*Int.J.Curr.Res.Aca.Rev.2015; 3(8): 309-324*

EXCELLENT PUBLISHERS

*International Journal of Current Research and Academic Review*

**ISSN: 2347-3215 Volume 3 Number 8 (August-2015) pp. 309-324**

www.ijcrar.com

# Effects of Planting Date on Performance of Common Bean (*Phaseolus vulgaris* L) Landraces of the Jos Plateau: A preliminary studies

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**KEYWORDS**

Planting date, Landrace, Interaction effects, Common bean, Morphor-agronomic, Traits

**A B S T R A C T**

Field experiment established to study the performance of nine common bean (*Phaseolus vulgaris* L) landraces grown on the Jos - plateau, over three planting dates. A Randomized Complete Block Design (RCBD) with three block was used.The study aimed at aiding selection for optimum planting date with respect to plant growth, development and yield performance under the existing environmental conditions The common bean landraces were: Bakin wake, Jan wake, Ngogot, Dan gora, Chanlet, Kwakil, Dan baga, ambul -1 and ambul-2. The effects of Planting dates on the performance of the accession lines and the interaction between the planting dates and individual genotypes on plant height, number of leaves per plant, number of primary branches per plant, stem collar girth, pod yield (kg/ha), seed yield (kg/ha), 100 seed weight(g) and dry matter yield(kg/ha) were statistically significant at p=0.05. Morphological and yield attributes were highest in May followed by August planting. The landraces namely : Ambul-1, Chanlet, Dan baga,Dangora, kwakil, Bakin wake and Ngogot recorded appreciable performance in all traits investigated while Ambul-2 recorded very low height and least in performance. Early planting in May is suggested and some furtherresearch investigation recommended.

## Introduction

The common bean (*Phaseolus vulgaris L) is* a member of the family Fabaceae, the genus phaseoleae, which includes over 150 species ( Baily, 1960 in Rania, 2010). The five widely cultivated are: *P.vulgaris*-common bean; *P.coccineus*-scarletrunner bean; *P.lunatus*-Lima bean; *P.acutifolius*-Gray, Tepray bean and *P. polyanthus*-Greenman year bean (Allaby, 1998; Norman *et al.*, 1995). Studies have shown that of all edible legumes *Phaseolus* vulgaris L have the widest geographical distribution (Norman *et al.*, 1995). The protein-rich seeds of common bean and its immature pod and leaves are an important food source worldwide (Salehi *et al.*, 2008; Adesoye and ojobo, 2012; Messina, 1999; Rosa et al., 1998; Anderson *et al.*, 1998; Bazzano *et al.*, 2001; Hangen and Bennick, 2002; Geil and Anderson, 1994 and Heimler *et al.*, 2005. The common bean as a food legume has been domesticated by evolution from a wild plant in the highlands of Middle America and the Andes into a major leguminous food crop, grown worldwide in a broad range of environments and cropping systems (Gepts and Debouck, 1991; Purseglove, 1988).The crop was introduced into Africa and other parts of the world by the Spaniards and the Portuguese (Rania *et al.*, 2010) The optimum temperature range for optimum bean growth is 16- $30^0$C (Nonnecke, 1989). The bean performs poorly in hot, wet and humid weather which results in flower and pod shedding and grow well in loamy soil, clay loam or sandy loam rich in organic matter and insensitive to day lengths (Norman *et al.*, 1995). The growth could be improved by its sowing on the proper date (AyoubandAbodalla,2014). Its water requirements is about 300-400mm per cropping cycle and seed maturation occurs during the dry weather (Norman *et al.*, 1995; Emam *et al.*, 2010).

The common bean is an annual species with typical out crossing rates less than 5% (Graham and Ranalli,1997). It is a morphologically diverse crop with large variation in growth (Singh *et al.*, 1991). The plant is classified base on the determinance of the main axis, growth habit, crop duration and seed characteristics.The plant may be erect, semi climbing or climbing while crop duration ranges between 75 days in the bush types to about 270days for the late maturing (Purseglove,1988). According to Food and Agriculture Organization Statistics (2008) common bean is globally grown in nearly 28 million ha and produced about 20 million metric tons. Its average yield in the world ranged from 493kg in 1961 to 729kg/ha in 2008 and still on the increase (Hala*et al.*, 2011). The leading dry beans producers by country as at 2007 are : Tanzania-0.5; Kenya-0.4; Argentina-0.4 and Uganda-0.3 (FAOSTAT, 2009).

Yield of common bean is appreciably low, this could be attributable to the very low research interest and efforts in terms of crop production and improvement which is still at its lowest level in Nigeria compared to other grain legumes such as cowpea, soybeans, groundnut etc. This less emphasised grain legume has been found to have nutritional significance in farming communities where farmers still cultivate traditional varieties of this crop for their nutritive, culinary and organoleptic values as well as source of income.(NACGRAB/FDA,2008).This class of plant are crucial to the balance of nature by producing a great mass of biologically nitrogen fixing organism into the soil, hence, could enabling vast land to be brought into arable cultivation. The extent of this untapped crop potential is exemplified by the fact that in spite of the multi-purpose and versatile nature of pulses like *phaseolus vulgaris L*. this crop is still classified as a minor food crop relative to other cereal (Sorghum, maize, millet) and tuber crops (yam, potato, cocoyam) etc., the crop is not clearly captured or even registered as a mandate crop to any of the various crop base national agricultural research institute in the country (NACGRAB/FDA, 2008). Thus, causing a dearth in literature relating to the crop local agronomy in terms of the optimum growth and development requirement, its socioeconomic trends in farming communities, domestication and yield records. Although, some references have been made to the use of common bean in human and animal feed. However, in order to boost production and meet demand, it is highly important to adopt strategies to increase yield of common bean per unit area of land. Therefore, the nine genotypes (landraces), used in this study with the aim of getting optimal planting datesso as to accurately synchronize rainfall incidences for the correct crop phenology, as well as,how the morpho-agronomic characters interact with one another in affecting yield components and aid in selecting better genotype with respect to growth, development and yield performance., under the existing environmental conditions.

