). After maize and teff (*Eragrostisteff*), it is Ethiopia's third-largest cereal crop. In Ethiopia, wheat is farmed as a rain-fed crop over 1500 meters above sea level. It was sowed on 1.696907 million hectares in 2017-18, yielding 46.429657 million tones with average productivity of 2.73 ton ha^{-1}(Anonymous, 2015). It is high in carbohydrates (68%) and proteins (13%) as well as minerals and vitamins. It offers 19% of all calories consumed by humans worldwide, which is more than other dietary sources (FAO, 2014)

Sowing date is one of the most important determinant factors of crop production that should be, managed (Murunguet al., 2010). Because of the variability in weather conditions, choosing the right sowing date is critical to achieving a high yield (Sun et al., 2007). Sowing time and varietal selection is two of the most important elements contributing to the wheat crop's low yield (Dabreet al., 1993). The appropriate sowing time influences the crop's access to water, heat, and sunlight. Climate change is one of the most pressing issues confronting humanity today, and one of the most significant scenarios witnessed by regions around the world, particularly in arid and semi-arid areas, is the rise in atmospheric CO_2, high rates of temperature, and low and fluctuating precipitation, which has resulted in the emergence of disturbances in some physiological functions. Wheat takes 110-130 days to mature from seed to harvest, depending on climate, seed type, and soil conditions. High temperatures during anthesis and grain maturity considerably inhibited wheat grain development when compared to plants grown in optimal conditions (Hurkman, 2003). Wheat development may be significantly impacted by high temperatures before and after ovulation, and this stress reduces the crop's photosynthetic productivity (Tewoldeet al., 2006)

Every crop variety has its own set of specific requirements for optimal development and yield in specific environmental conditions. Climate characteristics such as the distribution and length of the rainy season are shifting all across the planet these days. As a result, crop production must be adapted to these ever-changing climatic conditions by adjusting agronomic methods such as sowing dates and variety selection. Sowing date, weed infestation and limited varietal potential may all contribute to low yields of wheat at Gonde and Ardayita seed farms. Therefore this experiment was initiated in identifying appropriate sowing date of wheat varieties to different location.

Objective:

- To determine the ideal sowing period for wheat varieties at Gonde and Ardayita Seed Production Farms.
- To study the effect of two ways or three ways interaction of wheat varieties to different sowing date and location.

MATERIALS AND METHODS

Description of the Study Area

The influence of sowing dates on yield and yield components of wheat varieties was studied at Gonde and Ardayitaseed farm. Gonde is located 152Km South East of Addis Ababa, with the altitude of 2250 m.a.s.land average annual rain fall of ranging between 850-950mm and maximum and minimum temperatures are 27°C and 17°C respectively, while Ardayita is located306 Km far from Addis Ababa and the altitude is 2500 m.a.s.l, which receive average annual rainfall of 1200mm and the highest and lowest temperatures are 20 °C and 5 °C, respectively.

Experimental Design and Treatments

The Experiment was set up in randomized complete block design with three-replication. Four wheat varieties namely; Kingbird, Hidase, Picaflor, and Ogelcho, were studied with sowing dates of; June 17, 28, July 8, and 18. The experimental plot size was 1.2x2.5m ($3m^2$). The gap between plots was 0.5 m apart while the space between replications was 1 m. The seed was sowed at 20 cm spacing between rows with a seed rate of 150 kg per hectare. At each of the experimental treatments, a fertilizer dose of 100 kg NPS per hectare was applied. At the tillering stage, 100 kg of urea per hectare was applied for each plot. All agronomic practices such as weeding; disease and insect pest management were done equally for each treatment.

The climatic condition of the experimental sites during 2018 cropping season

The maximum and minimum amount of rainfall received were 178.1 mm and 0.2mm while the maximum and minimum temperatures observed during the growing season were 30.3^{0}c and 14.6^{0}c, respectively (Table 1) at Gonde site. It tells that rainfall amount declined from planting time to harvest, while the maximum temperature increased linearly as going to maturity date for both locations. As compared to the two location Ardayita place receive 189.1mm more rainfall than Gonde location, while the temperature condition was almost similar for both locations. Even though the amount of rainfall considerably decreased, it is suitable for wheat production. The characteristics of the experimental materials are also illustrated in the Table 2.

