Research Article

Yield Performance of Sugar Bean Varieties (*Phaseolus* spp.) Influenced by Sowing Time Under Overhead Irrigation at Chiredzi Research Station in Natural Region V of Zimbabwe

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Abstract: The most favorable time of sowing and a promising variety are of prime importance to harness potential yield in bean production. A trial was conducted on the effect of sowing date and variety on yield of sugar beans in the Lowveld at Chiredzi Research Station Semi-arid region of Zimbabwe. Twelve different determinate varieties of sugar beans and eight indeterminate varieties were evaluated. The determinate varieties were OPS-RSI, Natal Sugar beans, AND 897, Mus 97, Mug 38, Red Canadian wonder, Michigan pea bean, Cim 9314-17, Zebra, Grey Light, White Kidney, Cim 9406-3. The indeterminate varieties were Carioka, Ren 22, Iris, MCM 2203, Nyanga Red, APN 136, Black bean and Xan 76. Results showed that the number of pods varied across months with highest numbers produced May (20). Indeterminate varieties had more pods per plant than determinate varieties. The number of seeds per plant increased significantly ($p<0.05$) with Michigan producing the highest number (68). The number of seeds per pod was highest in May (36). Michigan pea bean had the highest average number of pods per plant (17). The average number of days to flowering were highest in May (51), June (55) and July (53). Average number of days to maturity were highest in April (99), May (106), June (98) and July (97). Marketable average yield increased significantly $p<0.05$) in April (1620 kg/ha), May (1719 kg/ha) and June (1633 kg/ha). Mean maximum temperature was above optimum requirement for bean production affecting number of pods per plant, seeds per plant and ultimately economic yield. Variety APN 136 planted in May was the best in the Lowveld of Zimbabwe.

Keywords: Variety; sowing date; temperature, indeterminate, determinate

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1. Introduction

Sugar bean (Phaseolus vulgaris L.) is a leguminous crop, implying that it has the capacity to fix atmospheric nitrogen and can be sown without rhizorbium inoculums at planting (Marco et al 2006). This biological aspect makes sugar beans a good fit in crop rotation and intercropping systems (Walter 2014). As a protein-rich food, sugar beans play an important role in human nutrition, especially in developing countries because it is a good source of iron and zinc (Buruchara et al., 2011). They contribute up to 33% of the dietary protein needs of humans (Vance et al., 2002). Common bean is a warm season annual legume crop grown primarily for its protein and energy-rich dry seeds. An estimated 23.1 million tons of common bean is produced annually on about 8.7 million hectares worldwide (FAO, 2014). In semi-arid regions of Zimbabwe (Natural Region 4 and 5) yield of field beans are reduced mainly by high day and night temperature (Catuchi et al 2019). In contrast, late planting date causes the reproductive growth stage of the crop

to face the fall chilling in areas that have chilling temperatures, which ultimately lowers yield (Esmaeilzadeh and Aminpanah 2015). Unfortunately, the sensitivity of sugar bean to low temperature (Badowiec & Weidner, 2014) may be troublesome in temperate climate regions where the transitional drop of temperature occur frequently during late growing season. Lowveld receives mild temperature in winter which is favorable to growth and development of the crop. Sugar beans being a C3-cycle plant, cultivation in high temperature environments results in decreased photosynthesis, mainly due to increased respiration and photorespiration **(**Karavidas et al. 2022). From the observations that were made at Chiredzi Research Station it was shown that some varieties of beans were affected very much by time of sowing, whilst some varieties performed relatively well regardless of time. High temperatures above 32^0C during flowering and pod filling stages contributed to poor pod filling (Madamba, 2003). Yoldas and Esiyok, (2009), reported that planting when temperatures were high, reduced plant growth cycle and flowering period. It was also shown that values of yields and number of normal seeds and pods were reduced. Heavy rains and humidity that contribute to the build-up of leaf and stem diseases reduced marketable grain. In Middle Sabi some newly settled farmer planted beans in August and yielded less than a half a ton on alluvial soils. Beans can tolerate low temperatures and even occasional mild frost during the early growth stages but this reduces yields (Madamba, 2003). However, yields of up to 3 t/ha are possible under the same soil type and good management. In Natural Region 1, 2 and 3 in Zimbabwe farmers normally sow beans in December and January when temperatures are still high (35^0C). From observations, Red mottled, Iris, Michigan Pea Bean and Zebra varieties were some of the good varieties that showed good yields when planted during these hot months of the year. The information generated from this trial would help to answer some of the challenges that are being faced by farmers as far as time of sowing; variety type and the economics of production are concerned. Varieties that are not affected by time of sowing would be selected and information made available to farmers. The objective of this trial was to find the effect of sowing date on the yield and financial returns of 20 varieties of field beans.

2. Materials and Methods

2.1 Experimental procedure and treatments

The trial was planted at Chiredzi Research Station in the Southeastern Lowveld of Zimbabwe (21^0 33' S and $31^0$30' E) at an altitude of 429 m above sea level. The trial was set up in a randomized complete block design with three replications and twenty varieties from Crop Breeding Institute were planted. The determinate varieties planted were OPS-RSI, Natal Sugar beans, AND 897, Mus 97, Mug 38, Red Canadian wonder, Michigan pea bean, Cim 9314-17, Zebra, Grey Light, White Kidney and Cim 9406-3. Indeterminate varieties were Carioka, Ren 22, Iris, MCM 2203, Nyanga Red, APN 136, Black bean and Xan 76.

2.2 Crop establishment and management

The trial was planted every first week of each month from January to December for three years. The mean maximum and minimum temperatures were 29^0C and 12^0C respectively. The soils were predominately sandy-clays, and shallow (0.6-1.0m deep) with 27-30% clay. Compound D (N:7: P:14: K:7) at a rate 300 kg/ha was applied as basal dressing and ammonium nitrate (34.5%N) at a rate of 50 kg/ha N was applied as topdressing at three weeks after planting. The land was prepared using a tractor drawn disc plough and discing done to attain fine tilth. Plot sizes were 4.2 m long and 2.7 m wide. Inter-rows spaced at 0.45 m and intra rows at 0.07 m (31,7460 plants/ha) were made by hands. All varieties were supplied by Crop Breeding Institute. The seed was sprayed with thiram at planting to prevent fungal infection using knapsack sprayers.

