Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(1): 2094-2098
Received: 18-11-2020
Accepted: 21-12-2020

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Physiological analysis for growth and yield of lablab bean (*Lablab purpureus* L. sweet) grown under residual moisture

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Abstract
An experiment was conducted at two locations for two years during rabi season during 2016-17 and 2017-18 in on residual moisture The experiment was laid out with 40 lablab bean genotypes in Randomized Block Design (RBD) with two replications with an object to study the growth attributes and yield attributes in wal genotypes. Among the forty wal genotypes, G15, G10, G16, G26, G27, G29 and G39 showed higher yield as compared to other genotypes. G15 produced highest yield under residual moisture, since it has exhibited higher number of branches, leaf area, total dry matter, higher AGR, RGR, LAI and number of pods per plant. Among all genotypes G10 showed 2nd ranking for yield due to higher number of leaves, higher RGR, NAR, number of pods/plant, 100 seed weight and seed yield (g/plant) when compared with other genotypes.

Keywords: lablab bean, growth and yield attributes, residual moisture

Introduction
Lablab bean (*Lablab purpureus* L. Sweet) chromosome number 2n=22 belongs to family Fabaceae, is one of the most ancient legume species widely distributed in Indian sub-continent, Africa and South East Asia and is consumed locally as a grain legume and vegetable. Lablab bean (Wal) is adaptable to wide range of climate conditions (Kimani *et al.*, 2012) [4] such as arid, semi-arid, sub-tropical and humid region where temperature varies between 220C to 350C, pH range varying from 4.4 to 7.8.

Being a legume, it can fix atmospheric nitrogen. It is being dabbled in standing field of rice at the time of maturity of rice crop in the month of Oct- Nov. In Konkan region it is grown on residual moisture in rice field. In Konkan region, lablab bean local types are of long duration (135- 145 days) and being grown on residual moisture. Hence, the crop is generally subjected to water stress during reproductive and pod development period. This experiment was aimed to reveal the best genotype responsible for sustaining yield level in water deficit condition with the support of morphological and physiological observations.

Materials and Methods
In the present investigation 40 genotypes having different growth and yield characters with varying durations were collected from Education and Research farm, Department of Agricultural Botany, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli and used for this study. The experiment was laid out in randomized block design with two replications, along with 40 treatments (Forty different genotypes of wal) at 30 cm × 20 cm spacing in 3 m × 3 m plot. The experiment was conducted immediately after harvest of Kharif rice without disturbing soil profile in the month Oct, 2016 at Agronomy and Gaontale. During the second-year sowing was done on Oct 2017 in Gaontale, Nov 2017 at Agronomy. Sowing was done on October 2016 and October 2017 at both farms. About 1-2 seeds were dibbled at each hill. Two weeding were done at 20 days and 50 days after sowing. For recording the morphological observations, five plants were selected randomly in each plot. These five plants were marked by using zinc labels. Following observations were taken during course of experimentations a. Plant height (cm) at harvest, b. Number of branches/plant (No.), c. Number of leaves/plant (No.), d. Number of nodes/plant (No.), e. Leaf area/plant(cm2) and f. Total Dry matter(g/plant). The growth parameters such as AGR was estimated as per Watson (1958), RGR as per Briggs *et al* (1920), NAR as per Gregory 1926) and LAI as per Watson (1958). Yield attributes were recorded at harvesting stage.

Morphological observations
Plant height, branching represents the components of structural architecture. The branches have direct relation with total flowers pods and yield in grain legumes. The emergence and expansion of leaves is pivotal to overall growth of a plant. The maintenance of functional leaves at maturity has direct relevance with assimilate supply to grain and hence yield performance of the crops especially under stress condition. The foliage growth highly depends upon the water supply to the plant. Dry matter production accounts for the proportion of assimilation deposited in structural components and indicate the extent of strength of structural frame work of a plant.

Plant height (cm)
A significant variation in plant height was noted among genotypes for years, locations and pooled mean analysis are presented in Table 1. Significantly higher plant height was recorded in G14 (101.21 cm) which was at par with G8 over other genotypes. Significantly lower plant height was recorded in G27 (85.63 cm) over other genotypes. Similar results were also reported by Naik (1990) [6] and Shinde (1998) [8], Naim *et al*. (2007) [7] reported that in cowpea increasing plant stand decreased plant height. Local varieties were taller than other varieties. Increased plant stand increased gram yield per unit area.

