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Performance of newly developed faba bean (*Vicia faba*) varieties in different agro-ecological condition of Eastern India

ANIL KUMAR SINGH[1]*, R S PAAN[2], R K SINGH[3], I S SINGH[4], DEEPAK SINGH[5], DEOKARAN[6], I S SOLANKI[7], S K SINGH[8], A RAHMAN[1], PAWAN JEET[1], ASHUTOSH UPADHYAYA[1] and B P BHATT[1]

ICAR-Research Complex for Eastern Region, Patna, Bihar 800 014, India

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ABSTRACT

Two varieties, the Swarana Suraksha and Swarana Gaurav of faba bean (*Vicia faba* L.), developed at ICAR Research Complex for Eastern Region, Patna; were evaluated against check variety Vikrant, for its suitability under different agro-ecological conditions of Eastern region of India. Performance evaluations were done at multilocation in eastern Indo Gangetic plains of Bihar; semiarid saline condition of Uttar Pradesh and in the acidic condition of hills and plateau region of Jharkhand. The multiplication testing was conducted during 2013–14 to 2015–16. Significantly higher yields of 3.03 t/ha and 4.32 t/ha were recorded with Swarana Suraksha while 2.31 t/ha and 4.91 t/ha for Swarana Gaurav under rainfed and irrigated conditions, respectively. Location wise significantly maximum seed yield of 3.61 t/ha was recorded at IARI, Pusa and the corresponding minimum of 2.33 t/ha was recorded at ICAR Ranchi centre. Individually, under irrigated condition, Swarana Gaurav produced significantly higher yield of 5.57 t/ha at IARI, Pusa. Swarana Suraksha was found suitable for both, rainfed and irrigated conditions; whereas Swarana Gaurav was suitable for irrigated condition. These two varieties are already been notified by the Cenral Varietal Release Committee for its cultivation in Bihar; but both the varieties could be recommended for its cultivation in Eastern states. Currently, both the developed varieties are under multiplication at ICAR Research complex for Eastern Region, Patna, right from 2015–16 onwards to introduce in seed chain by 2020–21.

Keywords: Agro-ecology, Faba bean varieties, Multilocation evaluation, Rainfed and irrigated

Faba bean (*Vicia faba* L.) is one of the oldest crops in the world and is third most important feed grain legume (Alba and Scippa 1999, Mihailovic *et al.* 2005). Fava bean, Broad bean, Horse bean, Windsor bean are the synonyms of faba bean. In India, it is popularly known as *kala matar* and *bakala* (Cubero 1974, Singh and Bhatt 2012a). Faba bean are grown in 58 countries (FAO 2009, Zohary and Hopf 2000), but in India the area under the faba bean crop is very less and therefore categorized as minor. It is still not been a fully exploited crop; though, it is an agronomically viable alternative crop to cereal with a potential of fixing free nitrogen even up to 300 kg N/ha (Singh *et al.* 2010, Singh *et al.* 2013). Despite being responsive to added inputs, it is grown on marginal lands as an intercrop under irrigated condition with potato, maize and wheat crop. Under rainfed conditions it is grown as sole crop, mixed or intercrop with lentil, linseed, gram etc. (Singh and Bhatt 2012a). It is good source of lysine rich protein and *levodopa* (*L-dopa*)- a precursor of dopamine and therefore can potentially be used as medicine in treatment of Parkinson's disease (Alba and Scippa 1999). In India its hidden potential has not been fully realised. The probable bottleneck for poor and slow expansion of this legume could be the lack of suitable cultivar coupled with appropriate package and practices (Singh *et al.* 2010). Due to scarcity of suitable cultivars and matching production technology its average productivity in India is low as 1.5 t/ha compared to other faba bean producing countries (FAO 2009, Singh *et al.* 2012a). Only few serious attempts are undertaken to breed out improved cultivar for this crop (Singh *et al.* 2012b). These facts were the basis for undertaking faba bean improvement work at ICAR Research Complex for Eastern Region Patna (Bihar) for developing suitable cultivar primarily for Eastern part of India.

MATERIALS AND METHODS

The multi-location trials were undertaken for three consecutive years during 2013–14 to 2015–16, to evaluate the recently released two faba bean varieties, the Swarana

Present address: [1]ICAR-Research Complex for Eastern Region Patna, Bihar; [2]ICAR-Research Complexes for Eastern Region RC, Ranchi, Jharkhand; [3]ICAR-Central Potato Research Station, Patna, Bihar; [4]ICAR-Research Complexes for Eastern Region RC, Darbhanga, Bihar; [5]Krishi Vigyan Kendra, Pupari Sitamarhi, Bihar; [6]Krishi Vigyan Kendra, Lalganj, Buxar, Bihar; [7]ICAR-IARI, Regional Station, Pusa, Samastipur, Bihar; [8]Krishi Vigyan Kendra, Auraiya, Uttar Pradesh. *Corresponding author e-mail: anil.icarpat@gmail.com.