Table1. The average monthly temperature and rainfall during 2018 cropping season of Gonde and Ardayita

Months	Gonde			Ardayita		
	Minimum temperature (^{0}C)	Maximum temperature (^{0}C)	Rain (mm)	Minimum temperature (^{0}C)	Maximum temperature (^{0}C)	Rain (mm)
June	11.6	23.13	119.9	10.2	23.5	87.2
July	11.8	21.96	137.2	10.1	21.2	198.6
August	11.54	21.93	149.1	9.8	20.9	253.2
September	10.26	23.33	59.5	8.9	22	156.6
October	10.09	23.98	28	6.6	22.9	8.3
November	10.32	23.03	31.6	5.8	23.2	10.5
Total	65.61	137.36	525.3	51.4	133.7	714.4
Mean	10.935	22.89	87.55	8.57	22.28	119.07

Source: Gonde and Ardayita seed production farm metrology station 2018 data

Table 2. Description of experimental materials

Varieties	Characteristics				
	Days to maturity	Altitude (m.a.s.l)	Rainfall (mm)	Year of release	Yield potential ton/ha
Hiddase	121	2200-2600	500-800	2012	4.5-7.0
Ogolcho	102	1600-2100	400-500	2012	2.8-4.0
Picaflore	90-120	1500-2200	500-800	2010	3.3-4.8
King bird	90-95	1500-2200	500-800	2015	4.0-4.5

Source: Ethiopian Agricultural Businesses Corporation (https://ethioagri.com/2021)

Data collection

Agronomic data such as growth, yield and yield component were collected to identify the effect of sowing date to wheat varieties. Date of heading (DH): It was recorded by counting number of days from the date of sowing until when 50% of the plants in a plot produced spikes above the sheath of the flag leaf that was determined by visual observation. Date of grain filling period was recorded from date of heading to date of maturity. Date of maturity was recorded by counting the number of days from date of sowing until when 90% of the plants changed green color to yellowish, loose its water content and attain to physiological maturity. Plant height was determined from 10 representative plants in a plot by measuring from the ground surface to the tip of the spike excluding the awns. Number of spike per m^2 (SPM) was counted from the central rows of 1m^2 area. Kernel number per spike (KNPS) was determined from representative ten plants per plot and the mean value was recorded. Thousand seed weight (1000 SW) was measured by taking 1000 seed from each plot and weighted by sensitive balance. Grain yield (GY): Grain yield in kilogram of the mid two rows adjusted to 13% moisture level was calculated and converted to hectare base. Biological yield (BY): was determined by weighing the two central rows of the total air and converted to hectare base.

Data analysis

Inferential data analysis like Analysis of Variation (ANOVA), least significant difference (LSD) of mean, coefficient of variation (CV), and probability value ($p \leq 0.05$) were calculated using software - R studio 4.0.3 using Readxl and Agricolae packages.

RESULTS AND DISCUSSION

Date of heading

There was a significant difference in the dates of heading between the two places. Ardayita obtained the highest (68.29) days while the Gonde site attained the lowest (61.31) days to heading (Table 3). The difference could be attributed to the Ardayita sites receive high rainfall, which implies that when a sufficient amount of moisture is available for the crop, the days to complete its life cycle become longer.

There were also significant variances in the days to heading among the varieties. The highest (67.21) days to heading were observed on the Ogolcho variety, while the lowest days to heading were found on the Picaflore variety (63.25 days), which is insignificant differences from the Kingbird variety (63.33days) (Table 3).This finding shows that the genetic difference in days to heading among varieties is due to morphological differences in leaf area, root length and number of leaves. According to several studies, there is a major diversity in varieties depending on the date of heading. The effect of sowing dates on the phenology of wheat varieties was studied by different author; found that the early sowed plants had significantly longer duration of heading than the lately sown wheat crop (Haideret al., 2003, Ghosh et al., 2004). On days to heading, there was a significant interaction effect of variety and location. The highest number of days (70.42) was obtained at the Ardayita location on Kingbird variety (Figure 1). This could be related to the amount of rainfall received at Ardayita was higher than Gonde which imply that as the availability of moisture high the crops stay to increase their growth rather than going to completing their phenology.