## Materials and Methods

A total of nine landraces of *P. vulgaris* L comprising Bakin wake, Kwakil Jan wake, Ngogot and Dan gora collected from Mangu Local Government Areas (LGA) on long.9° 29′ N, lat. 9° 08′ E. altitude 1134m ( genotypes-) and Chanlet, Dan baga, Ambul-1 and Ambul-2 collected from Bokkos Local Government Areas (LGA) on long.9° 17′ N, 8° 59′ E. altitude 1334m.,) of Plateau State, all within the mid-altitude agro-ecological zone.

2kg each of seeds of the accession lines were cleaned and subjected to simple seed viabibiltytest using floatation process Seed recovery was done using the aluminium screening mesh bowl to separate and discard the liquid portion. The seeds were spread on nine separate laboratory trays for each accession type and left to dry under the ambient room temperature (tempering) for 2days.

The experiments was conducted during 2012 wet cropping seasons at the Teaching and Research field of the Forestry Research Institute of Nigeria (FRIN), Federal College of Forestry, Jos Plateau State ( 09°56'N, 08°53'E altitude of 1,217M (Table 1). within the Northern Guinea Savanna ecological zone of Nigeria (Kowal and Knabe, 1972).A Randomized Complete Block Design (RCBD) with three block and nine genotypes were used.The land preparation were carried out manually and began by clearing the plot of land previously under fallow at the various experimental locations. The experimental gross plot size of 140.4m$^2$ (23.4m x 6m) were used. The required areas were marked out and made into nine plot of bed raised about 25cm from the ground using a hoe, and measured 1.8m long and 1.2m wide in each block. 0.6m spaced boarders were maintained for each plot per block respectively. The soil type is sandy loam in each plot(Table 2). The seeds were treated with a fungicide Apron-plus as recommended by ICS-Nigeria (2010), at recommended rate and sown at the three planting dates of on 1$^{st}$ May, August 14$^{th}$and 14$^{th}$September,respectively..Four seeds were sown per planting hole at spacing of 45cm x 60cm and plan were thinned to one plant per stand after germination at 2WAS (Weeks After Sowing) and gave total of 12 plant stand per plot of 3 rows of 4 plant per row and a total of 55,555 plant population per ha respectively. NPK 15-15-15 inorganic fertilizer were applied at the rate of 100kg/ha as a starter dose to the crop at the determined quantity of 0.13g per plot, at 2WAS after thinning operation while single super phosphate (18 % $P_20_5$ ), were applied at the rate of 30kg/ha according to ICS-Nigeria (2010), at the determined quantity of 36g per plot, according to Avav and Ayuba (2006), at the 4,6 and 8 WAS respectively. The Insect pests were controlled by the combined application of insecticides: (Cypermethrin plus Dimethoate) - Best Action and (Lamdacyhalothrine 25 EC ) - Karate 2.5 EC, at the recommended application rates of 1 L /ha, using 75 mL in 15-L knapsack sprayer and 0.8 L/ha, using 40 mL in 15 – L knapsack sprayer respectively according to Avav and Ayuba (2006), which started at 2WAS and were continued at weekly interval from the sixth week after sowing until harvest. Adequate farm sanitation was maintained by manual weeding regularly at two, four and six week's interval, using a hoe and complemented by hand pulling as the weeds appeared until the crops were harvested respectively.

## Data collection and analysis

To eliminate the border effect between the plots, observations were recorded on five (5) randomly selected plants per plots at 50% flowering and evaluated on the basis of morpho-agronomic traits as described below. Data was analysed according to the procedures in Genstat 7.1 version and SPSS, version 16.0. Combined analysis was performed and mean separation carried out using Duncan`s multiple range test at 5% level of probability (P=0.05):

1. Plant Height (cm): This was obtained by measuring the height of sampled plants in each sub plot, the Measurement was carried out from the base of the plant to the terminal point using a ruler. The values obtained were added together and divided by the total number of plants and expressed as the mean plant height in centimeter (cm).
2. Plant Stem Girth: This was determined by wounding a thread round the plant and placing the thread on a graduated meter rule to take the reading and obtain the circumference. All measurement were added together and divided by the total number of plants measured and recorded in centimeter (cm).
3. Number of leaves per plant: This was done by counting and adding together the number of leaves on the sampled plants and divided by the total number of plant.
4. Number of primary branches: The number of primary branches was obtained by counting all the primary branches arising from the main stem on every sampled plant. All the counts were added together and divided by the number of plant sampled and expressed in numbers.
5. 100 Seed weight: This was determined by measuring the weight of 100 seeds harvested from the sampled plants per plot in randomized procedure and expressed in grams (g).
6. Mass of Dry Matter Yield: This was determine by weighing of leaves, twigs and parts of roots of all plant after harvesting completely from each plot express in kg/ha.
7. Computed pod and seed yield per plot expressed in yield/ha: pod and seed yield for the various accessions lines was estimated in kilogram per hectare (or kg/ha) by obtaining the total pod and seed yield for each accessions by dividing the plot yield **($X_{ij}$)** by the plot area **($Y_{ij}$)** harvested and multiplied by

$$\frac{10{,}000m^2}{1000}$$

The total pod andseed yield per plot expressed in kg/ha $\frac{X_{ij}}{Y_{ij}} x \frac{10{,}000\,m^2}{1000}$

Where: **Xij** = the yield of the ith genotype in the jth block.

