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Growth and Development Pattern of Soybean Genotypes Under Different Fertilizer Levels and Spacings

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Abstract: *From the present investigation, it is concluded that the genotype MAUS-158, fertilizer level 37.5:75:37.5 and spacing 45 x 05 cm was found to be superior in respect of growth characters like plant height, number of functional leaves, leaf area, number of branches, total dry matter accumulation.*

Keywords: *Soybean, varieties, spacing, growth and development.*

INTRODUCTION

Soybean is natures most precious gift and on account of its three dimensional utility as pulse, oilseed and vegetable. The soybean seeds on an average contain 40% protein, 21% fat, 34% carbohydrates (including crude fibre and nitrogen free extract) and 5 % ash (Kawamura, 1960). It is often designated as golden bean and has become the miracle crop of the 21st century. In Maharashtra, soybean crop was grown on an area of 38.704 lakh ha in 2013-14 with an annual production of 48.565 lakh metric tones and productivity of 1255 kg ha^{-1} (SOPA, 2013).

The varieties show differential behavior in their per plant requirement because of their differential growth characters. There must be good conditions for proper growth and development and offering higher yield which can be achieved through balanced nutrition comprising Nitrogen (N) and adequate supply of Phosphorus (P) and Potassium (K). Establishment of an optimum plant density per unit area is a non-monetary input factor for getting higher soybean production. There is a considerable scope for increasing soybean yield by proper adjustment of spacing (Balyan and Mehta, 1985).spacing has a significant influence on the yield of soybean. It is therefore, very essential to find out the optimum plant population with its proper geometry to get maximum production.

MATERIAL AND METHODS

The field experiment was conducted at AICRP on Integrated Farming Systems, VNMKV, Parbhani during *kharif* 2013. The soil of the experimental field was clayey in texture, medium in available N (213 kg ha^{-1}), medium in available P (15.6 kg ha^{-1}), and high in available K (574 kg ha^{-1}). The soil was slightly alkaline in reaction (pH 7.7). The experiment was laid out in a split plot design with three replications. The treatments were used in the study as follows:

TREATMENT DETAILS

Main plot

1. Varieties

V_1 - MAUS - 71
V_2 - MAUS – 158

2. Fertilizer levels

F_1 - 100 % RDF (30:60:30 NPK Kg ha^{-1})
F_2 - 125% RDF (37.5:75:37.5 NPK Kg ha^{-1})

Sub – plot

3. Spacings

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S_1 – 60 x 05 cm
S_2 – 60 x 10 cm
S_3 – 30 x 30 cm
S_4 – 45 x 05 cm

The seeds were sown by dibbling at the spacings used in the experiment. The fertilizer treatments were applied at the time of sowing for recording observations on growth. Five plants from each net plot were randomly selected and labeled.

Following growth characters were studied like plant height, number of functional leaves, leaf area, number of branches and total dry matter accumulation.

RESULTS AND DISCUSSION

Effect on plant height per plant (cm)

Data on periodical mean plant height are presented in table 1. Data reveal that, in general the mean plant height of all the treatments increases rapidly up to 60 DAS and thereafter the increase in plant height slowed down. The variety V_2 - MAUS – 158 recorded significantly the highest plant height which was significantly superior over the V_1 - MAUS – 71. This could be attributed to genetic makeup of varieties. Similar results were quoted by Ruhul Amin *et al* (2009). The fertilizer level F_2 - 125% RDF (37.5:75:37.5 NPK Kg ha^{-1}) recorded significantly the highest plant height over the F_1 - 100 % RDF (30:60:30 NPK Kg ha^{-1}).

In case of spacing S_4 – 45 x 05 cm recorded maximum plant height which was significantly superior over the rest of the spacings. But S_1 – 60 x 05 cm and S_2 – 60 x 10 cm remains at par with each other. The probable reason for this may be the availability of more space for plant and less competition for space, nutrient, moisture and light. Similar results were reported by Arora (1981).

Effect on mean number of leaves per plant

Data in respect of mean number of leaves per plant are presented in Table 2. The data revealed that mean number of leaves per plant increased up to 60 DAS of crop growth and thereafter declined up to harvest, due to senescence of old leaves at time of maturity.

At 75 DAS, the genotype V_2 - MAUS – 158 (25.34) had significantly higher mean number of leaves per plant than V_1 - MAUS – 71 (21.91). The fertilizer level of 125% RDF (24.84) produced significantly superior number of leaves than the other level. Whereas, in that of spacing S_1 produced significantly superior number of leaves over S_3 and S_4 but remains at par with S_2. Similar results were reported by Arora (1981).