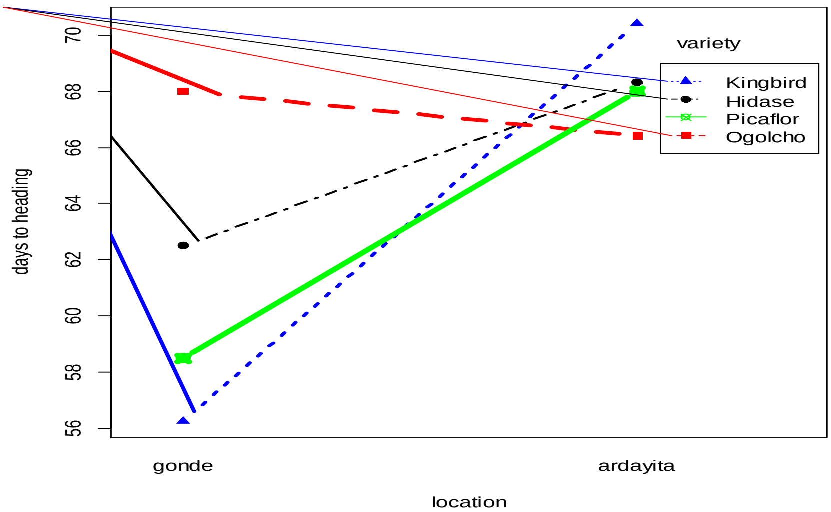

Figure 1. Interaction effect of varieties with location on date of heading

Days to heading also significantly influenced by the sowing date. Early sowing (June-17) received the highest number (67.00) of days to heading, while the minimum (62.49) days to heading was recorded on lately sowing date (July-18) (Table 3). This could be due to the crop can obtain water for longer days, it takes a longer time to form a head, but the late sown date was faced with a short period of time to receive rainfall, and the temperature increased as the rainfall volume decreased, forcing the crop to minimize the duration of heading. This finding is consistent with others study, who stated that in late-sown wheat variety; the time of anthesis formation is reduced, resulting in photosynthetic efficiency stress owing to temperatures above the optimum (Tewolde, 2006). The deposition of carbohydrates decreased as the season became dry and the rainfall volume decreased, owing to the continual rise in temperature (Hurkman,2003). On the day of heading, there is also a substantial interaction effect of location and sowing date. The maximum days (72.00) were observed at Ardayita on the early sowing date (June-17), whereas the minimum days 60.5 and 60.00 were recorded at Gonde on July-18 and June-28, respectively (Figure 2).Genotypes that head sooner are reported to be able to handle heat stress brought on by late sowing conditions, which helps to prevent yield loss and is thought to result in higher yield (Wang, 2011). Early heading causes the grain filling period to be relatively longer. This enables the crop to store more photosynthate and boost energy storage, which will partially offset yield loss brought on by heat stress (Kajla, 2015).

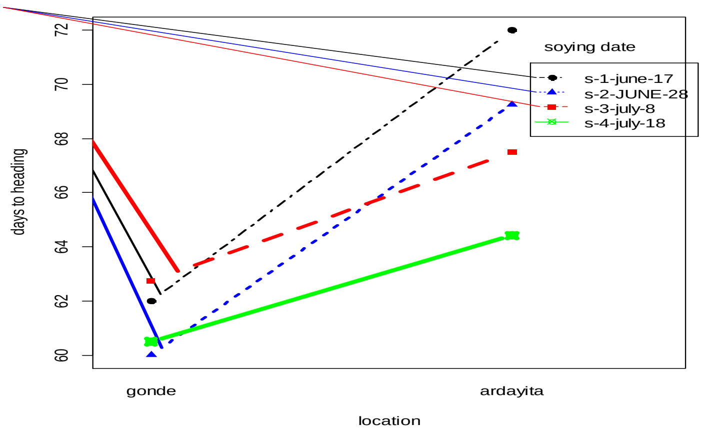

Figure 2. Interaction effect of sowing date with location on date of heading

Date of maturity

The maturity dates of the two locations varied significantly. The longer (116.17) days was recorded at Ardayita, whereas Gonde was recorded (107.67) days (Table 3). It means that the length of the rain and the temperature have a direct effect on the maturity date. On the other hand, climatic conditions can hasten or delay the physiological process of growth, if the temperature is high, the crop is forced to mature to escape the harsh conditions, or if it can gate sufficient amount and longer time of rainfall, the physiological process of growth will be extended. This result is coincide with climatic data recorded during the experiment which is presented in table 2 indicates 189.1mm amount of more rainfall was received at Ardayita than Gonde place.