Number of branches per plant
In branches per plant, a significant difference was observed among genotypes for years, locations and pooled analysis. In pooled mean of two years, significantly higher number of branches were observed in genotype G16 (6.75/plant) which was at par with G7, G27, G3, G25, G15, G26, G28, G29, G30, G34, G36, G8, G11, G22 and G24 over other genotypes. These results are in conformity with Das *et al*. (2008), Borkar *et al*. (2011) [1], Madasu *et al*. (2012) [5] and Joshi *et al*. (2012) [3]. They reported that number of branches is a yield attributing character in various crops.

Number of leaves per plant
In leaves per plant, a significant difference was observed among genotypes for years, locations and pooled mean analysis. In pooled mean of two years, significantly higher leaves were recorded in G20 (57.44/plant) which was at par G3 and G10 over other genotypes. Significantly lower number of leaves were recorded in G14 (31.10/plant) over other genotypes. Similar results were also reported by Shinde (1998) [8].

Leaf area (cm2/plant)
A significant variation in leaf area per plant was observed among genotypes for years, locations and pooled mean. In pooled mean in two years, significantly higher leaf area was recorded in G3 (582.35 cm2/plant) which was at par with G38, G37, G 20, G10, G11, G 27, G 5, G28, G39 and G2 over other genotypes. Significantly lower leaf area was recorded in G16 over other genotypes. Thrikawela and Bandara (1992) [9] also recorded higher reduction in cumulative leaf area in mung bean genotypes under moisture stress conditions. Mung bean genotypes were found to be more sensitive to moisture stress over that of other legumes and decrease in leaf area was also recorded.

Total dry matter (g/plant)
In total dry matter, a significant difference was recorded among genotypes for years, locations and pooled mean. Significantly higher total dry matter was recorded in G15 (34.54 g/plant) which was at par with G12, G36 and G26 over other genotypes. Significantly lower total dry matter was recorded in G19 over other genotypes. Similar results were also reported by Joshi *et al*. (2012) [3]. They stated that number of branches and total dry matter be considered as yield attributing characters in Indian bean.

Absolute growth rate (g/day/plant)
There was a significant variation found among years and locations and pooled data at harvest. Significantly higher AGR was recorded in G15 (0.663 g/day/plant) which was at par with G11 and G22 over other genotypes. Significantly minimum AGR was recorded in G8over other genotypes.

Relative growth rate (g/g/day)
There was a significant variation found among years and locations and pooled data at harvest. Significantly higher RGR was recorded in G13 (0.0463g/g/day) which was at par with G32, G11, G22, G14, G9, G25, G29, G30, G5, G31, G10, G27, G39 and G15 over other genotypes. Significantly lower RGR was recorded in G8 (0.0315 g/g/day) over other genotypes.

Net Assimilation Rate (g/dm2/day)
There was a significant variation found among years and locations and pooled data at harvest. Significantly higher NAR was recorded in G30 (0.00138 g dm-2day-) which was at par with G18, G2, G22, G38, G2, G39, G4, G10, G27 and G32 over other genotypes. Significantly lower NAR was observed in G26 (0.00058 g dm-2 day-) over other genotypes.

Leaf area index
A significant variation was found among years, locations and pooled data. Significantly maximum LAI was recorded in genotype G3 (0.97) which was at par with G38, G37, G20, G10, G11, G27, G15, G28, G39 and G2 over other genotypes. Significantly 261 minimum LAI was recorded in genotype G16 (0.56) over other genotypes.

Seed yield (kg/ha)
There was a significant variation found among years and locations and pooled data at harvest. Significantly higher seed yield (kg/ha) was recorded in genotype G15 (1888.13 kg/ha) which was at par with G28 and G10 over other genotypes. Significantly lower seed yield (kg/ha) was recorded in genotype G19 (673.13 kg/ha) over other genotypes.