Effect on mean leaf area per plant (cm^2)

Data on mean leaf area per plant are presented in table 3. In general, the mean leaf area of all the genotypes increased linearly upto 60 DAS and thereafter it declined towards maturity due to senescence of leaves.

At 75 DAS, the genotype V_2 (MAUS-158) (1611.7 cm^2) produced significantly higher mean area per plant followed by the genotype V_1 (MAUS-71) (1373.0 cm^2). According to Pawar (1978), Leaf area index was less at seedling stage and increased continuously up to 60 DAS and thereafter it declined. Among the fertilizer levels application of 125% RDF (1555.9) produced the maximum leaf area over the 100% fertilizer level (1373.0). The same consequence was quoted by Raut *et al* (2003). Whereas, in that of spacing significantly superior maximum leaf area per plant recorded by spacing S_1 (60 x 05 cm) over S_4 (45 x 05 cm) at all the growth stages and it was on par with S_2 (60 x 10 cm) at all the growth phases and with S_3 (30 x 30 cm) at 30 and 75 DAS. The results are in the line with earlier findings reported by Jadhav *et al* (1994).

Table 1
Mean plant height (cm) as influenced by different treatments during various growth stages of crop

Treatment	*DAS*				*At*
	30	*45*	*60*	*75*	*harvest*
Varieties (V)					
V_1 - MAUS-71	28.81	49.88	54.79	57.63	60.10
V_2 - MAUS-158	28.94	54.86	62.37	65.04	66.73
S.E. ±	1.51	0.78	0.37	1.08	1.09
C.D. at 5 %	NS	2.69	1.29	3.76	3.76
Fertilizer levels (F)					
F_1 - 100 % RDF	28.45	51.15	57.10	59.30	61.49
F_2 - 125 % RDF	29.30	53.59	60.05	63.37	65.34
S.E.±	1.51	0.78	0.37	1.08	1.09
C.D. at 5 %	NS	2.69	1.29	3.76	3.76
Spacings (S)					
S_1 - 60 x 05 cm	29.51	52.86	58.76	61.38	63.59
S_2 - 60 x 10 cm	28.50	51.69	58.06	61.11	63.33
S_3 - 30 x 30 cm	26.85	51.20	57.29	57.74	58.73
S_4 - 45 x 05 cm	30.64	53.73	60.21	66.08	68.00
S.E.±	1.58	1.03	0.15	1.38	1.35
C.D. at 5 %	NS	NS	1.49	4.03	3.95
Interaction (V x F)					
S.E. ±	2.14	1.10	0.52	1.54	1.54
C.D. at 5%	NS	NS	NS	NS	NS
Interaction (V x S)					
S.E. ±	2.24	1.46	0.72	1.96	1.92
C.D. at 5%	NS	NS	NS	NS	NS
Interaction (F x S)					
S.E. ±	2.24	1.46	0.72	1.96	1.92
C.D. at 5%	NS	NS	NS	NS	NS
Interaction (V x F x S)					
S.E. ±	3.17	2.06	1.02	2.77	2.71
C.D. at 5%	NS	NS	NS	NS	NS
General mean	28.87	52.37	58.58	61.34	63.41

Table 2
Mean number of functional leaves plant^{-1} as influenced by different treatments during various growth stages of crop

Treatment	*DAS*			
	30	*45*	*60*	*75*
Varieties (V)				
V_1 - MAUS-71	6.84	12.57	20.16	21.91
V_2 - MAUS-158	7.49	15.43	25.23	25.34
S.E. ±	0.32	0.26	0.23	0.19
C.D. at 5 %	NS	0.91	0.82	0.68
Fertilizer levels (F)				
F_1- 100 % RDF	6.89	13.00	20.85	22.42
F_2- 125 % RDF	7.44	14.99	24.55	24.84
S.E. ±	0.32	0.26	0.23	0.19
C.D. at 5 %	NS	0.91	0.82	0.68
Spacings (S)				
S_1 - 60 x 05 cm	7.82	14.92	23.67	24.82
S_2 - 60 x 10 cm	7.34	14.12	22.88	23.74
S_3- 30 x 30 cm	6.81	13.60	22.35	23.45
S_4- 45 x 05 cm	6.69	13.34	21.89	22.50
S.E. ±	0.46	0.35	0.38	0.43
C.D. at 5 %	NS	1.03	1.13	1.26
Interaction (V x F)				
S.E. ±	0.45	0.37	0.33	0.27
C.D. at 5 %	NS	NS	1.16	0.96
Interaction (V x S)				
S.E. ±	0.65	0.50	0.55	0.61
C.D. at 5 %	NS	NS	NS	NS
Interaction (F x S)				
S.E. ±	0.65	0.50	0.55	0.61
C.D. at 5 %	NS	NS	NS	NS
Interaction (V x F x S)				
S.E. ±	0.92	0.70	0.77	0.87
C.D. at 5 %	NS	NS	NS	NS
General mean	7.16	14.00	22.70	23.63

Effect on mean number of branches per plant

The data on the mean number of branches per plant are presented in table 4. It was revealed that variety MAUS-158 found significantly superior over MAUS-71 from 45 DAS onwards up to harvest of the crop. Sharief *et al* (2010) also found significant variation in number of branches due to different genotypes. Both the fertilizer levels influenced significantly the number of branches during all growth stages. Application of 125% RDF found significantly superior over 100% RDF level. More *et al* (2006) reported the same results.

