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Evaluation of soybean varieties for Kymore plateau and Satpura hills zone of Madhya Pradesh

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Abstract
The field experiment entitled "Evaluation of Soybean varieties for Kymore Plateau and Satpura Hills zone of Madhya Pradesh" was carried out during Kharif season of 2017-18 at Product Testing Unit, Department of Agronomy, JNKVV, Jabalpur. The investigation was aimed to identify the most suitable variety of soybean for Kymore Plateau and Satpura Hills zone of Madhya Pradesh was laid out in Randomized Complete Block Design with three replications and nine treatments. Data on growth parameters (viz., plant population, plant height, branches/plant, root nodules/plant) phenological characters (viz. days to flower initiation, days to 50% flowering and days to maturity), on weeds (viz., weed smothering efficiency) at the different intervals and harvest, yield attributes (pods/plant, seeds/pod and seed index) were taken. Study revealed that soybean cv.JS 20-69 was significantly superior in growth and yield attributing parameters. Phonological characters were significantly earlier attained by JS 95-60. Both seed and stover yields were significantly higher in soybean cv. JS 20-69. However, the variety Pandrinath-1 was found inferior as compare to other varieties. Soybean cv. JS 97-52 was superior in weed smothering efficiency (WSE). The variety JS 20-69 was also found more remunerative as it attained higher value of NMR (Rs.42,909) and B:C ratio (2.34).

Keywords: Pandrinath-1, varieties, WSE, soybean

Introduction
The soybean (*Glycine max* L.) is a leguminous crop, that can grows in tropical and sub tropical climate. Soybean is considered "Miracle Crop" or "Wonder Crop" owing to its good quality vegetable protein and edible oil. It is native of China and was introduced to India in 1968, from USA. It has emerged as one of the important commercial crops in many countries. Soybean seed contains 20 per cent oil, 40 per cent protein, 30 per cent carbohydrates, 4 per cent saponins, 5 per cent fiber, and contain no cholesterol. It commonly used as pulses, oil seeds, vegetarian meals and milk. Being a leguminous crop it improves soil fertility by fixing atmospheric nitrogen at the rate of 65-115 kg/ha/year with the process of symbiosis through *Rhizobium japonicum* (Eagleshan *et al.* 1983) [8]. Thus it is soil fertility builder and eco-friendly. Currently in India, it is grown in 11.67 million hectares with the production of 8.59 million tonnes (IASRI, 2017) [3]. Madhya Pradesh is a leading state in India for cultivation of soybean, where it is grown in 5.9 million hectares with the total production of 4.5 million tonnes. But the productivity is only 737 kg/ha, which is far below than its yield potential i.e. 2500 kg/ha (SOPA, 2016) [24]

Varietal adaptation and sub-optimal plant stand are the important factors which are generally associated with the productivity of crops. The old and degenerated cultivars due to their low yield potential and other draw backs like late maturity, shattering habit, poor response to fertilizers, irrigation, susceptibility to diseases and insect pests having poor yield productivity as compare to improved suitable cultivars of the region. Soybean seed yield can be increase by the adoption of suitable variety, improved agronomic practices and suitable soil moisture at the critical growth period. Varieties play an unique role in maximization of yield by improving the fertilizer use efficiency, water-use efficiency and cultural practices. Development of the new varieties with most desirable characters for a particular region is a continuous process under the plant breeding programme. Thus the selection of suitable cultivar of soybean is of prime importance as the genetic potential of a variety limits the expression of its yield and affects plant growth in response of environmental condition (Singh *et al.*, 2010) [23].

The newly developed soybean genotypes are available to soybean growers under different agro-climatic conditions. It was, therefore, essential to evaluate the most suitable variety for Kymore plateau and Satpura hills agroclimatic zone of Madhya Pradesh to achieve maximum productivity of soybean.

Keeping above facts in view, the present experiment entitled "Evaluation of Soybean varieties for Kymore Plateau and Satpura Hills zone of Madhya Pradesh" was undertaken to identify the most suitable varietyfor increasing the production of soybean.