2.3 Measurements

The number of days to 50% flowering, 95% maturity and marketable yields were recorded. Grain yield was adjusted to 13% moisture content and was determined by grain moisture meter. Two rows on either side of the plots were discarded as guard rows leaving a net plot 7.56 m^2.

2.4 Statistical analysis

The data were subjected to analysis of variance procedure as Randomized Complete Design. Analysis was done using Genstat 14th Edition. Where necessary least significant differences (L.s.d) were used to separate means at p=0.05.

3. Results and Discussions

3.1 Days to flowering and maturity

The number of days to flowering increased significantly $p<0.001$ from 39 days in January (summer) to 55 days in June (winter) and dropped to 43 days by December (table 1). Crop planted from March to June took significantly more days to flower. During periods of high temperature sugar beans hasten to flower. Similar results were reported (Essubalew Getachew Seyum 2014; Ndegwa et al. 2001). Consequently the number of days to maturity were significantly delayed $p<0.001$ for April, May and June crop 99, 106 and 98 days respectively compared to 80; 76; 75; 86; 82; 93; 80 and 81 days in January; February; March; August; September; October; November and December respectively (table 2). MCM 2203 and Iris had the longest days to maturity during winter (100-114) compared to 77- 97 days during summer months. During winter (April, May and June) it took longer for the varieties to flower and mature than in summer. This was also confirmed by Yoldas and Esiyok, (2009), who reported that plant growth cycle and flowering period were shorter when temperatures were high. When temperatures are low the crop takes a longer period to develop because of the reduced heat units.

3.2 Number of pods per plant and number of seeds per plant

Significant number of pods per plant was recorded among varieties and sowing dates. There were no significant differences on number of pods per plant among Black bean, Michigan pea bean, Nyanga Red, Iris, Ren 22, Mus 97 and Carioka (table 3). The number of seeds per plant showed significant differences $p<0.001$. The variety that exhibited highest significant differences in the number of seeds per plant was Michigan pea bean. Indeterminate varieties that had significantly the highest number of seeds per plant were APN 136, Nyanga red, Iris, Ren 22, Carioka and Xan 76. Determinate varieties that showed significant high numbers of seeds per plant were Michigan pea bean and Mus 97. The month of May had significantly the highest number $p<0.001$ of pods per plant and seeds per plant (fig. 2). There were no significant differences on number of pods per plant and number of seeds per plant for the months February, March, April, June and July. From August through to January the number of pods per plant was significantly lower than February through to July. There was a decrease in the number of seeds per plant from August to December. Sowing time may also affect yield due to the temperature and rainfall that prevail at critical developmental stages, specifically flowering and pod-filling (Karavidas et al. 2022). Catuchi et al (2019) found that when night and day temperatures exceed 25^0C to 30^0C respectively flower buds and pod formation are adversely affected and reduce in numbers per plant. Results also concur with (Getachew et al. 2014 and Qiu Ying Zhang et al. 2010) who reported that early sowing towards cooler months produced more branches and more pods and ultimately more seeds than late sowing towards hotter months. The increase in the number of pods and seeds per plant in early planted sugar beans could also be attributed to the development of more vegetative parts in earlier sowing, which resulted in the production of more number of pods per plant, and the difference between the varieties could probably be genetic, hence some varieties might be more tolerant to low temperature.

3.3 Response of sugar beans to time of sowing on yield

It was clear that planting sugar beans from March up to June gave significantly high yields ($p<0.05$) on average from the 20 varieties evaluated. In Zimbabwe's Natural Region V temperatures go down from April as winter will be drawing closer (Fig 5; 7 and 9). Reduction in yield for the January and February crop might be due to high temperatures during time of flowering that occurred in February and March respectively and pod setting (Elhag et al. 2014 and Sharma et al 2014) because the crop flowered when temperatures were still higher than optimum temperature requirement. This may be

ascribed to short growing season and ultimately lesser accumulation of photosynthates (Sharma et al. 2013). Stephen et al. (2014) found out that temperatures exceeding 30°C during flowering causes flower abortion in sugar beans (Fig 6; 8 and 10). Reduced yield from July through to December may be ascribed to very high temperatures during flowering periods causing flower abortion (Karavidas et al. 2022, Sharma et al 2014; Stephen et al 2014), rainfall during flowering (fig 11) that causes flower drop and bean rot at harvest and short growing period that occurs when temperatures are higher than optimum. Lower pod yield in the late planting season was due to a smaller biomass production from a shorter vegetative growth period and moreover, the decline in pod production may simply result from declining flower production as vegetative growth ceases (Molosiwa and Kgokong 2017). Sowing after July has negative consequences on yield because the reproductive stage occurs when weather conditions are less favorable (Karavidas et al. 2022). The reproductive period of sugar bean plants coincide with the highest summer temperatures and this cause abscission of many buds and flowers that results in a significant decrease in productivity (Marlene et al., 2008; Sharma et al 2013).Yield trends (fig 1) show that bean yield increased from February up to May sowing and starts to decline from June. Sugar beans should be planted from March until June as shown in (Fig 4). However, some varieties can be planted as early as February and still break even under these conditions. The varieties Xan 76 (1567 kg/ha), Mus 97 (1454.5 kg/ha), Nyanga red (1372.5 kg/ha), APN 136 (1698 kg/ha), Michigan pea bean (1718 kg/ha), Red Canadian wonder (1511.5 kg/ha) and black bean (1575 kg/ha) were conspicuous. If farmers are late in planting varieties like Iris (1770.5 kg/ha), Xan 76 (1488.5 kg/ha, CIM 9314-17 (1406.5 kg/ha), Black bean (1294.2 kg/ha) and Nyanga red (1449.5 kg/ha) can be sown in July and still break even.

The Lowveld experiences temperatures that are above the optimum temperature for sugar bean from August to January (fig. 6, 8 and 10). However, from February temperature starts to be suitable for bean production up to July. Considering viability of the crop from August to January conditions are not favorable for growing beans in the Lowveld (fig 2, 3 and 4).