The effect of variations on days to maturity of varieties was significant. Ogolcho variety had the highest maturity (120.04) days, followed by Hiddase (112.50) days, while Picaflore variety had the lowest maturity (106.67) days, which is insignificant difference with Kingbird variety (108.46 days) (Table 3).The reason could be attributable to genetic and physical differences between the genotype as a result of a change in the maturity period., a wheat variety was observed as not being greatly impacted by days to maturity (Inamullah, 2007). Date of sowing has a significant effect on maturity date. The highest number of days (116.96) was recorded on June 17 sowing date, while the lowest number of days (107.25) was recorded on July 18 which is the most lately sown date (Table 3). When compared to lately sown wheat, the early sowed crop can receive the longest duration and highest amount of rainfall. Crops develop vigorously in a favorable environment and mature later due to a sufficient amount of resource availability. This finding is consistent with; other report found that as the sowing date moved from October 25 to December 25 with a ten-day interval, the sowing maturity date reduced linearly (Inamullah, 2007). In Pakistan's early wheat seeding was reported to have increased days to maturity (Subhan, 2004).

Table 3. Effect of sowing date of wheat varieties on phenology and growth

Experimental factor	Treatment	Date of heading	Date of maturity	Grainfilling period	Plant height
Location	Gonde	61.31b	107.67b	46.52a	0.9977a
	Ardayita	68.29a	116.17a	48.08a	0.9856a
CV		6.82	5.23	16.34	10.47
LSD		1.80	2.39	NS	NS
Varieties	Hidasse	65.42ab	112.50b	47.00b	1.03b
	Ogolcho	67.21a	120.04a	53.25a	1.11a
	Picaflore	63.25b	106.67c	45.63b	0.93c
	Kingbird	63.33b	108.46c	43.33b	0.89c
CV		6.82	5.23	16.34	10.47
LSD		2.54	3.38	4.46	0.0599
Sowing date	Sowing dated-1(JUNE-17)	67.00a	116.96a	49.96a	0.94b
	Sowing dated-2 (JUNE-28)	64.63ab	110.75b	48.92ab	1.06a
	Sowing dated-3 (July-8)	65.13a	112.71b	45.63ab	1.02a
	Sowing dated - 4(July-18)	62.49b	107.25c	44.71b	0.95b
CV		6.82	5.23	16.34	10.47
LSD		3.60	3.38	4.46	0.0599

Means with the same latter are not significantly different

Grain Filling Period

There was no significant variation to grain fill period of the two locations. However, the grain filling period significantly vary among the varieties. The Ogolcho variety had the highest number of days (53.25), while the remaining three varieties Hiddase, Picaflore, and Kingbird had the lowest number of days 47.00, 45.63, and 43.33, respectively, and they don't have significant difference among them (Table 3). Because of changes in resource allocation and distribution to the sink organ, genetic differences across varieties have an effect on the duration of grain filling. The more vigorous cultivars have longer days, but the less vegetative and early maturing varieties hasten the grain filling process. In accordance with this, other researcher investigated that there is a substantial variation in the duration of the grain filling phase between two wheat crop varieties shows significant difference (Shirinzadeh, 2017).

The date of sowing has a significant variation on date of grain filling. The earliest sowing date (June 17) has the longest date (49.96), while the most lately sown date (July 18) has the shortest (44.71) duration (Table 3). This may be the optimal temperature and moisture during early sowing, but as the dates go, the temperature rises and the moisture decreases, affecting the grain-filling period significantly. As the length of the rainy season lengthens and the amount of rain received increases, the grain filling time lengthens as well. As a result, earlier sown seed takes longer duration to fill the endosperm, whereas recently sown grain will experience moisture stress as the rainy season retreat. According to a study conducted at Ardebil's research and training facility in Mogha, grain filling time reduced linearly as the sowing date of the wheat crop progressed from early to late November, 6 and 21 December (Arduini, 2006). Additionally, it was shown that the time grain fills in wheat shortens as temperature rises (Wheeler, 1996).