**Yij** = the area of the ith plot in the jth block

## Results and Discussion

The rainfall and other key environmental factors varied considerably across the months especially between April and October (Table 1). The planting dates represent the wide range of growing condition existing for the expected yield potential in the environment. The soil type is sandy loam with varied nutrient element status (Table 2). The interaction involving genotypes and planting dates varied on both the morphological and yield attributes. The mean indicates the magnitude of response of individual genotypes to the existing biotic and abiotic stress across the planting dates. Therefore, the magnitude of interaction involving the genotype the over planting date correlates with the bar chart area (Figure 1- 8).

Plant height: Plant height didn't differed significantly across the planting dates but plants grew taller in Mayas compared to other months. The genotypes differed significantly in height (Table 3). The tallest accession Kwakil (139.4 cm) was followed by Ambul-1(133.6cm) and Dan gora (132.4 cm).while the shortest plant (69 cm) was observed in accession Ambul-2.This results is in agreement with reports on relationship between different traits in common bean by Salehi *et al.*, (2008); morpho- agronomic characterization of common bean accession lines of diverse origin by Nwadike *et al*., (2014); genotypic variation in plant heights of collected bean germplasm by Amanullah and Asim (2011); variation in and relationship of biomass, growth rate and harvest index, and phenology to yield of common bean by Scully and Wallace (1990) and confirms the finding of Ayoub and Abdalla (2014), that early sowing in Bean had positive significant effect.

The effects of the interaction between the planting datesand genotypes were significant on the plant height(Table 3).The mean interaction effect of planting date on genotype is presented in Figure 1.The tallest plants(153.9 cm) was obtained from Ambul-1, chanlet (150.4cm) and Bakin wake (148cm) in May while ambul-1 obtained a tallest height of 154.5cm, Jan wake (146cm) and chanlet (150.4cm) which was statistically similar in May. The shortest plant height (28.3cm) was obtained from Ambul- 2, followed by Bakin wake (78cm) and chanlet (71cm) in September and similar to all other genotypes. The distinct variation in height express by kwakil in September planting date showed some degree of plasticity and supports the observation on the plant prostrate indeterminate growth habit.

Number of leaf: The number of leaf per plant showed significant variations among the planting dates (Table 3). The highest number of leaf count per plant (36.9) was in August. The lowest leaf count per plant (24.7) was obtained in September. The high leaf count recordedin the season might be due to prevailing environmental condition for increased vegetative growth (Ayouband Abdalla,2014), which is in sharp contrast to environment factor during the growing season of September planting date ( Table3). The leaf count per plant showed significant variation among the genotypes (Table 3).The highest leaf count per plant (37.8) was obtained from Ambul- 1, Chanlet (34.2) and Bakin wake (33.7). Leaf counts obtained from genotypes Dan baga, Kwakil and Dangora were statistically similar. The lowest number of leaf count per plant (18.5) was found Ambul-2. The variation in number of fruits per plant was genotype dependent. This results supports the earlier findings of Grafton and Shneiter ( 1981) and Ayouband Abdalla (2014).

The effects of the interaction between planting dates and genotypes were significant on the number of leaf count per plant (Table3). The mean interaction effect of planting date and genotypes on leaf count is shown in Figure 2.The highest number of leaf per plant (37.4) was obtained from Ambul-1 in May and the lowest mean of value leaf count obtained from Ambul-2 (12.5).Highest and lowest mean value of leaf count in August was obtained from Chanlet (36.7) and Ambul-2 (12.2). In contrast, the lowest number of leaf count per plant was obtained in September (11.2) from Ambul-2.

Number of primary branches: There was significant variation in the number of primary branches per plant among the planting dates (Table 3). The highest number of primary branches per plant (41.6) was observed in August followed by planting in May and the lowest number was observed in September. Variation among the genotypes for number of primary branches was significant (Table 3). The highest number of primary branches per plant (55.7) was observed in Chanlet. Bakin wake and Jan wake were statistically similar to Chanlet. The lowest number of primary branches per plant (16.6d) was observed in Ambul-2 while genotype Dan gora and Kwakil was statistically identical. Difference in number of branching in the genotypes may be due to its genetic potential. The above results of variability in branching collaborate the findings of (Edith *et al,* 1997; Alihan *et al.,*(2013).

The interaction effects of planting dates and genotypes were significant on the number of primary branches per plant (Table 3). The mean interaction effect of planting date on primary branch count is shown in Figure 3.The highest number of primary branches per plant (9.9) was obtained from Ambul-1, in August and in May(9.8). Both Chanlet and Bakin wake obtained a mean primary branch count of (9.4, 9.3) and 9.1, 8.1) in May and August respectively. The lowest mean interaction effect of primary branches per plant and genotype was obtained from Ambul – 2 (4.1).

Stem collar girth: The stem collar girth per plant showed significant variations among the planting dates (Table 3). The highest stem collar diameter per plant (2.76.cm) was in August. The Smallest collar girth (2.38cm) was obtained in September. The collar girth size per plant showed significant variation among the genotypes (Table 3). The largest stem collar girth per plant (2.8cm) was obtained from Kwakil and Dan baga followed by collar girth size obtained from Ambul -1(2.7cm), Ambul-2(2.7 cm) which were statistically similar. The least collar girth sizes per plant (2.4cm) was found in Bakin wake. The variation in girth size per plant was genotype dependent.