Table 1: Effect of time of sowing on days to 50% flowering across season

Variety	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
OPS-RSI	36^{def}	37^{e}	38^{cd}	39^{f}	51^{d}	49^{def}	52^{c-f}	46^{fg}	42^{d-h}	37^{gh}	47^{a-d}	34^{h}
Xan 76	44^{ab}	46^{ab}	41^{ab}	47^{abcd}	56^{bc}	66^{a}	58^{a}	54^{ab}	50^{a}	50^{bc}	54^{a}	45de
Zebra	34^{ef}	36^{ef}	33^{g}	37^{f}	47^{ef}	45^{f}	45^{h}	44^{h}	40^{h}	35^{h}	36^{e}	40^{g}
Grey Light	34^{ef}	37^{ef}	35^{efg}	38^{f}	47^{ef}	47^{f}	51^{e-h}	45^{gh}	41^{f-h}	36^{gh}	36^{e}	36^{h}
Carioka	41^{abcd}	43^{c}	41^{ab}	48^{ab}	57^{b}	51^{cdef}	55^{a-d}	56^{a}	45^{a-h}	46^{c-e}	37de	41^{fg}
Natal sugar beans	33^{f}	36 ^{ef}	33 ^{g}	38^{f}	46^{ef}	46^{f}	50^{e-g}	48^{ef}	43^{c-h}	47^{c-e}	36^{e}	34^{h}
Mus 97	39^{bcde}	44 ^{bc}	41^{ab}	49^{a}	60^{a}	66^{a}	57^{ab}	53^{bc}	48^{a-c}	47^{c-e}	43^{b-e}	43^{ef}
White Kidney	35^{def}	35 ^{f}	34^{fg}	36^{f}	47^{ef}	48^{af}	48^{f-h}	46^{gh}	42^{e-h}	36^{h}	38^{c-e}	42^{fg}
AND 897	46^{a}	46 ^{a}	41^{ab}	45^{d}	52^{d}	57^{bc}	57^{ab}	52^{cd}	43^{b-h}	45^{d-e}	47^{a-d}	53^{a}
Cim 9406-3	37.^{cdef}	37 ^{ef}	36^{def}	38^{f}	48^{e}	49^{def}	49^{f-h}	44^{gh}	40^{h}	40^{fg}	45^{a-e}	45de
Ren 22	40^{bcde}	41 ^{d}	41^{abc}	43^{e}	53^{cd}	55^{cde}	56^{a-d}	53^{bc}	46^{a-g}	45de	40^{c-e}	42^{fg}
Iris	44^{ab}	46 ^{a}	43^{a}	48^{abc}	56^{b}	63^{ab}	58^{a}	54^{ab}	48^{a-d}	50^{bc}	52^{ab}	49^{bc}
MCM 2203	43^{abc}	47 ^{a}	40^{bc}	48^{abc}	60^{a}	67^{a}	58^{a}	54^{ab}	47^{a-e}	49^{cd}	47^{a-d}	45de
Nyanga Red	38^{bcdef}	41 ^{d}	38^{cd}	46^{bcd}	52^{d}	57^{bc}	56^{a-d}	53^{bc}	46^{a-h}	44^{e}	37de	43^{eg}
Cim9314-17	47^{a}	46 ^{a}	38^{cd}	41^{e}	51^{d}	51^{cdef}	53^{b-e}	50de	48^{ab}	53^{ab}	46^{a-e}	52^{ab}
APN 136	37^{cdef}	40 ^{d}	37de	42^{e}	53^{d}	57^{bc}	55^{a-d}	53^{bc}	44^{b-h}	43^{ef}	36^{e}	40^{g}

Michigan Pea bean	38^{bcdef}	41 ^{d}	38^{cd}	45^{cd}	52^{d}	65^{a}	56^{a-c}	53^{bc}	46^{a-g}	47^{c-f}	39^{c-e}	41^{g}
Red Canadian Wonder	39^{bcdef}	36 ^{ef}	34^{fg}	37^{f}	45^{fg}	55^{cd}	46^{gh}	44^{h}	41^{gh}	38^{gh}	39^{c-e}	43^{eg}
Black Bean	39^{bcde}	41 ^{d}	42^{ab}	49^{a}	43^{g}	62^{ab}	56^{a-c}	54^{bc}	47^{a-f}	45de	48^{a-c}	43^{ef}
Mug 38	46^{a}	47 ^{a}	38^{cd}	42^{e}	52	51^{cdef}	52^{d-f}	50de	46^{a-h}	56^{a}	53^{ab}	47^{cd}
Means	**39**	**41**	**38**	**43**	**51**	**55**	**53**	**50**	**45**	**45**	**43**	**43**
LSD (0.05)	5	1.7	2	2	2	6	4	2	5	4	10	3
CV%	4	3	4	3	7	6	5	3	7	6	15	4
P-value	<0.001	0.023	0.035	0.016	<0.001	<0.001	0.035	0.028	0.042	0.044	0.05	0.008