There was significant variation in case of mean numbers of branches per plant due to different spacings at all the dates of observation. The spacing S_1 (60 x 05 cm) recorded maximum number of branches per plant which was significantly superior over S_4 (45 x 05 cm) and S_3 (30 x 30 cm) at 60 and 75 DAS but at par with S_2 (60 x 10 cm) at 45 and 75 DAS respectively. The results are in conformity with Nimje (1996).

Effect on mean total dry matter accumulation per plant

Data in respect of mean dry matter accumulation (gm) per plant is presented in table 5. It was revealed that the mean dry matter accumulation per plant increased progressively upto 75 DAS. Varieties differed significantly in respect of total dry matter per plant at all the growth stages of crop except at 30 DAS. Variety MAUS-158 recorded significantly higher dry matter than MAUS-71. Larger leaf area resulted in more photosynthetic activities and more accumulation of carbohydrates which in turn increased dry matter accumulation. Chiezy and odunze (2005) studied parallel results in respect of total dry matter accumulation.

Both the fertilizer levels produced significant effect during all the growth stages of crop. The fertilizer level 125% RDF recorded the highest amount of dry matter accumulation per plant. Raut *et al* (2003) reported the same results.

Mean total dry matter accumulation per plant was influenced significantly due to different spacing at all

Table 3
Mean leaf area (cm^2) plant^{-1} as influenced by different treatments during various growth stages of crop

Treatment	*DAS*			
	30	*45*	*60*	*75*
Varieties (V)				
V_1 - MAUS-71	358.92	1243.2	1317.1	1373.0
V_2 - MAUS-158	389.17	1416.2	1565.5	1611.7
S.E. ±	17.28	10.34	25.95	24.46
C.D. at 5%	NS	35.75	89.67	84.52
Fertilizer levels (F)				
F_1- 100 % RDF	376.71	1274.6	1386.9	1428.8
F_2- 125 % RDF	371.38	1384.9	1495.7	1555.9
S.E. ±	17.28	10.34	25.95	24.46
C.D. at 5%	NS	35.75	89.67	84.52
Spacings(S)				
S_1 - 60 x 05 cm	416.00	1375.0	1501.0	1551.3
S_2 - 60 x 10 cm	393.58	1351.2	1470.8	1516.8
S_3- 30 x 30 cm	378.50	1335.8	1413.3	1476.8
S_4- 45 x 05 cm	308.08	1257.0	1380.0	1424.3
S.E. ±	21.13	21.68	28.35	25.47
C.D. at 5%	61.57	63.21	82.63	74.47
Interaction (V x F)				
S.E. ±	24.44	14.63	36.70	34.59
C.D. at 5%	NS	NS	NS	NS
Interaction (V x S)				
S.E. ±	29.88	30.67	40.09	36.03
C.D. at 5%	NS	NS	NS	NS
Interaction (F x S)				
S.E. ±	29.88	30.67	40.09	36.03
C.D. at 5%	NS	NS	NS	NS
Interaction (V x F x S)				
S.E. ±	42.25	30.67	56.70	50.95
C.D. at 5%	NS	NS	NS	NS
General mean	374.54	1329.8	1441.3	1492.3

Table 4
Mean number of branches plant^{-1} as influenced by different treatments during various growth stages of crop

