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Determination of the Optimum Sowing Date of Chickpea (Cicer arientinum L.) Under Rain Fed Condition

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Abstract
A field experiment was conducted in Guraghe zone Meskan and Sodo districts, from August 2013 to February 2014 on farmers' fields with objectives of investigating effects of seven sowing dates namely Mid to late August (23/08/2013), late August (30/08/2013), Early September (06/09/2013), Mid September (13/09/2013) Mid to late September (20/09/2013) Late September (27/09/2013) Early October (04/10/2013) on growth and yield components of chickpea variety Habru (FLIP 88-42c). The trial was carried out with RCBD design with three replications in each of the sites. Results showed mean squares of plant height, grain yield and growth duration were significant unlike that of seeds/pod, branch number/plant and hundred seed weight. Plants from early sown plots were 13.8 cm and 36 days taller and older than plants from later sowings, respectively. Similarly, disease incidence was significantly higher ($p<0.05$) in earlier sowings than that of later once. Consequently, grain yield due to Mid September sowing resulted in significantly higher ($p<0.05$) yield (24.7 q/ha) compared to either early October (14.8 q/ha) or early August (15.1 q/ha) sowings. The harvest index showed that resource use efficiency and partitioning between growth and yield components was maximized in September sowings. Thus this study revealed that neither early nor late sowing are suitable for chick pea production under rain fed conditions of Guraghe zone.
Keywords: Chickpea, sowing date and growth duration

1. Introduction
Chickpea (*Cicer arientinum* L.) is exotic legume crop originated in Eastern Turkey and neighboring Syria. When it comes to Ethiopia, it grows in northern, central and Eastern highlands already becoming the third most widely cultivated food grain legume next to common bean and soybean. It belongs to the *Leguminosae* family and is C3 crop with diploid chromosome number (2n=24) having self pollination mode of reproduction. According to Shiferaw *et al*. (2007) Chickpea provides unique opportunity of enhancing legume production in Africa and in Ethiopia as it does not compete for area with other major legumes since it grows in residual moisture. As a result, growing chickpea allows the farmers to produce extra crop each year. However, the production system is not adequately market-oriented and competitiveness of smallholders is limited by low productivity.

Despite its potential yield of more than 3 ton $ha^{-1,}$ current chickpea productivity is only 1.6 ton ha-1 in Ethiopia. This is mainly because of lack of adapted varieties suitable to growing conditions, poor crop management practices, inappropriate seeding rates, traditional methods of tillage and conventional sowing dates. Furthermore, chickpea is seriously affected by time of sowing since it is commonly grown on residual moisture preserved in the soil (Summerfield et al., 1990). Chickpea planted during rainy season suffers from water logging (high moisture stress) and soil born diseases while when late planted it may suffer from low water moisture stress during germination and plant establishment (Geletu and Abebe, 1982). Hence this field experiment was implemented with objective of determining the appropriate sowing date of chickpea in the study areas.

2. Materials and methods
A field experiment was conducted in Meskan and Sodo districts of Guraghe zone from August 2013 to February 2014 to determine the effect of sowing dates on growth, yield and yield components of chick pea in rain fed condition. The treatments comprised of seven sowing dates namely mid to late August (23/08/2013), late August (30/08/2013), Early September (06/09/2013), mid September (13/09/2013) mid to late September (20/9/2013) Late September (27/09/2013) Early October (04/10/2013). The experimental design was randomized complete block design with three replications. The plot size was 2.1m (*7*rows x 0.3m) x 4m (40 plants x 0.1m). Sowings were done every day after land preparation by taking notes to soil moisture and applying recommended 100kg/ha DAP, which was drilled in a row and incorporated with the soil before sowing. Habru (*Flip 88-42C*) chickpea variety was used as the experimental test crop. The phonological data were recorded at 50% emergence, flowering and physiological maturity. Plant height was measured from the soil surface to the longest top leaf at physiological maturity. Growth duration was calculated by counting the dates between emergence and physiological maturity. Disease incidence was scored in plot basis using 1to 9 scale were 1 indicate absence of disease (healthy plants) and 9 indicate severe disease incidence. Pods per plants were counted by selecting five plants randomly in a net plot area and their average was recorded as number of pods/plant. Seeds per pod were recorded by randomly selecting five pods per plant from net plot area and