Table 2: Time of sowing on days to 95% maturity across seasons

Variety	**Janu-ary**	**Febru-ary**	**Marc h**	**April**	**May**	**June**	**July**	**August**	**Sep-tember**	**October**	**November**	**December**
OPS-RSI	91^{a}	73^{cd}	76^{cd}	97^{defgh}	96^{b}	94^{fgh}	95^{f-h}	86^{fg}	85^{a-c}	92^{fg}	79^{d-e}	70^{fg}
Xan 76	89^{bc}	78^{abcd}	78^{abc}	104^{bc}	112^{a}	100^{cd}	99^{a-d}	90^{cd}	84^{a-c}	90^{fg}	84^{ab}	81^{d}
Zebra	73^{f}	73^{cd}	69^{f}	90^{h}	96^{b}	91^{h}	92^{h-I}	77^{hi}	78^{fg}	80^{i}	80^{cd}	81^{d}
Grey Light	66^{g}	72^{d}	70^{f}	92^{gh}	94^{b}	94^{fgh}	93^{g-I}	76^{i}	78^{f-h}	91^{fg}	77^{ef}	70^{f}
Carioka	83^{d}	77^{abcd}	71^{ef}	100^{cdef}	111^{a}	99^{cde}	97^{c-f}	90^{cd}	84^{a-d}	95^{ef}	80^{cd}	80de
Natal sugar beans	67^{g}	73^{cd}	70^{f}	91^{gh}	95^{b}	92^{gh}	93^{h-i}	76^{hi}	77^{gh}	93^{f}	77^{f}	67^{g}
Mus 97	74^{f}	75^{bcd}	76^{cd}	99^{cdef}	112^{a}	99^{cde}	99^{a-e}	91^{ab}	82^{c-e}	92^{fg}	77^{ef}	80de
White Kidney	67^{g}	73^{cd}	69^{f}	91^{gh}	96^{b}	92^{gh}	91^{i}	77^{hi}	75^{h}	76 ^{j}	79de	79de
AND 897	82^{d}	82^{ab}	79^{ab}	103^{bcd}	109^{a}	100^{cd}	99^{a-e}	93^{a}	86^{a}	86^{h}	84^{a}	87^{b}
Cim 9406-3	88^{c}	79^{abcd}	78^{abc}	95^{efgh}	99^{b}	95^{fgh}	96^{e-g}	85^{g}	83^{c-e}	104^{ab}	82^{bc}	88^{b}
Ren 22	91^{ab}	77^{abcd}	75^{cd}	104^{bcd}	112^{a}	109^{a}	101^{a}	91^{bc}	83^{b-e}	96^{def}	79de	82^{d}
Iris	88^{c}	77^{bcd}	79^{ab}	103^{bcd}	114^{a}	105^{b}	99^{a-e}	91^{ab}	84^{a-d}	97de	80^{cd}	82^{cd}
MCM 2203	88^{c}	80^{ab}c	79^{ab}	104^{bc}	114^{a}	110^{a}	100^{a-c}	90^{cd}	84^{a-d}	94^{f}	79de	85^{bc}

Nyanga Red	79^{e}	75^{bcd}	71^{ef}	100^{cdef}	111^{a}	99^{cde}	96^{d-g}	87^{ef}	83^{c-e}	99^{cd}	79de	82^{d}
Cim9314-17	93^{a}	84^{a}	77^{bc}	111^{a}	110^{a}	95^{efg}	101^{ab}	88^{e}	86^{ab}	104^{ab}	80^{cd}	88^{b}
APN 136	74^{f}	77^{bcd}	76^{cd}	95^{efgh}	112^{a}	99^{cde}	98^{b-f}	86^{eg}	84^{a-d}	101^{bc}	78^{d-f}	81^{d}
Michigan Pea bean	78^{e}	76^{bcd}	74de	101^{cde}	111^{a}	102^{bc}	100^{a-c}	87^{ef}	83^{c-e}	94^{f}	79^{d-f}	78^{e}
Red Canadian Wonder	74^{f}	74^{bcd}	75^{cd}	93^{fgh}	100^{b}	94^{fgh}	95^{f-h}	78^{h}	81^{d-f}	90^{fg}	81^{c}	80de
Black Bean	68^{g}	75^{bcd}	76^{bcd}	98^{cdefg}	112^{a}	99^{cde}	97^{d-f}	89^{d}	81^{e-f}	92^{fg}	79^{d-e}	78^{e}
Mug 38	91^{a}	76^{bcd}	81^{a}	108^{ab}	111^{a}	96^{b}	101^{ab}	90^{cd}	86^{a}	107^{a}	80^{cd}	93^{a}
Means	**80**	**76**	**75**	**99**	**106**	**98**	**97**	**86**	**82**	**93**	**80**	**81**
LSD	**2**	**6**	**3**	**6**	**7**	**3**	**3**	**2**	**3**	**3**	**2**	**3**
CV%	**5**	**5**	**2**	**4**	**1**	**2**	**2**	**1**	**3**	**18**	**1**	**2**
P-value	**0.045**	**0.021**	**0.035**	**<0.001**	**<0.001**	**0.021**	**0.035**	**0.042**	**0.05**	**0.05**	**0.041**	**0.036**

Table 3: Number of pods/plant and number of seeds per plant

Variety	**Number of pods/plant**	**Number of seeds/plant**
OPS-RSI	10^{ef}	30.4^{ef}
Xan 76	13^{bcde}	52^{bc}
Zebra	10^{def}	25^{f}
Grey Light	12^{bcdef}	41^{cde}
Carioka	15^{ab}	51^{bc}
Natal sugar beans	12bcdef	41^{cde}
Mus 97	14^{abc}	56^{b}
White Kidney	10^{ef}	24^{f}
AND 897	8^{f}	25^{f}
Cim 9406-3	10def	25f
Ren 22	14^{abc}	50^{bc}

Iris	16[ab]	52[bc]
MCM 2203	12bcdef	41[cde]
Nyanga Red	14[abc]	55[b]
Cim9314-17	10[def]	31[ef]
APN 136	14[abc]	45[bcd]
Michigan Pea bean	17[a]	68[a]
Red Canadian Wonder	12bcdef	35[def]
Black Bean	15[ab]	56[b]
Mug 38	11cdef	33[def]
Means	**12.42**	**41.7**
LSD (0.05)	3.4	11.04
CV%	18.1	16.5
P-value	<0.001	<0.001