The effects of the interaction between planting dates and genotypes were significant on the collar girth size per plant (Table 3). The mean interaction effect of planting date and collar girth per plant is shown in Figure 4.The highest collar girth per plant (3.0 cm) was obtained from Kwakilin May and the lowest mean collar girth size obtained from Ambul-2 ( 2.2cm) and Bakin wake (2.2cm) highest and lowest mean collar girth value in August was obtained from Dan gora (2.9cm) and Ambul-2 (2.5 cm). In contrast, the least collar size per plant was obtained in September (2.1 cm) Bakin wake and Ambul-2 (2.3 cm).

Days to maturity: the mean number of days to maturity showed significant variations among the planting dates (Table 4). The highest mean number of days to maturity (44.0) was in May, and September planting date recorded the least (39). The variation in number of days to maturity recorded might be attributed due to prevailing environmental condition (Ayouband Abdalla, 2014), which is in sharp contrast to environmental factors during the growing season in September planting date (Table 1).This prevailing environmental situation suggest induced plasticity which enables the plants to change their structure and adapt to the environmental changes. The mean number of days to maturity per plant ranged between 38.1 – 49.8 days. Genotype Chanlet (40.0), Jan wake (49.6) and Dan gora (49.0) recorded longer days to maturity while least days to maturity was recorded by Ambul-2 (38.9), Dan baga (38.9) and Kwakil (39.0), Ambul-1(39.8) respectively. Furthermore, this result lends credence to the earlier findings of Grafton and Shneiter (1981) and Ayoub and Abdalla (2014).

The effects of the interaction between planting dates and genotypes were significant on the number of days to maturity (Table 4), while mean interaction effect of planting date and genotypes on planting dates is presented in Figure 1. Variation in mean of days to maturity recorded for the various planting dates ranged between 65.7- 78.7days (Ambul-2 – Jan wake) for May, 65.2 – 79.7days (Ambul-2 – Dan gora ) for August and 64-76 days (Ambul-2 – Jan wake) for September respectively.

Pod yield kg/ha:pod yield per plot in t/ha was significant across the three planting dates.(Table4). Delayed maturity was obtained from last planting date leading to low pod yield, this result confirms the earlier reports by Grafton and Shneiter (1981). The highest pod yield per plot (2771.9 kg/ha) was obtained in May and September gave the lowest yield of per plot (1045.7kg/ha). Similarly, pod yield per plot per genotype was statistically significant(Table 4). Plots of genotype Ambu1-1 had the highest yield(2735.6 t/ha), while yield obtained from Dan baga (2372.3 kg/ha), kwakil (2305.7 kg/ha) and Chanlet (2323.2 kg/ha)were statistically similar. Genotype Ambul-2 recorded the lowest yield per plot (1186.2 kg/ha).Variability in yield performance recorded during the planting dates might be attributable to the inherent genetic variation in the respective genotypes and environmental stress. The result confirmed the finding of Alemayehu (2010) and Amanullah and Asim (2011).

The effects of the interaction between planting dates and genotypes were significant on pod yield per plot (Table 4).The mean interaction effect of planting date and genotypes on pod yield per plot is shown in Figure 5.The mean highest plot yield (3743.7 kg/ha) was obtained from Ambul-1 in May with the lowest yield recorded for Ambul-2.. The highest yield was obtained from Ambul-1 (3296 kg/ha) in August and lowest pod yield plot (1222 kg/ha). The highest and least mean yield per plot was obtained from Dan baga (1290 kg/ha) and Ambul-2 (778 kg/ha)in September.

Seed yield per plot (kg/ha): the result of the combined analysis revealed variation in seed yield obtained per plot was significant (Table 4). The highest seed yield per plot (2377.2 kg/ha) was recorded in May followed by (1914.3 kg/ha) in August. This result supports the earlier findings of Poincet (1980) and Ayoub (2014). The lowest seed yield ofper plot (907 t/ha) was recorded in September planting date. A marked variation in seed yield per plot was recorded by the different genotypes (Table 4). The highest seed yield per plot (2357.8 kg/ha) was recorded for Ambul-1. Bakin wake (1529.9 kg/ha ), Jan wake (1438.1kg/ha) and Ngogot (1459.8kg/ha) recorded seed yield per plot are statistically similar. The lowest recorded yield of seed per plot (1026.7kg/ha) was obtained from Ambul-2, which was different statistically from other genotypes.

The interaction effects of planting dates and genotypes were significant on the seed yield per plot (Table 4). The mean interaction effect of the planting dates and genotypes on seed yield per plot is shown in Figure 6. The highest and least number of seed yield per plot (3256.6kg/ha) was obtained from Ambul-1 and Ambul-2 in May planting and growing season. August highest mean seed yield per plot was obtained from ambul-1 (2802.3 kg /ha) while Ambul-2 recorded lowest mean seed yield per plot (2027.7 kg/ha). The planting date of September recorded high and low yield in contrast.

100 seed weight (g): The 100 seed weight of genotypes revealed significant variation in different planting dates (Table 4). The highest seed weight (37.85g) was recorded in May and statistically similar to seed weight obtained in August (37.30 g). The lowest seed weight (30.30 g) occurred in September. The individual 100 seed weight varied significantly among the genotypes (Table 4). The heaviest seed weight (48.56 g) occurred inkwakil followed by Chanlet (42.3 g). Ambul-1 and Ambul-2 were statistically similar and recorded 100 seed weight of (38.2 g) and (36.89 g). In contrast the lightest seed weight were recorded for Bakin wake (29 g), Jan wake (29.3 g) and Ngogot (29.4 g) and statistically similar. Variability in 100 seed weight of individual genotypes might be due to their different genotypic characteristics and interaction with environmental factors.