Suraksha and the Swarana Gaurav, developed ICAR Research Complex for Eastern Region, Patna, released by the Bihar Varietal Release Committee. A two-year multi-location trial was undertaken during *rabi*. Eight different sites covering three states, viz. Uttar Pradesh (1 location), Bihar (6) and Jharkhand (1). Auraiya centre (Uttar Pradesh) was identified to test the performance of both the varieties under saline conditions. Ranchi was selected for evaluation under acidic conditions of hills and plateau region. Six locations in Bihar, spreading equally under southern and northern parts, were Buxar (1) and Patna (2) Pusa, Samastipur (1), Sitamadhi (1) and Darbhanga (1). Under southern Bihar the Buxar and Patna were selected for rainfed as well as assured irrigation conditions, whereas North Bihar for its flood-prone situation. Data were recorded on growth and development, yield attributes and the seed yield. Seed yield was adjusted at 12% moisture. The effects of different environment on varieties at various locations were analysed using pooled analysis procedures described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Plant height: Plant height is important characteristic features of a variety upon which other yield attributes excel under prevailing circumstances (Singh *et al.* 2012a). Perusal of data (Table 1) revealed that the height was varied according to variety across the locations. Under hills and plateau condition the performance of all the varieties were considerably lower than plains. Over all, the tallest plant (80.1 cm) was produced by variety Swarana Gaurav, whereas Vikrant produced shortest (46.3 cm) plant. Plots which received irrigation produced taller plant (74.2 cm) as compared to rainfed conditions (58.1cm). Location-wise maximum plant height (77.5 cm) was recorded at IARI, Pusa; whereas the overall minimum (51.4 cm) was noticed at Ranchi. Similarly, the variety wise the maximum average plant height (96.0 cm) was recorded with Swarana Gaurav at IARI, Pusa and corresponding minimum (37.3 cm) was recorded with Vikrant under rainfed conditions at Sitamarhi. Results clearly indicate that both the developed varieties performed better with respect to plant height than check variety Vikrant at different location under irrigated as well as under rainfed situation. Under stress condition of acidic hill and plateau (Ranchi) and salinity condition (Auraiya) performance was not as much as in case of normal and favourable conditions like Patna and Pusa.

Days taken to anthesis: Faba bean has unique capacity to switch over its vegetative growth phase to reproductive phase quickly as compared to other crop, especially the cereals. After initial vegetative phase, both vegetative and reproductive phases advance ahead simultaneously. Early onset of reproductive phase was good for legume and having direct bearing on seed-yielding capacity (Singh *et al.* 2011, Singh and Bhatt 2012b). Results indicate that the minimum of 58.8 days was taken to come to flowering by Vikrant and maximum of 61.9 days was taken by Swarana Gaurav; therefore, no significant differences among the varieties with respect to this parameter. Response of different locations with respect to days taken to anthesis was significant. At Ranchi, the minimum of 42.5 days was for first flowering, whereas significantly higher days of 66.8 days at Buxar to come in reproductive phase. It was also noticed that under rainfed conditions force flowering occurred across the location and varieties (Singh *et al.* 2012a).

Days taken to maturity and pods/plant: Early onset of reproductive phase is good for legume crop for boosting its production, as early flowering provides more time for seed production. Sometime early anthesis is an indicator of early maturity which could be due to earliness or unfavourable agroclimatic conditions (Singh and Bhatt 2012b). Findings indicate that considerable homogeneity was seen in case of this trait among the variety, environments and locations as well. Results indicated that among the tested varieties, maximum time (114.1 days) was taken by Swarana Gaurav, whereas minimum of 112.8 days was for Check Vikrant.

Table 1 Plant height of faba bean varieties at different locations under irrigated and rainfed environment

Location of evaluation	Plant height (cm) at maturity					Average
	Varieties			Environments		
	Swarana Suraksha	Swarana Gaurav	Vikrant	Rainfed	Irrigated	
ICAR, Patna	83.0	89.7	52.5	67.4	82.7	75.1
ICAR, Ranchi	56.0	59.5	38.9	46.8	56.0	51.4
IARI, Pusa	79.5	96.0	57.1	67.1	87.9	77.5
ICAR, Darbhanga	79.3	90.6	53.5	66.6	82.2	74.4
CPRS, Patna	83.0	93.2	52.5	67.3	85.1	76.2
KVK Auraiya	59.1	63.4	37.3	46.4	60.1	53.3
KVK, Sitamarhi	60.8	70.9	37.8	47.8	65.1	56.5
KVK, Buxar	76.0	76.7	41.2	54.7	74.5	64.6
CD with location (± 5%)		6.79			5.5.54	3.92
Average	72.1	80.1	46.3	58.1	74.2	
CD (± 5%) (Variety × Location)			3.38			