Plant Height

Plant height was not significantly affected by location. There was a significant variation in plant height among varieties. The Ogolcho variety had the highest plant height (1.11m), followed by Hiddase (1.03m). Kingbird and Picaflore varieties had the shortest plant heights of 0.89m and 0.93m, respectively, with no significant difference between them (Table 3). Variation in plant height may be attributable to differences in root, stem, leaf, and internodes lengths across varieties evaluated during variety improvement, and these differences contribute to resource uptakes such as water, temperature, and nutrients, resulting in a significant influence on plant height. Wheat varieties were found to have a significant variance in plant height (Wahid, 2017). The difference in plant height among varieties could be related to differences in their genetic makeup (Iqbal, 2012). Plant height was also significantly affected by sowing dates. The maximum plant heights of 1.06m and 1.02m were obtained on the second (June 28) and third (July 8) sowing dates respectively, with no significant difference between them, and the minimum plant heights of 0.94m and 0.95m were obtained on the first (June 17) and fourth (July 18) sowing dates respectively, with no significant difference between them (Table 3). Plant growth is heavily reliant on the availability of resources such as moisture, light, and nutrients at the right moment. As a result, climatic conditions change with time, implying that the sowing date reflects the amount of rainfall and temperature dependent. The shorter growing period with late sowing was the cause of the decrease in plant height. Early-planted crops may have benefited from favorable environmental factors, such as higher temperatures and more sunlight, which led to taller plants. This finding is consistent with those, who found that the early sowing on October 20th produced the tallest plants (108.86cm) when compared to late sowing date (Wahid, 2017). Additionally, mentioned that the tallest plant originated from the earlier-related sown (Kumar et al., 2003).

Number of spike per m^2

There was a significant difference between the locations on number of spikes per meter square area. The Gonde site recorded the highest number of spike m^2 (500.97), while the Ardaite site obtained the lowest (403.06) spike per m^2 (Table 4). The Gonde location had a 19.54 percent spike number increase over the Ardayita site, suggesting that climate variations affect wheat's ability to till due to the availability of resources.

There was also a significant variation among varieties in number of spikes per meter square area. The Hidasse variety respond with the highest number (486.50) of spikes per meter square, while the remaining varieties, King bird, Ogolcho, and Picaflore, scored 443.08, 442.37, and 436.12, respectively, they had no significant differences among them (Table 4). This is owing to genetic differences that result in producing different numbers of effective tillers. According to (Shirinzadehet al., 2017), the Chamran variety with the highest spike density (577.67) and the Gonbad variety with the lowest spike density (402.08) were identified.

The amount of spikes per meter square area varies significantly on date of sowing. The highest and lowest numbers of spikes per meter square area were 510.45 and 402.66, at sowing date of June 28 and July 18 respectively (Table 4). There is a climatic variation as time progresses in terms of solar radiation intensity and rainfall amount, both of which have a direct impact on crop photosynthesis and respiration. Assimilation of high temperatures at early sowing generates high food preparation, which could promote growth and spike number per meter square (Bassuet al., 2010, Thiryet al., 2002).

Number of kernel per spike

There is a considerable variance in the number of kernels per spike between the two places. The Ardayita site had the maximum number of kernels per spike (50.05), while Gonde site obtained the lowest (44.15) kernel per spike (Table 4). This is owing to the fact that resources such as temperature, moisture, and soil condition (nutrient) vary from place to place; resulting in variations in resource consumption, allocation, and assimilation to the sink organ. There was no significant variation among varieties on number of kernels per spike. According to (Wahid et al., 2017), there were no notable differences between the varieties; however, the quantity of seeds per spike varies significantly between varieties (Reiadet al., 2007).

The amount of kernels per spike varies significantly on the date of sowing. The maximum number (50.70) was obtained on early sowing (June 17), while the lowest number (43.65) was recorded on July 8 (Table 4). This could be because as the crop matures, the light intensity and temperature increase linearly, causing male reproductive (pollen) to fail and the number of kernels per spike to decrease, whereas at an earlier sowing date, the crop receives the optimum temperature and moisture, which is critical for the proper functioning of physiological processes. This conclusion was similar to that as the date of sowing became later, the number of seeds per spike decreased(Shirinzadehet al., 2017). Accordingly, the number of seed affected as an increase in temperature above the optimum, resulting in floret abortion in lately sown wheat crops (El-Saragand Ismaeil, 2013). Additionally the number of seeds per spike increased linearly as the amount of spike dry matter increased during pollen transfer between male and female reproduction(Shirinzadeh et al., 2017).