Interaction effects of planting dates and genotypes was significant on 100 seed weight (Table 4). The mean individual interaction effect of the planting dates and genotypes on 100 seed weight per plot is shown in Figure 7. The mean heaviest 100 seed weight in kwakil ( 54 g ) occurred in May and lightest seed recorded in bakin wake (30 g).heaviest 100 seed weight in August occurred in Chanlet (46.3 g ) while the Bakin wake obtained (30.g). The planting date of September recorded (37.7 g) and (27 g) respectively for 100 seed weight in contrast.

**Dry matter yield (kg/ha):**dry matter yield per plot was significant across the three planting datesand growing periods.(Table 4). The highest dry matter yield per plot (3291.3 kg/ha) was obtained in May and September gave the lowest yield of per plot (643.1 kg/ha). Similarly, dry matter yield per plot per genotype was statistically significant (Table 4). Plots of genotype Ambu1-1 had the highest dry matter yield(3535.2 t/ha) followed by Dan gora (2570.1 kg/ha), while dry matter yield obtained from Chanlet (2323.2 t/ha) and Ngogot(2220 kg/ha) were statistically similar. Least dry matter yield were obtained from Ambul-1 (1416.17 kg/ha) and Bakin wake (1522.9 kg/ha) were statistically similar. Dry matter yield performance recorded during the planting dates might be attributable to the inherent genetic variation in the respective genotypes and environmental stress.

The effects of the interaction between planting dates and genotypes were significant on dry matter yield per plot (Table 4). The mean interaction effect of planting date and genotypes on dry matter yield per plot is shown in Figure7.The mean highest dry matteryield ( 3855 kg/ha) was obtained from Ambul-1 in May with the lowest yield recorded for Ambul-2 ( 1919 kg/ha).Similarly, the highest yield in August was obtained from Ambul-1 (3954 kg/ha) and lowest dry matter yield perplot (1815 kg/ha). The highest and least mean dry matter yield per plot was obtained from Dan gora( 797 kg/ha) and Jan wake ( 500 kg/ha)in September.

## Conclusion

The results of the experiment indicated that early planting in the month of May recorded high yield in both pod and dry seed yield (kg/ha). Hence, its recommended that early planting of common beans be encouraged in the study area. Ambul-1, Chanlet, Dan baga, Dan gora, kwakil, Bakin wake and Ngogot recorded better performance of all the accessions over the planting dates in terms of the highest pod, seed yield and dry matter production, while Ambul-2 recorded very low height and least in performance in terms of all the traits investigated.

**Table.1** Average Monthly meteorological data at the Teaching and Research Farm of the Federal College of Forestry- Jos during the 2012 cropping season

| Month | No.of Rainy days | Total Rainfall (mm) | Av.Max. Temp (°C) | Av.Min Temp. (°C) | Relative Humidity (%) | Solar Radiation (btu/hr) |
|---|---|---|---|---|---|---|
| January | 0.0 | 0.0 | 21.58 | 12.81 | 30.58 | 39.82 |
| February | 0.0 | 0.0 | 25.7 | 17.20 | 26.3 | 45.8 |
| March | 0.0 | 0.0 | 25.1 | 20.7 | 21.9 | 47.0 |
| April | 6.0 | 33.7 | 27.6 | 21.6 | 60.0 | 48.7 |
| May | 13 | 176.9 | 26.1 | 20.2 | 65.2 | 47.2 |
| June | 14 | 206.4 | 24.1 | 19.5 | 71.0 | 44.3 |
| July | 25 | 710.8 | 22.8 | 18.6 | 79.2 | 29.9 |
| August | 17 | 189.1 | 22.7 | 18.7 | 78.95 | 32.7 |
| September | 15 | 348.9 | 24.4 | 18.4 | 75.1 | 38.4 |
| October | 5 | 64.1 | 27.3 | 19.0 | 63.95 | 47.0 |
| November | 0.0 | 0.0 | 28.1 | 15.5 | 39.6 | 48.5 |
| December | 0.0 | 0.0 | 23.3 | 13.9 | 32.5 | 43.2 |

Source: Federal College of Forestry- Jos, Metrological unit, 2012

**Figure.1** Mean interaction effect of genotypes over planting dates on plant height of some common bean landraces in Jos, 2012