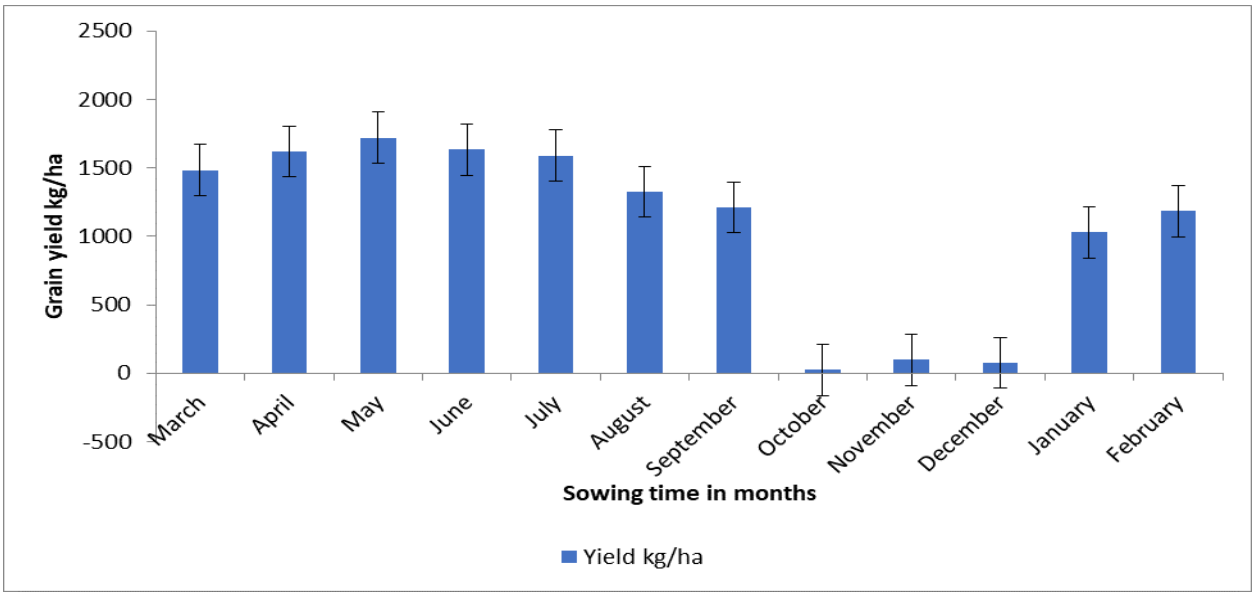

Fig. 1: Average yield performance of 20 sugar beans varieties grown at different times of the year across season.