Table 4. Effect of sowing date of wheat varieties on yield and yield component

Experimental factor	**Treatment**	**Number spike per m^2**	**Number of kernel spike^{-1}**	**1000 SW**	**Above ground biomass**	**Seed yield**
Location	Gonde	500.97a	44.15b	39.33a	1.47b	61.62a
	Ardayita	403.06b	50.05a	38.89	2.71a	60.86a
CV		12.35	10.41	4.33	12.89	11.84
LSD		22.76	1.9996	0.6924	0.11	NS
Varieties	Hidasse	486.50a	47.35a	39.12b	2.09a	64.80a
	Ogolcho	442.37b	47.41a	45.33a	2.12a	61.78ab
	Picaflore	436.12b	47.23a	36.50c	2.13a	59.17b
	Kingbird	443.08b	46.39a	35.50d	2.02a	59.23b
CV		12.35	10.41	4.34	12.89	11.84
LSD		32.23	NS	0.9792	NS	4.18
Sowing date	Sowing date-1(June-17)	436.16b	50.70a	39.04ab	2.19a	63.52b
	Sowing date-2 (June-28)	510.45a	47.42b	39.83a	2.32a	69.72a
	Sowing date-3 (July-8)	458.79b	43.65c	39.04ab	2.02b	61.02b
	Sowing dated -4(July-18)	402.66c	46.62b	38.54b	1.82c	50.72c
CV		12.35	10.41	4.34	12.89	11.84
LSD		32.19	2.8279	0.9792	0.15	4.18

Means with the same latter are not significantly different

Thousand seed weight (g)

Thousand seed weight of the two locations was not significantly affected. Results in Table 4 showed that there were significant differences in thousand seed weight among varieties. The highest 1000 seed weight (45.33g) was obtained on Ogolcho variety while king bird recorded the lowest 1000 seed weight (35.5g).Similarly, a significant difference in cultivars on mean grain weights(Naeem, 2001).

Sowing date also significantly affected thousand seed weight. The maximum thousand seed weight was obtained on June 18 (39.83 g), while the lowest seed weight was recorded on July 18 (38.54 g) which is the lately sown (Table 4). The maximum thousand seed weight was obtained on June28 might be due to the favorable and prolonged environmental conditions for vegetative growth, which led to active photosynthesis and the greatest amount of assimilates being transferred to the seeds. According to these findings, other reported that early sowing of wheat greatly increased the 1000 seeds weight as compared to late sowing (Sufyan, 2013). A shorter grain filling period under late sowing could be the cause of a drop in 1000-seed weight (Aglan et al., 2020).

Above Ground Biomass

The total amount of dry matter produced by physiological and biochemical processes in the plant system is referred to as above-ground biomass yield. Table 4 reveals that there was a significant variation in wheat crop dry matter production between locations. Ardayita site had the highest biomass (2.71tonha^{-1}), whereas Gonde site obtained the lowest biomass (1.47ton ha^{-1}). This demonstrates that the crop's photosynthesis and assimilation rate were affected by differences in climatic conditions between the two locations. On above-ground biomass, there was a strong interaction impact between location and variety. Picaflore variety yielded the maximum value (2.89ton ha^{-1}) at Ardayita site, while Kingbird variety yielded the lowest (1.27ton ha^{-1}) at Gonde site (Table 5). The above-ground biomass response varies by location due to genetic differences in the varieties' responses to various climatic conditions such as temperature, moisture, nutrient requirements, and the varieties' use efficiency of those resources. Those with a high number of leaves and leaf area to harvest the most resources may have a higher resource allocation to the sink organ, and their root biomass may have an impact on absorbing more nutrients and moisture from the soil.

Table 5. Interaction effect of varieties with location on above ground biomass

Location	**Varieties**			
	Hidasse	Ogolcho	Picaflore	Kingbird
Gonde	1.67d	1.56de	1.36ef	1.27f
Ardayita	2.51c	2.67bc	2.89a	2.77ab
CV	12.8973			
LSD	0.2200			

Means with the same latter are not significantly different

There was no significant difference among the varieties of wheat on dry matter production, but there was a significant difference on sowing date. The highest dry matter production of 2.19 and 2.32 tons per hectare were observed at the early sowing dates of June-18 and June 17, respectively, which are not significantly different between them, while the lowest (1.82ton ha^{-1}) was reported at the lately sowed date (July-18) (Table 4). This is due to the crop's ability to retain moisture for a longer period of time during its early growth stage, as well as more time to employ optimal solar radiation for photosynthesis, resulting in increased dry matter allocation. There is also significant interaction effect of sowing date and location to biological yield. The maximum 3.07 and 3.04 ton ha^{-1} were recorded at Ardayita location on the first (June-17) and second (June 28) sowing dates respectively, while the lowest 1.33 ton ha^{-1} was recorded at the Gonde location on the fourth sowing date (July-18) (Table 6). The availability of environmental conditions during plant life that aided quick development and the formation of a good canopy capable of performing effective photosynthesis may be the cause of the rise in this attribute with sown on June-17.