Treatment	*DAS*			*At*
	45	60	75	*harvest*
Varieties (V)				
V_1 - MAUS-71	2.66	3.21	3.75	4.03
V_2 - MAUS-158	3.39	4.11	4.99	5.24
S.E. ±	0.05	0.09	0.08	0.09
C.D. at 5%	0.18	0.31	0.28	0.31
Fertilizer levels (F)				
F_1- 100% RDF	2.80	3.47	4.07	4.30
F_2- 125% RDF	3.25	3.85	4.68	4.97
S.E. ±	0.05	0.09	0.08	0.09
C.D. at 5%	0.18	0.31	0.28	0.31
Spacings(S)				
S_1 - 60 x 05 cm	3.22	3.91	4.68	5.10
S_2 - 60 x 10 cm	3.08	3.69	4.41	4.65
S_3- 30 x 30 cm	2.98	3.56	4.31	4.45
S_4- 45 x 05 cm	2.83	3.49	4.09	4.34
S.E. ±	0.07	0.06	0.11	0.09
C.D. at 5%	0.21	0.18	0.33	0.27
Interaction (V x F)				
S.E. ±	0.07	0.12	0.11	0.13
C.D. at 5%	NS	NS	NS	NS
Interaction (V x S)				
S.E. ±	0.10	0.09	0.16	0.13
C.D. at 5%	NS	NS	NS	NS
Interaction (F x S)				
S.E. ±	0.10	0.09	0.16	0.13
C.D. at 5%	NS	NS	NS	NS
Interaction (V x F x S)				
S.E. ±	0.14	0.12	0.23	0.19
C.D. at 5%	NS	NS	NS	NS
General mean	3.03	3.66	4.37	4.63

the growth stages of crop growth. The treatment of 60 x 05 cm spacing was found to be significantly superior over rest of spacings in recoding total dry matter per plant at all the growth stages except at 30 and 45 DAS, where it was on par with the spacing S_2 (60 x 10 cm) and S_3 (30 x 30 cm) and S_2 (60 x 10 cm) respectively. Increase in dry matter accumulation per plant was the cumulative effect of increase in various growth characters like number of branches per plant, number of leaves per plant, leaf area per plant. The results are in confirmation with Nimje (1996).

Interaction effect

The interaction of V x F was found to be significant in influencing the number of functional leaves plant^{-1} at 60 and 75 DAS. Data from Table 6 indicating that, interaction of V_2F_2 at 60 and 75 days of crop age recorded significantly higher number of functional leaves than all the other combinations of varieties and fertilizer levels.

The interaction of V x F was found to be effective in influencing total dry matter accumulation at 75 DAS. Data from Table 7 indicated that, the combinations of V_2F_2 recorded significantly higher dry matter plant^{-1} (g) accumulation (32.06 g) over V_1F_1, V_1F_2 and V_2F_1

Table 5
Total dry matter plant^{-1} (g) as influenced by different treatments during various growth stages of crop

Treatment	*DAS*				*At*
	30	*45*	*60*	*75*	*harvest*
Varieties (V)					
V_1 - MAUS-71	3.35	8.44	19.14	28.62	30.50
V_2 - MAUS-158	3.20	10.30	21.96	30.90	32.51
S.E. ±	0.17	0.13	0.33	0.20	0.47
C.D. at 5%	NS	0.48	1.14	0.72	1.63
Fertilizer levels (F)					
F_1- 100% RDF	3.18	8.84	19.84	29.00	30.89
F_2- 125% RDF	3.36	9.90	21.26	30.52	32.12
S.E. ±	0.17	0.13	0.33	0.20	0.47
C.D. at 5 %	NS	0.48	1.14	0.72	1.63
Spacings (S)					
S_1 - 60 x 05 cm	3.62	9.76	22.30	31.41	35.33
S_2 - 60 x 10 cm	3.61	9.49	20.59	29.86	31.84
S_3- 30 x 30 cm	3.35	9.21	20.45	29.46	31.21
S_4- 45 x 05 cm	2.52	9.03	18.87	28.30	30.64
S.E. ±	0.18	0.23	0.37	0.42	1.06
C.D. at 5%	0.55	0.68	1.09	1.25	3.09
Interaction (V x F)					
S.E. ±	0.25	0.19	0.46	0.29	0.66
C.D. at 5%	NS	NS	NS	1.01	NS
Interaction (V x S)					
S.E. ±	0.26	0.33	0.53	0.60	1.50
C.D. at 5%	NS	NS	NS	NS	NS
Interaction (F x S)					
S.E.±	0.26	0.33	0.53	0.60	1.50
C.D. at 5%	NS	NS	NS	NS	NS
Interaction (V x F x S)					
S.E. ±	0.37	0.46	0.75	0.85	2.12
C.D. at 5%	NS	NS	NS	NS	NS
General mean	3.27	9.37	20.55	29.76	31.51

Table 6
Mean number of functional leaves plant^{-1} as influenced by (V x F) interaction at 60 and 75 DAS

Treatment	*60 DAS*		*75 DAS*	
	F_1	F_2	F_1	F_2
V_1	17.44	22.89	20.37	23.46
V_2	24.26	26.21	24.46	26.23
S.E.+	0.33		0.27	
C.D. at 5 %	1.16		0.96	

Table 7
Mean dry matter plant^{-1} (g) as influenced by (Varieties x Fertilizer levels) interaction

Treatment	F_1	F_2
V_1	28.25	28.98
V_2	29.75	32.06
S.E.±	0.29	
C.D. at 5 %	1.01	

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