Materials and Methods

A field experiment was conducted during *kharif* season of the year 2017 at Product Testing Unit, Department of Agronomy, Jawaharlal Nehru Kirshi Vishwa Vidyalaya, Jabalpur (M.P.). The monsoon commenced in the first week of July and terminated in the 1st week of October. The total rainfall received during the crop season was 912.58 mm, which was unequally distributed in 44 rainy days from June last week to 4th week of October. Minimum and maximum mean temperature ranged from 5.1 ^{0}C to 24.9^{0}C and 24.0^{0}C to 33.8^{0}C. The relative humidity ranged between 81 to 94% in morning and 26 to 81% in evening.The soil of the experimental field was sandy clay loam in texture. It was medium in organic carbon (0.60%), available nitrogen (367 kg/ha), phosphorus (16.23 kg/ha) and available potassium (317.10 kg/ha). The soil was nearly neutral in reaction (pH 7.1) and electrical conductivity (0.34 ds/m). A total nine varietal treatments were laid out in Randomized Complete Block Design with three replications. The nine soybean varieties are JS 20-69,JS 20-29,JS 97-54,JS 20-34,RVS 2007-6,NRC-86,JS 95-60,JS 335 and Pandrinath-1. Soybean varieties were planted on 30 X 5 cm row spacing using the seed @ 80kg/hain the experimental field with recommended package of practices. Fertilizers were applied uniformly at 20, 60 and 20 N, P_2O_5 and K_2O kg/ha, as basal application through urea, single super phosphate and muriate of potash. Before sowing, the seeds were treated with vitavax at 2.5 g/kgof seed. Plant population of soybean was recorded at 30 DAS and harvest stage. Growth parameters (*viz.*, plant height (cm), number of branches per plant, root nodules per plant) and yield attributing characters were recorded at different time intervals. Phenological characters (viz. days flower initiation, days to 50% flowering and maturity) Pods per plant, seeds per pod and seed index (100 seed weight) were recorded at maturity. Finally, seed and stover yields were recorded treatment wise. The economic analysis of each treatment was done on the basis of prevailing market prices of the inputs used and outputs obtained under each varieties.

Results and Discussion

Growth parameters

The uniform plant density is an important requisite for obtaining higher precision when it is not a variable factor as the treatments. The data in Table 1. indicate that the plant population/m^2 at 30 DAS and harvest were remained non-significant under various soybean varieties without any definite trend. It ranged from 41.49 to 49.77/m^2 in different varieties. It is obviously reflected from these data that the sowing of varieties was done properly, uniformly in each variety using healthy of viable seeds to maintain the better crop stand. The germination potentiality of each variety was the same. There was no any harmful effect of chemical fertilizer applied in the same furrow in which seeds were hand- drilled.

A liner increase in plant-height was observed with the advancement in age of all soybean varieties. The height of all the soybean varieties increased rapidly up to 60 days after sowing. The fast increase in plant height in the early stage of plant growth may be attributed to higher production of food by photosynthesis, which reflected into increased cell division and resulted in rapid growth of the plants. Beyond 60 days, the plant height became slow till maturity stage which may be due to the fact that plant started entering from vegetative to the reproductive phase of growth and development. Among soybean varieties, JS 20-69 produced significantly greater plant height at 30 and at harvest, whereas, Pandrinath-1was recorded lowest in plant height. (shown in table 1). This variation in plant height among different soybean varieties may be attributed to their genetic constitution. Such variations in plant height among different soybean varieties were also reported by Ali *et al*. (2013) [2] and Dubey *et al.* (2014) [7].

Number of branches/plant as significantly influenced by different soybean varieties. Among all the varieties, JS 20-69 exhibited significantly higher value of number of branches/plant (table 1). The significant improvement in branches/ plant in cv. JS 20-69 than other cultivars may be attributed as inherent variation due to their superior genetic makeup. The significantly minimum number of branches/plant was recorded in Pandrinath-1. The varietal differences in number of branches/pant also been reported by Liu *et al.* (2005) [11] and Sharma *et al*. (2009) [20].

The effect of varieties on number root nodules/plant was significant at 30 and 60 DAS (Table 1). The variety JS 20-69 produced significantly the highest root nodules/plant at 30 DAS and 60 DAS was 48.33 and 46.00 as compared to other varieties. On the other hand, Pandrinath-1 produces lowest number of root nodules/ plant at 30 and 60 DAS 46.33 and 45.67. Nodulation in a variety is governed by the certain genetic factors associated with micro-climatic conditions of the soil in which the plant grows, hence, it varies from one variety to another. The varietal response in respect of number of root nodules was also reported by Ramesh *et al* (2004) [17], Sarawgi *et al*. (2005) [19], Pankaj *et al*. (2006) [15], Sharma *et al.* (2009) [20] and Dubey *et al.* (2014) [7].

Phenological characters

Understanding the phenological causes of reduction in seed yield may help to develop strategies for improved seed yield in crops. Earliest crop maturity is the desirable trait without any reduction in yield of high yielding varieties. In view of this fact, phenological studies of the newly developed varieties, having most desirable features, has got its own importance.