Table 6. Interaction effect of sowing date with location on above ground biomass

Location	**Sowing date**			
	June-17	June-28	July-8	July-18
Gonde	3.07 a	3.04a	2.43b	2.31b
Ardayita	1.3d	1.61c	1.61c	1.33d
CV	12.8973			
LSD	0.2200			

Means with the same latter are not significantly different

Seed Yield

The influence of seed yield does not vary significantly by location. The effect of varieties on seed yield was significant. Hidasse variety produced the highest seed yield (5.48 ton ha^{-1}) followed by Ogolcho (5.18 ton ha^{-1}) with insignificant difference among them, while the lowest seed yield (4.92 ton ha^{-1}) was obtained in Picaflore variety (Table 4).The difference could be due to the Hidasse variety's higher yield being related to the higher number of spikes per meter square and kernel number per spike. In contrast, (Wahid et al., 2017)found that there is no significant difference in seed production among genotypes of wheat cultivars (Mahgouband Sayed, 2001) also noted Giza 167 and Side 1 varieties were assessed and they found no significant differences in seed output. The interaction of varieties with location had significant effect on seed yield of wheat. The highest (6.00 ton ha^{-1}) yield was obtained at Gonde location on Hidasse variety, but it obtained the lowest yield at Ardayita place (Figure 3) this could be the deferent response of variety to different location. Picaflore variety attained the highest yield (5.22 ton ha^{-1}) at Ardayita and it obtained the lowest value (4.62 ton ha^{-1}) at Gonde site. These indicate that the same variety responded differently to different locations.

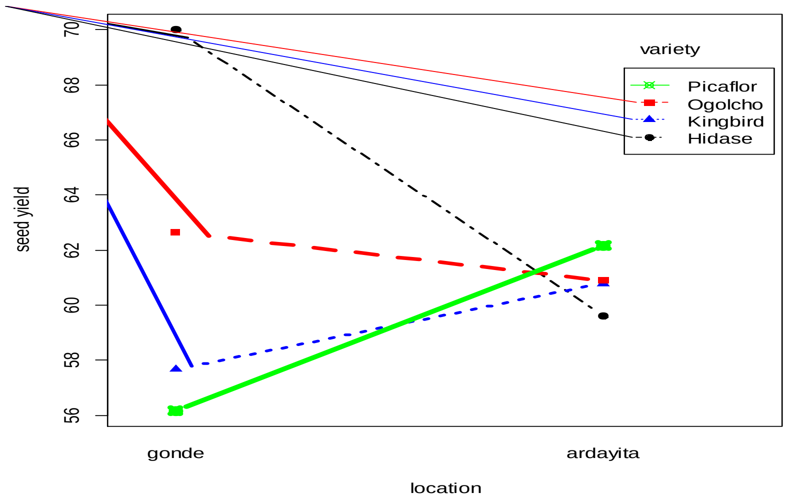

Figure 3. Interaction effects of varieties with location on seed yield

The sowing date had a significant effect on seed yield of wheat. The maximum (6.97 ton ha^{-1}) yield was achieved at the second sowing date (June-28), followed by the first sowing date (June-18) (6.35 ton ha^{-1}) with insignificant deference between them, while the lowest (5.07 ton ha^{-1}) seed yield was recorded in the lately sown date (July-18) (Table 4). The difference could be due to the quantity of effective tillers and above-ground biomass in order to have the highest yield on the second (June-28) sowing date. It was also about getting the right quantity of moisture and solar radiation at the right time throughout growth to enable the plant digest the highest amount of food and maximize the output. At the optimum sowing date (June 28) wheat crop has a 27.25 percent yield advantage over lately sowed (July 18). Different Authors demonstrated that variable sowing dates of wheat genotypes result in significant yield variation, with the second sowing date (30th November) producing the highest yield (2.63 ton ha^{-1}) (Wahid et al., 2017). Similar findings obtained by another researcher that optimum sowing date, crops results in better photosynthetic partitioning when compared to late sowing (Hameedet al., 2003, Donaldson et al., 2001). As the temperature rises steadily over the optimum in C3 plants, the yield is lowered due to photorespiration increments (Polley, 2002). There was significant interaction effect of sowing date and varieties on seed yield of wheat crop. From the Figure 4 showed that all varieties sowed in sowing date two (June-28) gave highest yield. From these, Hidasse obtained in sowing date two (June-28) performed higher yield over the others. In a field study, found that early sowing led to greater grain yields overall and enhanced wheat straw output when compared to mid- to late-sowing dates (Tammam, 2004).