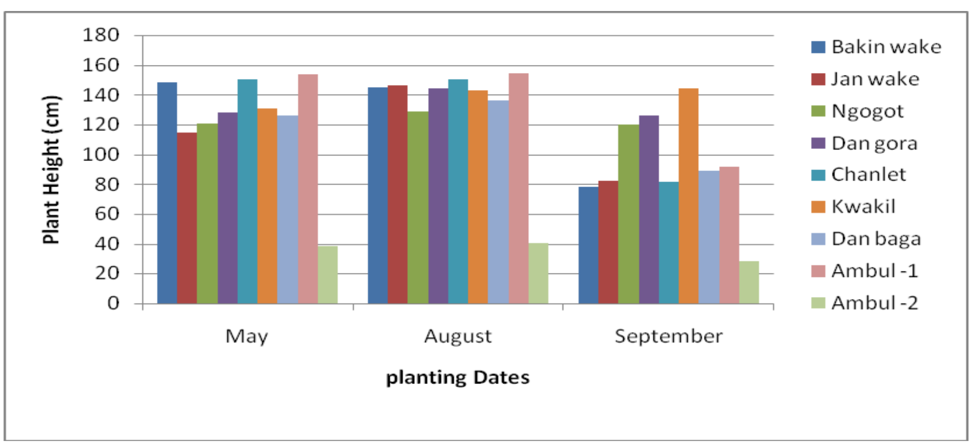


**Table.2** Physical and Chemical properties of the soil of the Jos experimental plots before cropping in 2012

| s/no | Experimental fields | Particles size distribution | | | | pH | | Org. C (%) | Org. M (%) | N % | Bray P PPM | Exchangeable Cations Centimol/kg soil | | | | | Zn ppm | Fe ppm | Cu ppm | Mn ppm | S ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sand % | Silt % | Clay % | Soil Class | $H_20$ 1:1 | Kcl 1:1 | | | | | Ca | Mg | K | Na | CEC | | | | | |
| 1 | A | 82.1 | 10.2 | 7.5 | Loamy sand | 5.95 | 5.16 | 0.60 | 1.04 | 0.080 | 3.1 | 3.40 | 1.81 | 0.31 | 0.65 | 6.30 | 5.78 | 3.66 | 2.15 | 1.10 | 0.77 |
| 2 | B | 78.5 | 10.4 | 6.4 | ,, | 5.70 | 5.00 | 0.56 | 0.97 | 0.088 | 3.5 | 2.95 | 1.90 | 0.22 | 0.46 | 5.40 | 6.20 | 4.07 | 3.15 | 1.60 | 0.56 |
| 3 | C | 80.7 | 11.7 | 7.0 | ,, | 6.10 | 5.31 | 0.69 | 1.19 | 0.063 | 2.6 | 3.25 | 1.88 | 0.36 | 0.60 | 6.60 | 4.11 | 3.75 | 2.20 | 1.17 | 0.82 |

**Table.3** Morphological attributes of some Common Bean Landraces over Sowing Date(S) During The 2012 Wet Cropping Season

| **Treatment** | Plant Height (cm) | Leaf count | Primary Branch count | Plant Collar Girth (cm) | Days to Maturity |
|---|---|---|---|---|---|
| **Sowing Date** | | | | | |
| May | 134.6a | 28.3b | 8.03b | 2.60b | 44.0a |
| August | 132.1a | 36.9a | 41.6a | 2.76a | 42.9b |
| September | 93.4a | 24.7c | 6.8b | 2.38c | 39.7c |
| LSD | 19.3 | 1.08 | 2.8 | 0.11 | 0.99 |
| **Genotype** | | | | | |
| 1-Bakin wake | 124.0a | 33.7bc | 54.1ab | 2.4cd | 38.1d |
| 2-Jan wake | 114.0a | 27.0d | 53.8ab | 2.6bc | 49.6a |
| 3-Ngogot | 123.7a | 28.7cd | 48.2c | 2.5bcd | 46.4b |
| 4-Dangora | 132.9a | 29.9c | 52.7abc | 2.6bc | 49.0a |
| 5-Chanlet | 128.4a | 34.2b | 55.7ab | 2.6bc | 40.0c |
| 6-Kwakil | 139.4a | 29.9c | 52.8abc | 2.8a | 39.0cd |
| 7-Dan baga | 117.3a | 29.7c | 51.2a | 2.7a | 38.9cd |
| 8-ambul -1 | 133.6a | 37.8a | 57.2a | 2.7ab | 39.8cd |
| 9-ambul -2 | 69.0b | 18.5e | 16.6d | 2.7ab | 38.9cd |
| L S | * | * | * | * | * |
| LSD | 33.9 | 1.87 | 4.89 | 2.3d | 3.31 |
| **Interaction** PD XG | * | * | * | * | * |

Note: * Significant at 5% level of probability. Means with the same letter(s) on same column are not significant different.

**Table.4** Mean Values of yield and Yield attributes of some Common Bean Landraces over sowing date(S) during The 2012 wetCropping Season

Note: * Significant at 5% level of probability.Means with the same letter(s) on same column are not significant different.

| Treatments | Pod yield kg/ha | Seed yield kg/ha | 100 seed weight (g) | Dry matter weight kg /ha |
|---|---|---|---|---|
| **Sowing Date** | | | | |
| May | 2771.9a | 2377.2a | 37.85a | 2836.8b |
| August | 2249.0b | 1914.6b | 37.30a | 3291.3a |
| September | 1045.7c | 907.c | 30.30b | 643.1c |
| LSD | 128.1 | 177.0 | 0.91 | 203.8 |
| **Genotype** | | | | |
| 1-Bakin wake | 1777.7d | 1529.9e | 29.0e | 1522.9e |
| 2-Jan wake | 1661.4d | 1438.1e | 29.3e | 2158.6cd |
| 3-Ngogot | 1694.4d | 1459.8e | 29.4e | 2220.1bcd |
| 4-Dangora | 2024.8c | 1740.8d | 33.4d | 2570.1b |
| 5-Chanlet | 2441.6b | 2104.b | 42.3b | 2323.2bcd |
| 6-Kwakil | 2305.7b | 1898.2cd | 48.56a | 2508.3bc |
| 7-Dan baga | 2372.3b | 2044.1bc | 30.3e | 2058.7d |
| 8-ambul -1 | 2735.6a | 2357.8a | 38.2c | 3535.1a |
| 9-ambul -2 | 1186.2e | 1026.7f | 36.89c | 1416.7e |
| L S | * | * | * | * |
| LSD | 221.9 | 177.1 | 1.58 | 353.1 |
| **Interaction** | * | * | * | * |
| **PD X G** | | | | |