All soybean varieties were differed significantly in relation to their phenological development because of their genetic characters. Among the varieties, cv. JS 95-60 was earlier in attaining the first flower (30.67 days), 50% flowering (33.0 days), and maturity (82.0 days) as compared to rest of the varieties. In the contrast, cv. JS 97-52 took the significantly maximum days to flower initiation (39.33 days), 50% flowering (42 days) and maturity (101.0 days). Other soybean varieties were in the intermediate position to attain different growth stages (Table 2). This variation in phenology among different soybean varieties may be attributed to their genetic pattern. Variation in the phenological development among nine varieties of soybean reflects the fact that there were wide differences in the duration of vegetative growth, thereby

duration in the reproductive phase, which are genetically controlled. The variation in phenological development among soybean varieties have been reported by Raut *et al*. (2001) [18], Chandankar *et al*. (2002) [4], Singh *et al.* (2003) [21], and Hundal *et al*. (2003) [10], Liu *et al*. (2005) [11], Holkar *et al.* (2008) [9].

Yield attributing characters

The effect of varieties on number pods/plant, number of seeds/pod, and test weight (g) was found significant at (Table 3). The variety JS 20-69 produced significantly higher number of pods/plant (59.57), number of seeds/pods (3.00), pod and seed index (12.55 g) as compared to rest of the varieties. The variety Pandrinath-1 showed poor bearing capacity of pods/plant (18.7), lesser number of seeds/pod (2.07), and lowest seed index (10.55 g). The differences in yield attributing characters of among soybean varieties may be due to variability in their genetic constitution. The differences in yield attributes of different soybean varieties had been well documented by Chettri *et al.* (2005) [5], Mandal *et al.* (2005), Liu *et al*. (2005) [11], Pandy *et al.* (2005), Ramesh *et al.* (2006) [17], and Sharma *et al* (2009) [20].

Productive parameters

Seed yield

The final yield of any crop species depends on the source and sink relationship and on different components of sink viz., number of pod/plant, number of seeds/pod and seed index (100 seeds weight). Yield is a complex trait and exhibits continuous variation. Most of the yield contribution characters also exhibit continuous variation, such continuous variation being generally attributed to polygenic control. Yield is governed not only by polygenes but also highly influenced by environmental fluctuations.

It is evident from table 3. that the genotypic effect on grain yield was significant. The variety JS 20-69 produced significantly higher seed yield (20.13 q/ha) than that of other tested varieties. The second best variety was NRC-86 (17.06 q/ha). The variety Pandrinath-1 produces lowest yield 9.64 q/ha. The highest yield of JS 20-69 may be due to highest grain yield per plant and better number of root nodules, number of pods per plant and number of seed per pod. These favorable morphological phenomenon in this variety resulted in significantly highest yield. Thus, the significant variation in yield and yield attributing characters among the varieties may be due to genetic variation, photoperiodic response and genetic potentiality. These results are in agreement with those of Thakur *et al.* (2003) [25], Parmar and Nema (2002) [16], Singh *et al* (2005) [21], Panday *et al*. (2005), Mondal *et al*. (2005) [5], Ramesh *et al.* (2006) [17], Sharma *et al*. (2009) [20], Abayomi and Mahamood (2009) [1] and Myo and Tint (2011) [13], Anonymous (2017) [3].

The increase in haulm yield is directly related mainly to an increase in the vegetative growth and to a negligible extent the increase in the reproductive portion of the plants. It reveals that effect of varieties on haulm yield was found to be significant. The variety JS 20-69 and JS 97-52 produced equally higher straw yield (42.68 q/ha) than the remaining varieties. This was equally followed by NRC-86 and JS 20-34 (38.67 to 42.48 q/ha). On the other hand, the soybean variety Pandrinath-1 gave the lowest haulm yield 22.97 q/ha. The variation in haulm production in different varieties was also observed by Dubey *et al*. (2001), Sarawgi *et al*. (2005) [19], Parmar and Nema (2002) [16], Ramesh *et al*. (2006) [17] and Sharma *et al*. (2009) [20].

The analysis of variance for harvest index reveals that effects of varieties were significant. Accordingly the variety JS 20-69 resulted in significantly higher harvest index (32.48%) as compared to the remaining varieties of soybean. The next best varieties were JS 20-34 (31.91%) followed by NRC-86 (31.59%), JS 335 (30.31%) and JS 20-29 (30.00%). The significantly lowest values of harvest index was observed in Pandrinath-1 (28.74%). Probably, this may be attributed to the fact that the harvest index is the ratio of economic (grain yield) and biological yield (grain+ straw). The harvest index increased JS 20-69 and JS 20-34 might be attributed to better partitioning of dry matter into grain portion. In fact, the harvest index is dependent on the ability of treatment to produce more grain yield than the straw accumulation. As such, higher the grain yield than the straw would account for the higher harvest index. The varieties JS 20-69 and JS 20-34 received the most favourable genetical attainment to secure the above situation.