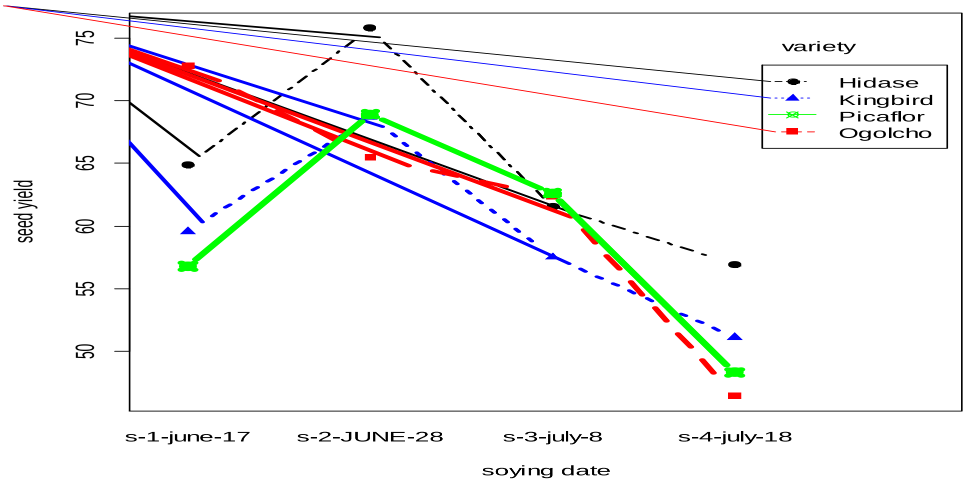

Figure 4. Interaction effects of varieties with sowing date on seed yield

Sowing date and location also significantly interact on grain yield of wheat. The maximum (6. 38 ton ha^{-1}) seed yield was recorded at Gonde location to the second (June 28) sowing date and followed by the first sowing date, June 17 (5. 82 ton ha^{-1}) at Ardayita without significant difference with sowing date June 28 while the lately sown (July 18) was obtained the minimum (38.83Qt./ha) yield at Gonde site (Table 7).

Table 7. Interaction effect of sowing date and location on seed yield

Location	**Sowing Date**			
	June-17	June-28	July-8	July-18
Gonde	48.83c	63.83a	55.00b	38.83e
Ardayita	58.21ab	55.60b	547.0cd	42.60de
CV	11.83594			
LSD	5.915657			

Means with the same latter are not significantly different

CONCLUSION

Sowing wheat on optimum time according to environmental conditions is the best way to increase growth and yield. Within a species, crop varieties may differ significantly in terms of a number of morpho-physiological traits. According to the result, there was a significant difference between the two locations on date of heading, date of maturity, number of kernels spike^{-1} and above-ground biomass. On the other hand, location had no effect on the grain-filling duration, plant height and seed yield. There is significant interaction effect of sowing date and location to biological yield. The maximum 3.07 and 3.04 ton ha^{-1} were recorded at Ardayita location on the first (June-17) and second (June 28) sowing dates respectively, while the lowest 1.33 ton ha^{-1} was recorded at the Gonde location on the fourth sowing date (July-18). The interaction effect of variety and sowing date showed that all varieties obtained in sowing date June 28 gave highest yield except Ogolcho variety obtained highest yield at the first sowing date (June 17). Hidasse variety in sowing date June 28 performed higher over the others. In general, from the result Hidasse variety performs highest on the second sowing date (June 28) whereas the Ogolcho variety performs better at the first sowing date (June 17) in both locations.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ACKNOWLEDGEMENTS

Authors would like thanks Ethiopian Agricultural Businesses Corporation, Ethiopian Seed and Natural Forest Supply Sector for their unreserved support of research land and other required materials.

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