**Figure.2** Mean effect of planting dates on plant height of some common bean landraces in Jos, 2012

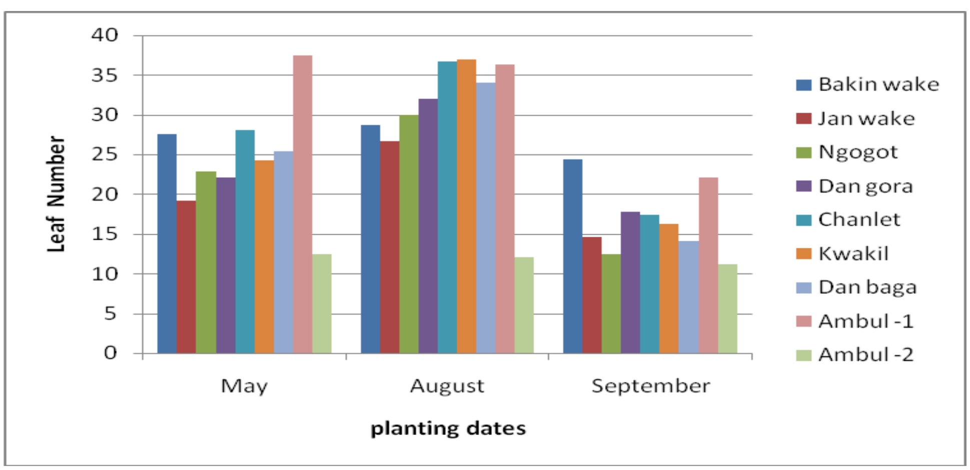
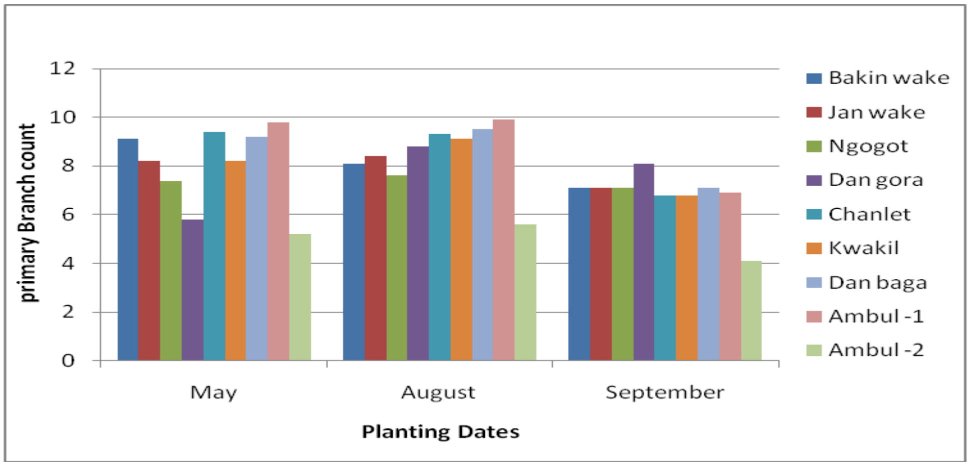


**Figure.1** Mean interaction effect of genotypes over planting dates on plant primary branch number of some common bean landraces in Jos, 2012.



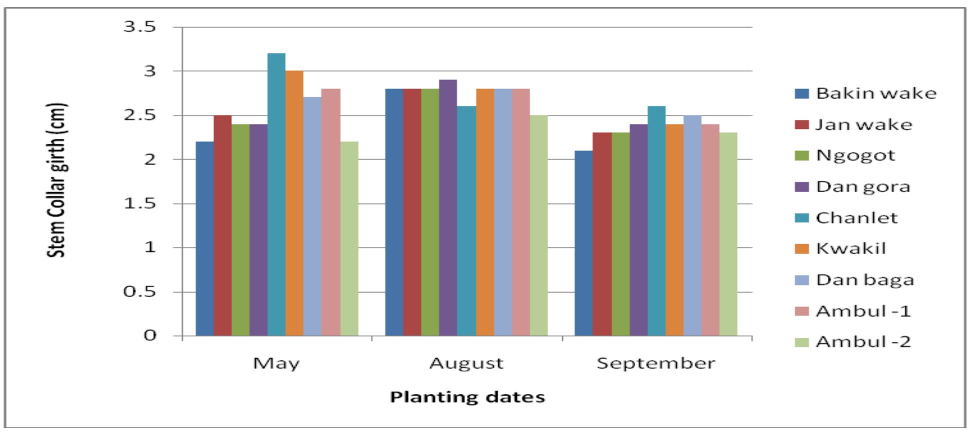




**Figure.1** Mean interaction effect of genotypes over planting datays to maturity on some common bean landraces in Jos, 2012.

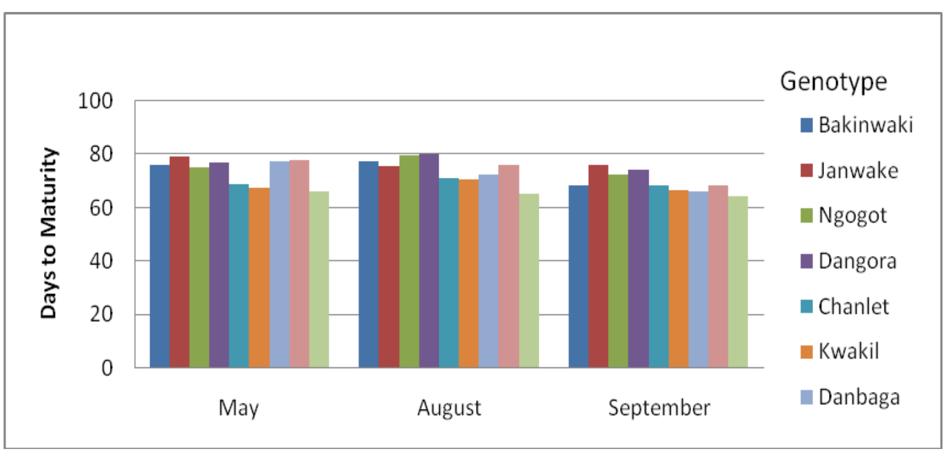


**Figure.5** Mean interaction effect of genotypes over planting dates on plant pod yield (kg/ha) of some common bean landraces in Jos, 2012