Economics

Economics of a treatment is directly related to the success of that particular treatment and the extra input and outcome due to the treatment. Benefit: cost ratio is the another way of expressing the net return per rupee invested under each treatment. Amongst the nine varieties under test, JS 20-69 gave the maximum net income up to Rs. 42,909 /ha and B:C ratio up to 2.34 (Table 3). This was followed by NRC-86 (Rs. 39,658 /ha and B:C ratio 2.59). The third best variety was JS 20-09 giving net income of Rs. 32357/ha and B:C ratio from 2.24. The lowest net income (Rs. 4,219 /ha) and B:C ratio 1.13 was obtained from Pandrinath-1 variety of soybean. These economical gains were exactly in accordance with the grain and haulm yields obtained from these varieties in terms of market value and gross return per hectare. (Sarawgi *et al.* (2005) [19].

Conclusions

Soybean variety JS 20-69 proved to be most suitable for agroclimatic condition of Kymore plateau and satpura hills of Madhya Pradesh. This variety gave the highest growth, yield attributes, seed yield and found to be more remunerative as it received higher values of NMR (Rs. 42,909 /ha) and B:C ratio (2.34) as compared to other varieties. Two varieties NRC-86 and JS 20-34 were also performed better as compare to other varieties. Soybean c.v. JS 20-69 was found superior in weed smothering efficiency for effective suppression of weeds in soybean.

Table 1: Growth parameters of different soybean varieties

Treatment	Plant Population(m^{-2})		Plant height (cm)		Branches/plant	Nodules/plant	
	30 DAS	At harvest	30 DAS	At harvest	At harvest	30 DAS	60 DAS
T_1 JS 20-69	47.8	46.03	25.48	47.42	3.02	48.33	46.00
T_2 JS 20-29	48.57	48.27	22.20	45.38	2.67	46.88	46.33
T_3 JS 97-52	46.13	46.10	19.63	43.42	1.90	47.88	46.67
T_4 JS 20-34	49.77	49.53	20.00	43.23	2.67	46.88	46.33
T_5 RVS 2007-6	47.53	47.33	19.50	43.52	2.50	48.33	46.67

T_6 NRC 86	46.35	46.13	24.80	47.35	2.73	47.88	46.67
T_7 JS 95-60	48.08	47.93	21.00	43.16	2.47	46.67	46.33
T_8 JS 335	43.50	43.27	20.30	44.43	2.60	46.33	45.67
T_9 Pandrinath-1	43.4	42.83	17.30	41.49	1.84	46.33	45.67
SEm±	1.57	1.56	2.62	1.19	0.20	0.28	1.52
CD at 5%	NS	NS	NS	3.35	0.60	0.84	3.58

Table 2: Average phenological observations and weed smothering efficiency of different soybean varieties

Treatments	Phenological phases			WSE (%)
	Days to flower initiation	Days to 50% flowering	Days to maturity	
T_1 JS 20-69	38.00	41.00	94.00	49.58
T_2 JS 20-29	38.33	40.62	95.00	47.63
T_3 JS 97-52	39.33	42.00	101.00	59.51
T_4 20-34	33.00	35.00	87.00	43.51
T_5 RVS 2007-6	39.00	42.00	99.00	53.36
T_6 NRC-86	38.33	40.00	96.33	57.31
T_7 JS 95-60	30.67	33.00	87.00	41.82
T_8 JS 335	38.33	41.00	98.00	42.28
T_9 Pandrinath-1	38.33	41.67	95.00	38.87
SEm±	0.64	0.64	0.47	
CD at 5%	1.93	1.93	1.41	

Table 3: Pods/plant, seeds/pod, seed index and economics of different soybean varieties

Treatment	Pods/plant	Seeds/pod	Seed index (g)	Seed yield (kg/ha)	Haulm yield (kg/ha)	Harvest index (%)	GMR (Rs/ha)	NMR (Rs/ha	B:C Ratio
T_1 JS 20-69	59.57	3	12.55	20.13	42.68	32.48	74,841	42,909	2.34
T_2 JS 20-29	57.77	2.65	11.55	15.07	34.80	30.00	56,391	24,459	1.76
T_3 JS 97-52	50.03	2.43	10.77	11.80	42.68	29.51	44,115	12,183	1.38
T_4 JS 20-34	49.13	2.53	12.66	17.16	38.67	31.91	64,120	32,188	2.00
T_5 RVS 2007-6	55.17	2.32	10.55	13.56	32.88	28.99	50,912	18,980	1.59
T_6 NRC-86	56.57	2.66	12.22	19.18	42.48	31.59	71,590	39,658	2.24
T_7 JS 95-60	48.57	2.62	10.77	10.86	25.28	29.19	40,664	8,732	1.27
T_8 JS 335	51.33	2.22	11.21	14.88	33.56	30.31	55,603	23,671	1.74
T_9 Pandrinath-1	46	2.07	10.55	9.64	22.97	28.74	36,151	4,219	1.13
SEm±	0.67	0.14	0.14	0.69	0.76	-			
CD at 5%	2.00	0.41	0.43	2.07	2.28	-			

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