Biological Yield (kg/ha)
There was a significant variation found among years and locations and pooled data at harvest. Significantly higher biological yield (q/ha) was recorded in genotype G15 (3325.84 kg/ha) which was at par with G1, G2, G10, G11, G14, G17, G28, G30, G32, G33 and G37 over other genotypes. Significantly lower biological yield (kg/ha) was recorded in genotype G19 (3026.38 kg/ha) over other genotypes.

Harvest Index
The data regarding harvest index, showed a significant variations in both the years, locations and pooled mean data. Significantly higher harvest index was recorded in genotype G27 (28.37%) which was at par with G10, G15, G16 and G28 over other genotypes. Significantly lower harvest index was recorded in genotype G4 and G19 (10.70%) over other genotypes.

Table 2: Mean performance of different lablab bean genotypes for growth characters grown under residual moisture.

Genotypes	Height (cm)	Branches Per Plant	Leaves per plant	Leaf area (cm2/plant)	Total dry matter (g/plant)
G1	91.63	5.75	40.34	450.83	28.34
G2	96.25	5.50	42.37	502.99	28.45
G3	97.29	6.38	57.30	582.35	28.91
G4	95.40	5.75	38.34	438.11	27.49
G5	97.74	5.75	39.16	430.31	29.11
G6	96.94	5.50	38.79	427.65	29.79
G7	94.90	6.50	34.16	397.61	32.13
G8	100.49	6.13	41.62	440.84	29.66
G9	93.59	5.38	34.00	375.33	30.15
G10	92.78	5.25	55.38	563.43	31.70
G11	92.26	6.13	51.06	552.38	31.56
G12	94.19	4.88	38.87	426.57	32.91
G13	93.84	6.00	39.13	439.02	32.28
G14	101.21	4.88	31.10	397.55	32.28
G15	98.73	6.25	37.96	547.38	34.54
G16	92.36	6.75	36.84	335.12	32.01
G17	90.00	5.75	39.54	422.55	31.74
G18	88.89	5.25	40.06	412.14	30.22
G19	90.56	5.88	42.89	458.58	26.22
G20	90.39	5.13	57.44	567.56	28.14
G21	92.98	6.00	36.61	376.19	30.51
G22	90.10	6.13	41.43	471.17	29.00
G23	96.16	6.00	33.53	352.78	28.48
G24	93.60	6.13	31.50	374.11	30.25
G25	89.95	6.38	37.91	420.73	32.32
G26	90.10	6.25	34.69	409.99	32.57
G27	85.63	6.50	50.58	551.56	29.50
G28	93.18	6.25	53.62	530.76	31.66
G29	90.94	6.25	39.11	363.41	31.62
G30	89.59	6.25	38.51	353.55	30.56
G31	97.33	6.00	37.18	347.43	32.23
G32	97.61	6.00	35.94	398.12	32.35
G33	92.58	5.25	40.48	383.14	31.28
G34	91.85	6.25	41.43	454.12	32.08
G35	91.56	5.50	40.45	485.68	30.64
G36	94.20	6.25	35.17	429.72	32.84
G37	94.59	5.50	52.79	573.18	29.08
G38	96.51	5.38	50.92	577.84	29.16
G39	91.83	5.75	40.71	508.27	29.50
G40	96.43	5.88	42.34	449.98	30.59
S.E±	0.55	0.25	0.895	30.081	0.74
C.D at 5%	1.57	0.71	2.561	86.048	2.13

Table 2: Mean performance of different lablab bean genotypes for growth parameters grown under residual moisture (At 60-80 DAS)