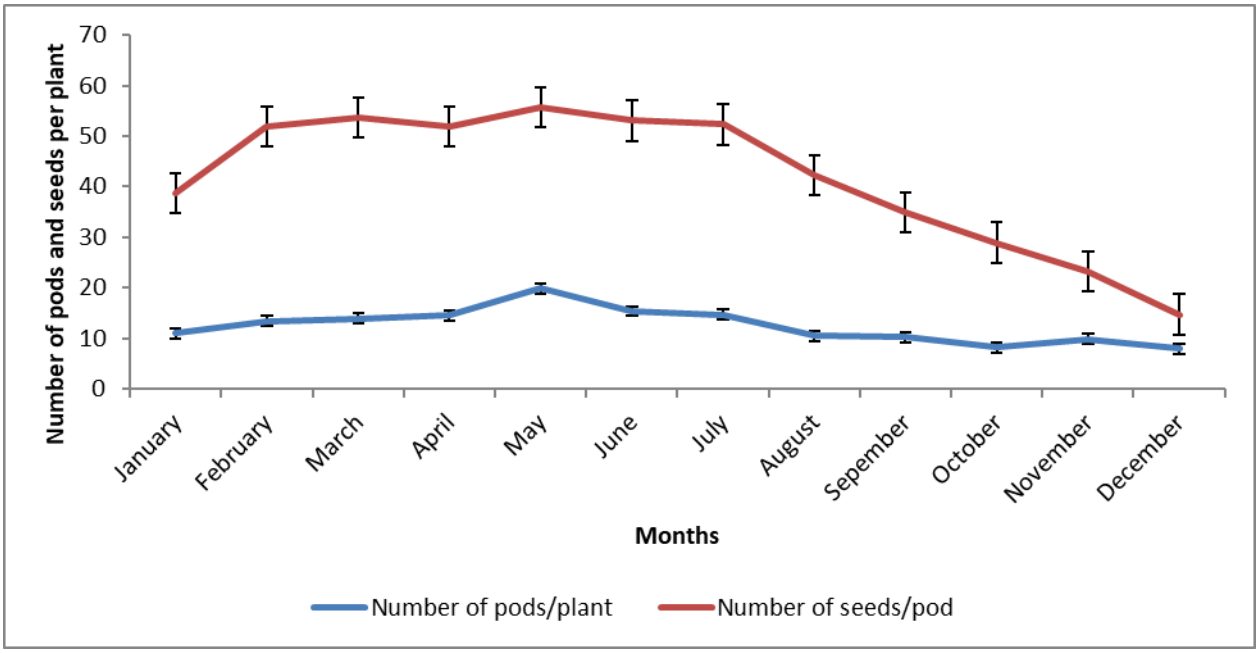

Fig. 2: Average number of pods per plant and average number of seeds per plant

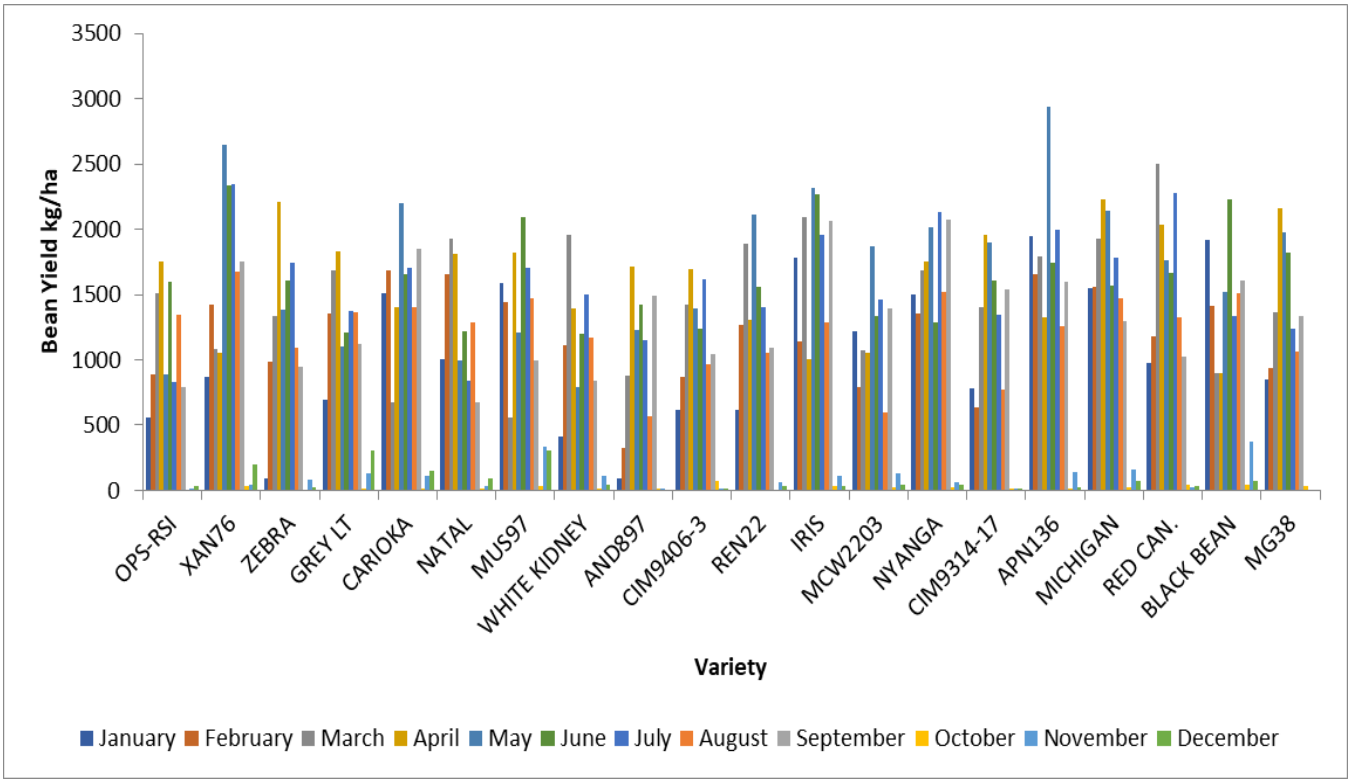

Fig 3: Performance of twenty varieties of beans in relation to sowing dates across season.

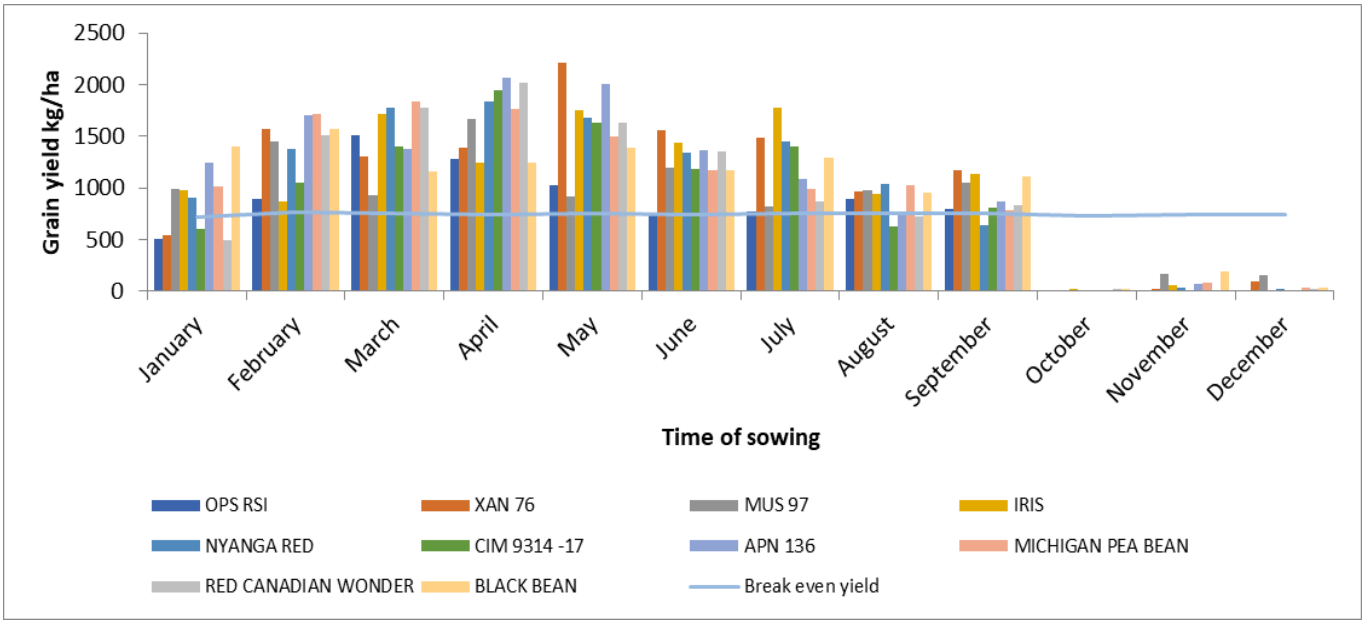

Fig 4: Break-even yield (kg/ha) of 10 best varieties of beans from the trial

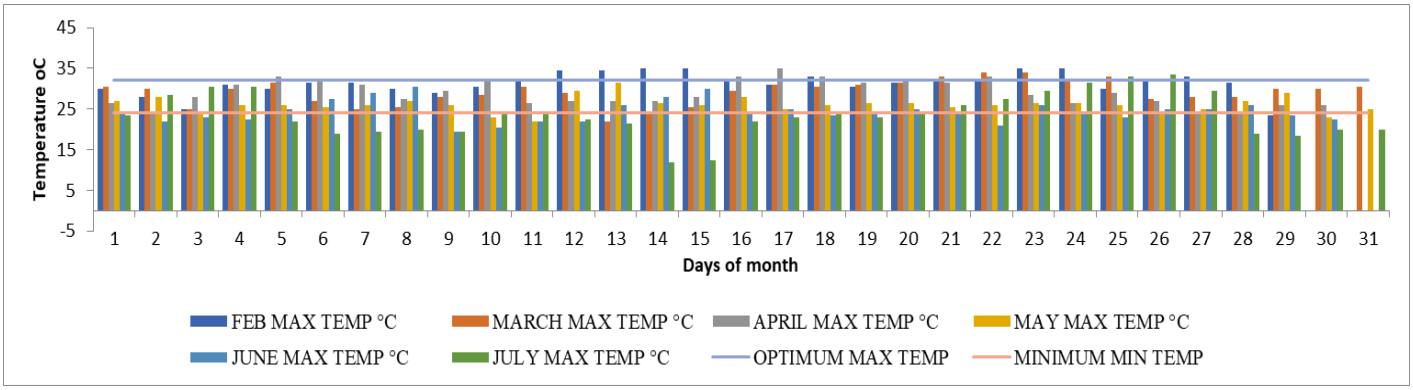

Fig 5: Maximum and minimum temperatures February to July year 1 in relation to optimum temperatures