counting the number of seeds in each pod and then taking average of it. Number of primary branches per plant was measured from randomly selected five plants by counting branches emerging from main stem at physiological maturity. The total biomass (grain plus straw) was recorded by measuring all plants of net plot area using hanging balance prior threshing the grains. Grain yield was estimated by sun drying grains and weighing harvested grains from net plot area. Hundred seed weight was measured by picking hundred seeds randomly from threshed grain yield of net plot area and weighing them using sensitive balance. Harvest index was calculated by dividing grain yield to the total biomass of respective net plot area and recorded on treatment basis. Straw yield was measured by subtracting grain yield per plot from respective biomass and converted to hectare basis.

3. Result and Discussion

3.1 Mean squares

Result of mean square revealed that there was more response of growth and yield components of chickpea in Meskan than that of Sodo (Table 1&2). This was manifested in mean squares of grain yield, pod/plant, branches/plant and plant height. This could be attributed to better soil conditions in Meskan compared to that of Sodo. The significant response of replication for branches, biomass, hundred seed weight, grain yield and growth duration, and also increased magnitude of response due to treatments testifies the strength of treatment effects.

Table 1. Mean squares of growth and yield components of chickpea

Source	Seeds /pod	Plant height	Branches /plant	Pods /plant	Biomass	HSW	Grain yield	Growth Duration
Replication	0.280ns	91.1ns	5.38*	2802.2ns	1.24*	12.4*	75093.3**	22.5*
Treatment	0.028ns	95.5*	3.43ns	2088.2ns	0.58ns	3.4ns	313050.9*	184.9***
Error	0.024	27.9	1.39	3611.8	0.29	2.7	90400.513	6.09
CV(%)	12.06	11.3	12.01	46.53	14.58	5.7	18.41	2.16

CV=coefficient of variance, *, **, *** shows significant, highly significant and strongly significant.

Table 2. Mean Square of growth and yield components of chickpea at Guraghe Sodo

Source of variation	Grain yield	Pods/plant	Branches/plant	Plant height
Replication	10.2ns	878.4ns	0.53ns	29.4*
Treatments	92.3ns	946.6ns	1.33ns	13.7ns
Error	41.3	496.6	1.42	5.5
CV (%)	24.21	24.8	23.88	5.81

CV=coefficient of variance, ns= non significant, *=shows significant

3.2. Soil conditions during sowing

As a matter of fact there was variation in soil moisture during land preparation and sowing in both Meskan and Sodo districts. Some soils were wet while other was moist and still others were dry (Table 3). Consequently the emergence during early stage of growth has ranged between poor (in mid august sowing) and excellent (in later once) (Table 4).

Table 3. Soil conditions in Meskan and Sodo during chickpea growth under rain fed conditions

Treatments	Sowing	Growth	Harvest
1. Mid to late August (23/08/13)	Wet	Moist	Dry
2. late August (30/08/13)	Wet	Moist	Dry
3. Early September (6/9/13)	Moist	Moist	Dry
4. mid September (13/9/13)	Moist	Moist	Dry
5. mid to late September (20/9/13)	Moist	Moist	Dry
6. Late September (27/9/13)	Dry	Dry	Dry
7. Early October (04/10/13)	Moist	Dry	Dry

Table 4. Farmers' assessment of treatment performance during different growth stages of chick pea in Meskan

Treatments	Emergence	Growth	Harvest
1. Mid to late August (23/08/13)	Poor	Poor	Poor
2. late august (30/08/13)	Medium	Medium	Excellent
3. Early September (6/9/13)	Excellent	Medium	Excellent
4. mid September (13/9/13)	Medium	Medium	Medium
5. mid to late September (20/9/13)	Good	Good	Medium
6. Late September (27/9/13)	Good	Good	Poor
7. Early October (04/10/13)	Excellent	Excellent	Medium