Genotypes	AGR (g/day/plant)	RGR (g/g/day)	NAR (g/dm2 /days)	LAI
G1	0.474	0.0364	0.00109	0.75
G2	0.482	0.0357	0.00124	0.84
G3	0.483	0.0342	0.00107	0.97
G4	0.575	0.0395	0.00122	0.73
G5	0.600	0.0443	0.00103	0.72
G6	0.470	0.0366	0.00063	0.71
G7	0.508	0.0399	0.00088	0.66
G8	0.400	0.0315	0.00069	0.73
G9	0.581	0.0450	0.00101	0.63
G10	0.598	0.0436	0.00122	0.94
G11	0.650	0.0461	0.00098	0.92
G12	0.571	0.0405	0.00103	0.71
G13	0.611	0.0463	0.00082	0.73
G14	0.606	0.0452	0.00084	0.66
G15	0.663	0.0421	0.00112	0.91
G16	0.516	0.0384	0.00074	0.56
G17	0.536	0.0401	0.00101	0.70
G18	0.549	0.0401	0.00116	0.69
G19	0.468	0.0418	0.00115	0.76
G20	0.467	0.0365	0.00099	0.95
G21	0.535	0.0379	0.00096	0.63

G22	0.637	0.0457	0.00126	0.79
G23	0.493	0.0361	0.00076	0.59
G24	0.551	0.0414	0.00098	0.62
G25	0.599	0.0448	0.00090	0.70
G26	0.510	0.0406	0.00058	0.68
G27	0.568	0.0435	0.00119	0.92
G28	0.548	0.0405	0.00101	0.88
G29	0.606	0.0446	0.00130	0.61
G30	0.592	0.0445	0.00138	0.59
G31	0.595	0.0438	0.00092	0.58
G32	0.603	0.0462	0.00117	0.66
G33	0.543	0.0410	0.00075	0.64
G34	0.557	0.0394	0.00069	0.76
G35	0.583	0.0404	0.00105	0.81
G36	0.541	0.0416	0.00087	0.72
G37	0.548	0.0403	0.00093	0.96
G38	0.570	0.0414	0.00125	0.96
G39	0.597	0.0432	0.00123	0.85
G40	0.528	0.0388	0.00096	0.75
S.E±	0.015	0.0016	0.00008	0.050
C.D at 5%	0.043	0.0045	0.00022	0.143

Table 3: Mean performance of different lablab bean genotypes for yield parameters grown under residual moisture

Genotypes	Seed yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
G1	1357.50	3279.30	20.14
G2	1580.63	3311.11	24.54
G3	1042.50	3054.00	16.60
G4	690.00	3139.89	10.70
G5	1121.25	3177.28	17.20
G6	716.25	3118.08	10.74
G7	933.75	3218.98	14.13
G8	1128.75	3164.04	17.38
G9	1093.13	3068.95	17.34
G10	1871.25	3251.70	28.25
G11	1428.75	3290.54	20.96
G12	746.25	3238.54	11.20
G13	832.50	3186.38	12.72
G14	907.50	3266.98	13.62
G15	1888.13	3325.84	27.63
G16	1809.38	3166.38	27.81
G17	1057.50	3292.63	15.63
G18	901.88	3114.63	14.08
G19	673.13	3026.38	10.70
G20	1025.63	3095.19	16.12
G21	1096.88	3176.17	16.80
G22	1263.75	3202.41	19.22
G23	958.13	3174.92	14.68
G24	1173.75	3175.48	17.98
G25	873.75	3067.57	13.86
G26	1691.25	3072.45	26.80
G27	1775.63	3046.09	28.37
G28	1875.00	3269.67	27.92
G29	1743.75	3136.73	27.05
G30	1233.75	3253.42	18.45
G31	1070.63	3180.98	16.38
G32	1020.00	3303.04	15.02
G33	1048.13	3263.35	15.61
G34	1059.38	3162.19	16.33
G35	791.25	3088.80	12.47
G36	984.38	3247.42	14.75
G37	1089.38	3304.36	16.31
G38	1323.75	3153.16	20.43
G39	1665.00	3090.13	26.23
G40	1160.63	3175.13	17.80
S.E±	8.44	26.76	0.291
C.D at 5%	24.16	76.54	0.831

Conclusion

Among the forty genotypes grown under residual moisture for two years and two locations G15, G10, G16, G26, G27, G29 and G39 showed significantly higher yield as compared to other genotypes. G15 produced highest yield under residual moisture, since it has exhibited higher number of branches, leaf area, total dry matter, higher number of pods per plant. Among all genotypes G10 showed 2nd ranking for yield due to higher number of leaves, higher RGR, NAR, number of pods/plant, 100 seed weight and seed yield when compared with other genotypes.

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