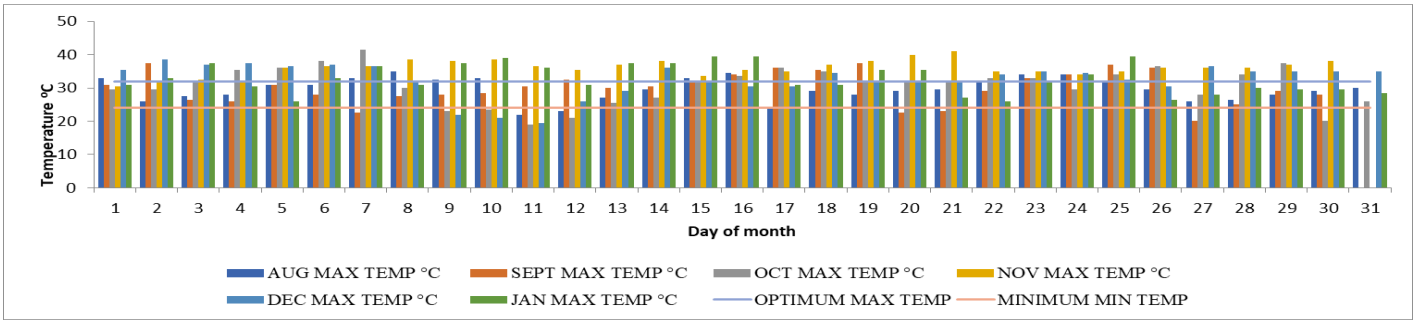

Fig 6: Minimum and maximum temperatures August to January year 1 in relation to optimum temperatures.

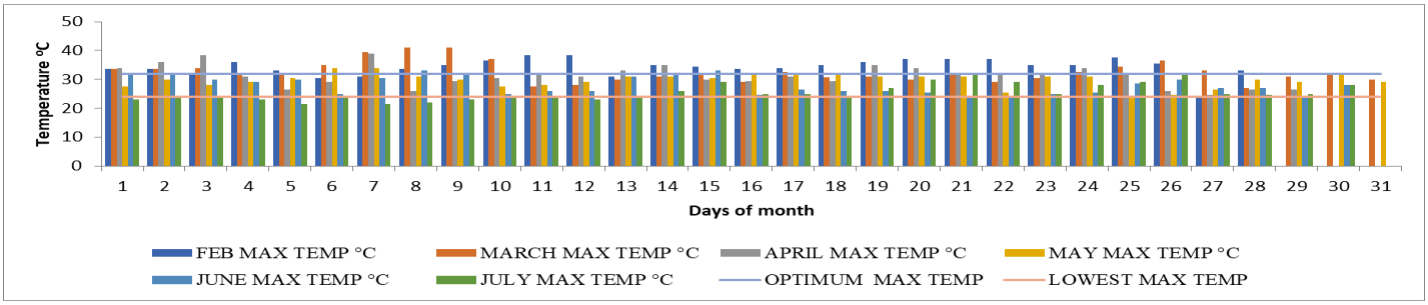

Fig 7: Minimum and maximum temperatures February to July year 2 in relation to optimum temperatures

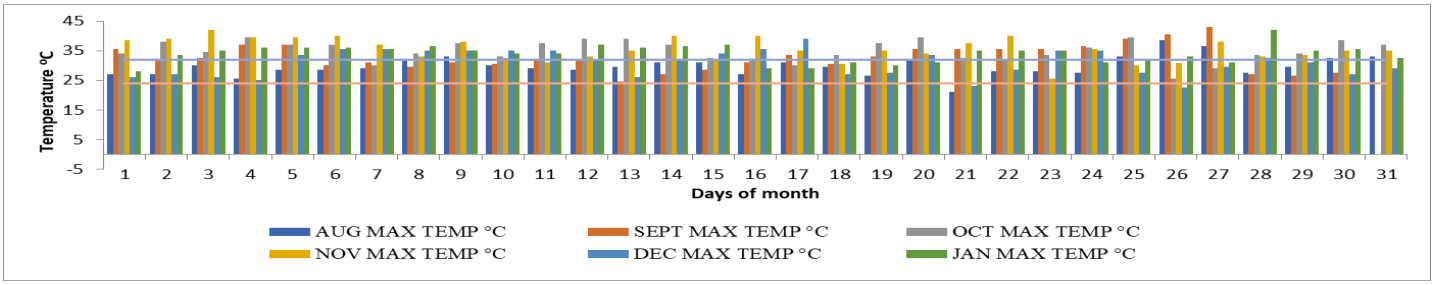

Fig 8: Minimum and maximum temperature August to January year 2 in relation to optimum temperatures

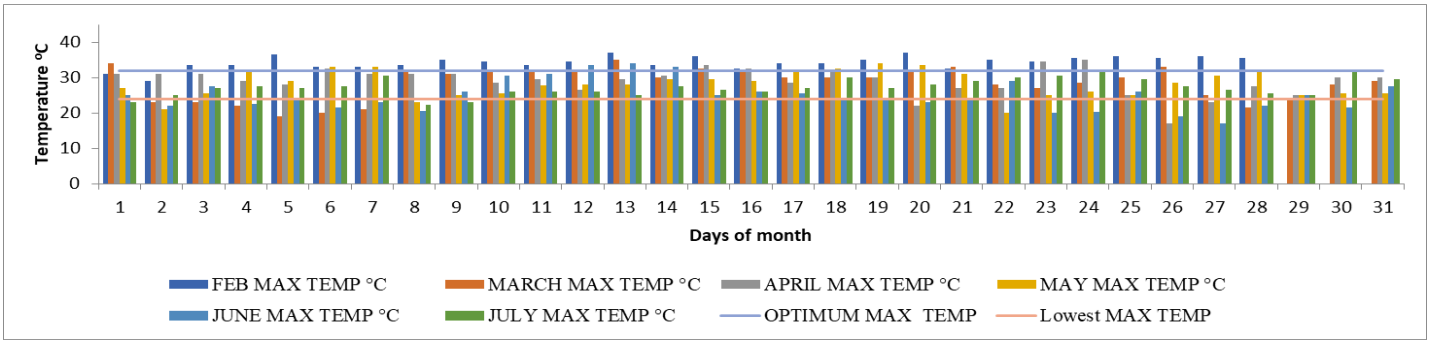

Fig 9: Minimum and maximum temperature February to July year 3 in relation to optimum temperatures