Table 5. Land preparation in Meskan for chick pea sowing

Treatments	1st tillage date	2nd tillage date	3rd tillage date	Sowing date
1. Mid to late August (23/08/2013)	23/06/2013	09/08/2013	23/08/2013	23/08/2013
2. Late august (30/08/2013)	23/06/2013	09/08/2013	23/08/2013	30/08/2013
3. Early September (06/09/2013)	23/06/2013	09/08/2013	23/08/2013	06/09/2013
4. mid September (13/09/2013)	23/06/2013	09/08/2013	23/08/2013	13/09/2013
5.Mid to late September (20/09/2013)	23/06/2013	09/08/2013	23/08/2013	20/09/2013
6. Late September (270/9/2013)	23/06/2013	09/08/2013	23/08/2013	27/09/2013
7. Early October (04/10/2013)	23/06/2013	09/08/2013	23/08/2013	22/01/2013

3.3 Growth Durations and Plant Height

The response of plant height to effects of sowing dates under rain fed condition was significant (P<0.05) in Meskan unlike that of Sodo district (Table 6 and 7). The tallest plant (54.5 cm) was due to late August sowing where as the shortest plants (38.1 cm) were due to sowings in late September. However, plant height due to mid August to early September sowings were statistically invariable. When growth durations are considered, there was a significant variation (p<0.05) due to sowing dates. Mid to august sowing stayed in the field for 134 days unlike the early October sowing which stayed for only 98 days. However, the response of disease score was significant in Meskan to effects of sowing dates. Significantly severe infestations were observed due to early sowing compared to late sowings with degree of incidence becoming reduced as dry season begins. Especially, *Fusarium* wilt incidence has been observed in most plots where sowing was carried out in August (Table 6). The abundance of disease in early sowings is in line with findings of Moore *et al*. (2011) who found significant fungal disease treat in earlier sowings. Moreover, Sheleme *et al.* (2013) identified the existence of *Fusarium* wilt incidence during growth period. Late seeding result in shorter plants, late-formed flowers and pods and reduced grain yield.

Table 6. Means of growth and yield components of chickpea in Meskan

Treatments (Sowing Dates)	Ph (cm)	SP	BP	PP	BM (q/ha)	HSW (g)	GY (q/ha)	St(q/ha)	GD (Days)	DS	HI
1. Mid to late August (23/08/13)	52.7	1.28	7.20	26.5	51.20	26.00	15.10	36.10	134	2.53	0.28
2. late august (30/08/2013)	54.5	1.26	8.20	70.1	53.60	27.10	21.20	32.40	126	1.65	0.39
3. Early September (06/09/2013)	50.7	1.29	5.80	194.0	41.60	29.10	16.80	24.90	116	1.78	0.39
4. mid September (13/9/2013)	50.0	1.33	6.20	131.0	50.00	28.20	24.70	25.30	112	1.78	0.49
5.Mid to late September (20/9/2013)	38.1	1.40	4.20	166.0	44.00	28.90	21.30	22.70	113	0.30	0.48
6. Late September (27/9/2013)	40.7	1.40	5.10	115.5	39.30	30.90	22.20	17.10	100	0.00	0.56
7. Early October (04/10/2013)	41.7	1.40	4.70	200.2	30.90	30.40	14.80	16.10	98	0.30	0.43
LSD	13.8*	NS	NS	NS	NS	NS	9.39*	NS	6.5*	2.33	0.18*
CV (%)	11.3	12.06	20.1	46.53	14.58	5.69	18.41	20.59	2.16	29.3**	16.00

Ph=plant height, SP= seeds per pod, BP= branches per plant, PP= pods per plant, BM= biomass, HSW= Hundred seed weight, St= straw weight, GD=growth duration, DS=disease score, HI= harvest index *, **- shows significant difference at 5 and 1% of probability, ns=non significant, LSD=Least significant difference, CV=Coefficient of Variance

3.4. Yield and yield components

The response of seeds/pod, branches/plant, biomass/plot and 100 seed weight were not significant (p<0.05) to direct effect of sowing dates in both Meskan and Sodo. However, the response of grain yield was significant in Meskan to effects of sowing dates. The results show that mid September sowings produced the highest grain yield (24.7 q/ha) compared to mid August (15.1 q/ha) and early October (14.8 q/ha) sowings. The superior performance of mid to late September sowings were due favorable soil moisture and low disease pressure (Table 1 & 7).