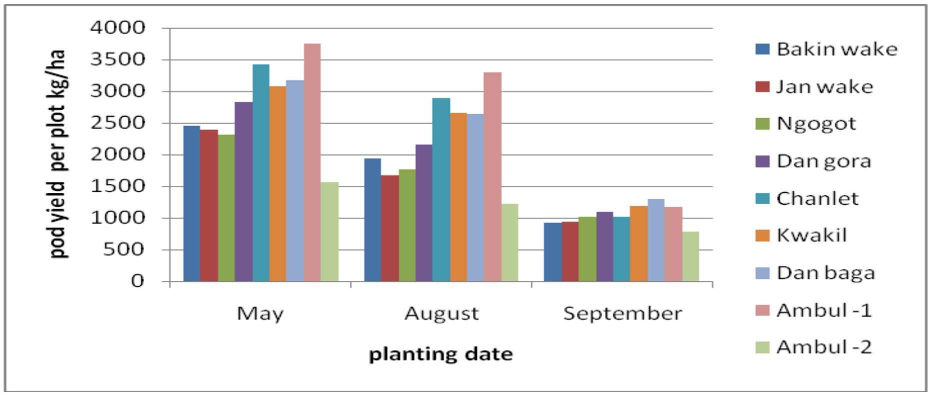



Figure6: Mean interaction effect of genotypes over planting dates on seed yield per plot (kg/ha)plant height of some common bean landraces in Jos, 2012.

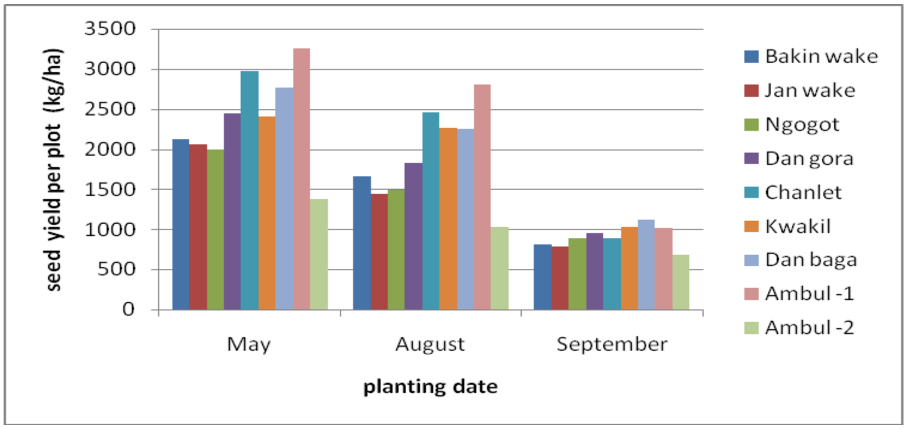



**Figure.7** Mean interaction effect of genotypes over planting dates on 100 seed weight (g) of some common bean landraces in Jos, 2012

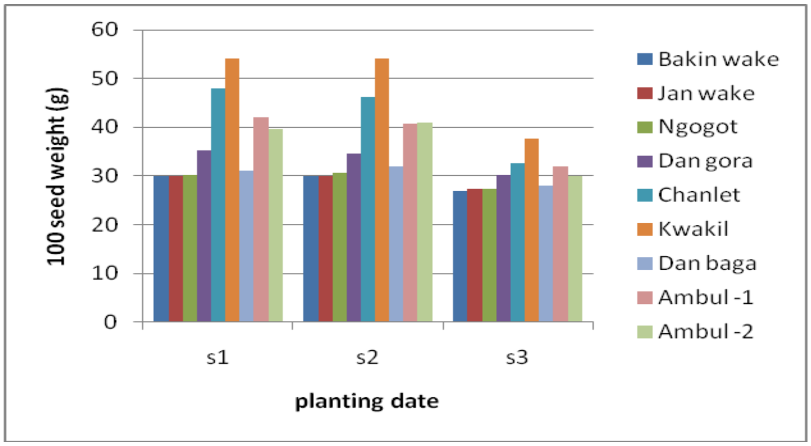
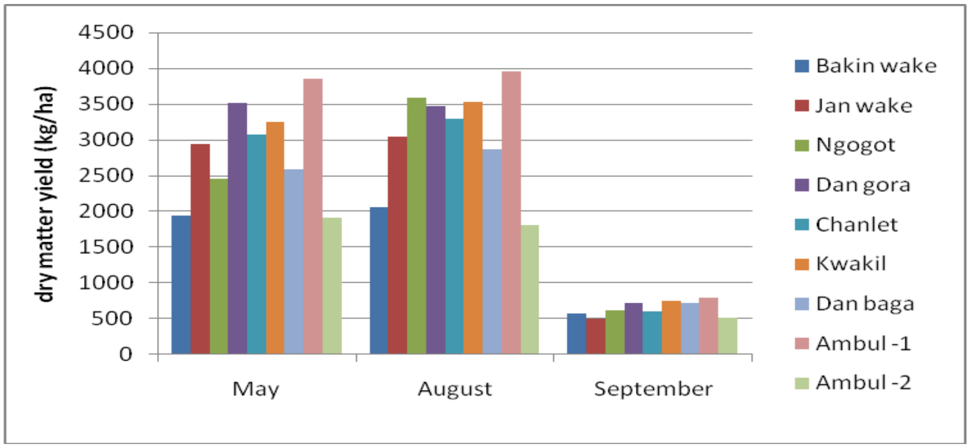


**Figure.8** Mean interaction effect of genotypes over planting dates on plant dry matter yield (kg/ha) of some common bean landraces in Jos, 2012

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