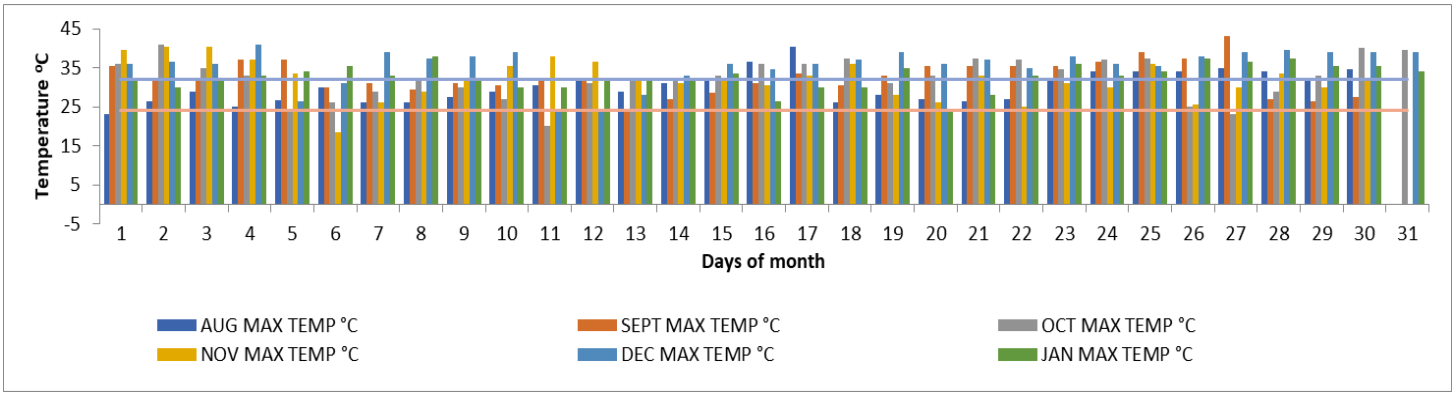

Fig 10: Minimum and maximum temperature August to January year 3 in relation to optimum temperatures.

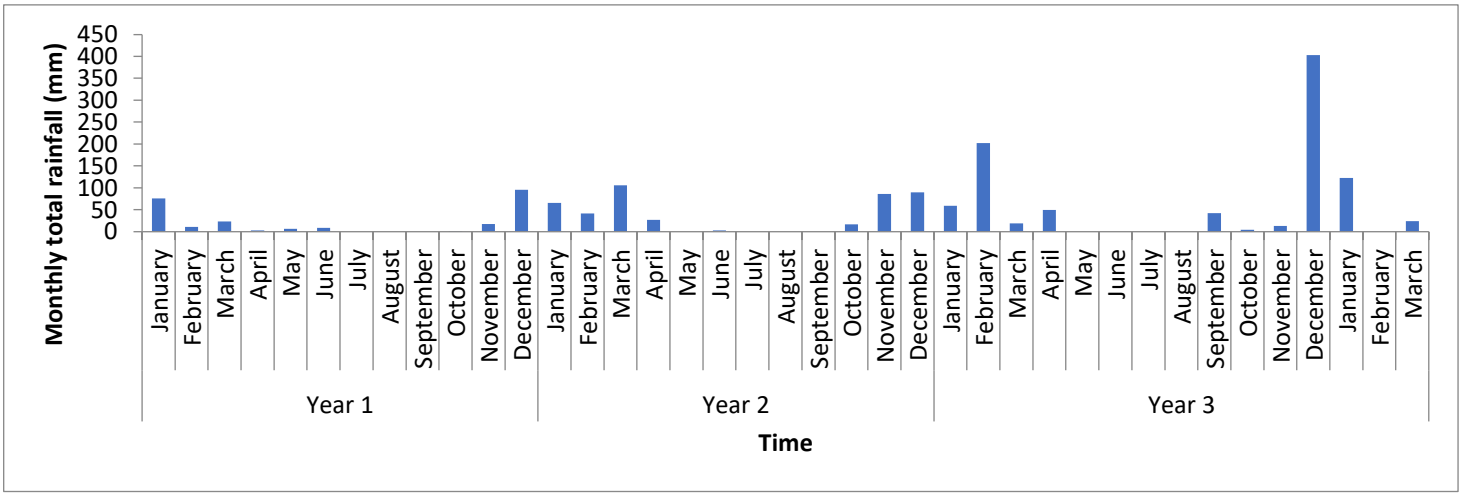

Fig 11: Monthly rainfall totals during the trial period

A combination of rainfall and high temperatures in November, December, January and February caused flower abortion and pod rotting reducing yields of the crop that was sown in October, November, December and January. August, September and October sowing were affected mainly by high temperatures that occurred in September, October and November respectively when flowering takes place causing flower abortion resulting in low counts of pod numbers per plant. In January yield started to rise above breakeven point but not economical (fig 4). Most of these bean varieties performed better from February to July. Varieties that are the best from February to July are Xan 76, Carioka, Red Canadian wonder, APN 136 and Michigan pea bean. Natal sugar bean showed a short range of time from February to April.

Conclusions:

Selection of best varieties, with appropriate sowing dates is a very important factor in increasing the productivity of common beans. The best sowing date was May with an average of 1718 kg/ha across twenty varieties. The best varieties are APN 136 (indeterminate), Michigan Pea Bean (determinate), Red Canadian Wonder (determinate), Xan 76 (indeterminate), Mug 38 (determinate) in that order. The most suitable time for planting was from March to July with yields ranging from 1482 to 1718kg/ha on average. However, there are some varieties that do well when sown in March and July. The highest yields of 2940kg/ha came from APN 136 May sowing. Farmers should not sow a crop that would flower when temperatures are above optimum temperatures to avoid flower abortion. There is also need to avoid maturity of the crop during wet months to avoid diseases like bean rot and flowering during rainy months as flower shedding occurs due to heavy rain drops. Therefore, the results of this study have shown that different sowing dates and varieties had a significant positive influence on the yield of sugar bean.

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