Chickpea straw production was highest with earliest sowing dates and conversely the least straw yields were measured due to latest sowing dates. Straw yield decreased linearly as sowing dates were delayed. However, grain yield increased as sowing dates were delayed until mid September sowing and then grain yield started to decrease linearly (Table 7). As Thus August (early sowing) resulted in higher vegetative growth and lower grain yield in case of Meskan. However, October sowings resulted in lower vegetative growth and lower grain yield. Even so, the grain yield and straw yields were judiciously partitioned between growth and yield components in September sowings. This depicted that partitioning of assimilates to vegetative (straw) and reproductive (grain) growth components was optimized with Mid September sowing in the study area.

Table 7. Growth and yield components of chickpea (Sodo district)

Treatment	Grain yield (Q/ha)	Pods/plant	Branches/pod	Plant height (cm)
1. Mid to late August (23/08/2013)	32.8	108.5	5.2	39.7
2. late august (30/08/2013)	19.5	69.1	4.9	38.6
3. Early September (06/09/2013)	18.2	95.2	4.9	42.3
4. mid September (13/09/2013)	30.2	118.6	6.1	43.7
5. mid to late September (20/09/2013)	25.6	77.3	5.0	39.7
6. Late September (27/09/2013)	31.2	84.7	5.1	42.0
7. Early October (04/10/2013)	28.4	75.2	3.8	37.1
LSD	NS	NS	NS	NS
CV (%)	24.21	24.81	23.88	5.81

NS=non significant, LSD=Least significant difference, CV=Coefficient of Variance

3.5 Association of traits

Positive and strong significant association occurred between plant heights and number of branch ($p<0.001$, $r^2=0.752$), plant height and disease score ($p<0.001$, $r^2=0.556$),number of branch and pods per plant ($p<0.01$, $r^2=0.501$), number of branch and growth period ($p<0.01$, $r^2=0.618$), pod per plant and growth period ($p<0.01$, $r^2=0.458$), biomass and grain yield ($p<0.001$, $r^2=0.789$).This shows that increase in plant height and number of branches increases biomass of the crop which in turn accounts for enhanced grain yield. Conversely strong significant negative association was observed between seeds/pod and disease score ($R^2 = -0.496$, $p<0.05$), seeds/pod and growth period ($R^2 = -0.514$, $p<0.05$) and grain yield and disease score ($R^2 = -0.499$, $p<0.05$)

This depicts that crop disease like *Fusarium* wilt recorded in Meskan adversely affects most yield components including seeds/pod and grain yield, and also the longer stay of the crop in the field doesn't necessarily warrant increased number of seeds per pod or increased grain yield. The lower grain yield was resulted from higher disease incidence, lower seeds/pod and longer growth period, which was intern due to early sowings which took longer time for physiological maturity (Table 8).

Table 8. Coefficient of correlation (R^2) of chickpea in Meskan (n=21, R^2=0.624)

	PH	NB	PP	BM	HSW	GY	SP	GP
PH	1.00							
NB	0.75***	1.00						
PP	0.37	0.50*	1.00					
BM	0.41*	0.11	-0.18	1.00				
HSW	-0.30	0.01	-0.05	-0.35	1.00			
GY	0.16	-0.06	-0.12	0.76***	0.00	1.00		
SP	-0.24	-0.28	-0.34	0.26	0.24	0.28	1.00	
GP	0.55**	0.61**	0.46*	-0.08	-0.41	-0.39	-0.51*	1.00
DS	0.55***	0.55*	0.55	-0.18	-0.35	-0.49*	-0.49*	0.78***

PH= plant height, NB= number of branches per plant, PP=pods per plant, BM=biomass, HSW=hundred seed weight, GY=grain yield, SP=seeds per pod, GP=growth period, DS= Disease score

4. Conclusion and Recommendation

Early sowings are in the growing season was affected by f*ussarium* wilt disease. So, farmers growing early should accompany drainage measures or crop disease control option in order to reduce yield reduction. Although it is difficult to recommend depending on a single year data, the current finding showed that neither early nor late sowing dates are suitable under rain fed conditions in the study area. However, mid to late September sowing would enhance the productivity of chickpea. Optimum resource use (carbon dioxide, water, sun light and nutrient) resulting in average vegetative growth (rather than maximum) was useful for maximization of yield and yield components of chickpea under rain fed growing condition of Meskan and Sodo districts. Under growing conditions of Meskan and Sodo districts, the traits dominantly and directly responsible for increased grain yield of chickpea was biomass and indirectly were number branches, pods/plant and plant height.

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