Significant difference was seen for water management practices. Under rainfed conditions force maturity was noticed and significantly minimum time (109.4 days) was taken to complete its lifecycle. Similarly, minimum of 92.1 days was required at Sitamarhi to complete its life cycle successfully and significantly maximum time of 119.0 days were taken at ICAR, Patna centre to mature (Singh *et al.* 2012a). Pods per plant is one of the crucial economic yield-deciding factor, by and large depends on branching pattern of variety (Singh *et al.* 2011).

Perusal of data (Table 2) revealed that considerable influences of locations and provided environment on podding behaviour were realized. Significantly highest number of pods per plant (71.9) was recorded with variety Swarana Gaurav and lowest (58.4 pods/plant) in case of Vikrant. In case of environment, irrigated crop produced significantly more pods (77.3) as compared to non-irrigated crop (55.5). Location plays a crucial role in realizing the podding pattern of tested varieties. CPRS, Patna produced significantly maximum (91.7) pods per plant, whereas Sitamarhi centre produced plant with lowest (37.4) pods per plant. Individually highest (103.8) pods per plant under irrigated conditions at CPRS, Patna. Results indicate that developed varieties were proven superior over the tested check variety Vikrant (Singh *et al.* 2012a).

Pod length (cm) and seeds/pod: Length of pods is mainly associated with genetic makeup of a particular variety and the role of environment and management practices are limited. Length of pod is the trait, which gives an indication about seed bearing capacity of particular variety (Singh and Bhatt 2012a). Results revealed that location wise significantly maximum pod length (4.7 cm) was recorded at Sitamarhi centre, followed by Ranchi (4.4 cm) and least (3.5 cm) was with Darbhanga and CPRS centre of Patna. Significantly highest pod length (4.2 cm) was recorded with variety Swarana Gaurav than other tested varieties. Likewise, under given environment, i.e. irrigated and rainfed conditions (water management practices) also influenced the pod length significantly, higher pods length (4.3 cm) than rainfed situation (3.6 cm). Individually maximum pod length (5.3 cm) was noticed for developed variety Swarana Gaurav at Sitamadhi (Singh *et al.* 2012a and Singh *et al.* 2011).

Seed-bearing capacity of pod is one of the yield attributers, which by and large seed yielding patterns of particular variety; however, the average seed weight plays secondary but significant role on final performance of given variety (Singh *et al.* 2011). Seed-bearing capability is mainly governed by its genetic makeup and least influenced by environmental conditions and other agronomic management practices (Singh and Bhatt 2012a). Results obtained with two years of experimentation were summarized and presented in Table 8. Perusal of data on seeds per pod revealed that, significantly higher seeds per pod (3.7) were recorded with variety Swarana Gaurav, whereas corresponding lowest seeds per pod (2.8) was obtained in case of Vikrant. Environmental factors, i.e. water management practices influenced the seed-bearing ability. Further, significantly maximum seeds per pod (3.6) were recorded under irrigated conditions as compared to rainfed (3.0). Location wise Sitamarhi produced highest (4.1) seed-bearing pod and positively associated with pod length. At Sitamarhi, a maximum (4.5) seed per pod was recorded for Swarana Gaurav under irrigated condition (Singh *et al.* 2012a). Developed faba bean varieties were performed better under saline conditions as compare to acidic hills and plateau conditions.

Seed yield: Results (Table 3) clearly indicates that significantly higher yield (3.03 t/ha and 4.32 t/ha) was recorded with variety Swarana Suraksha and Swarana Gaurav (2.31 and 4.91 t/ha) under rainfed and irrigated conditions over used check variety Vikrant. Location wise significantly maximum (3.61 t/ha) seed yield was obtained at Pusa Centre, whereas corresponding minimum (2.33 t/ha) was recorded at Ranchi centre (Singh *et al.* 2012a). Under hills and plateau and acidic soil conditions at Ranchi Swarana Gaurav produces (3.51 t/ha) under assured water management condition; whereas under rainfed conditions

Table 2 Pod/plant of faba bean varieties at different locations under irrigated and rainfed environment

Location of evaluation	Pods/plant					Average
	Varieties			Environments		
	Swarana Suraksha	Swarana Gaurav	Vikrant	Rainfed	Irrigated	
ICAR, Patna	84.6	96.4	71.9	71.4	97.2	84.3
ICAR, Ranchi	48.7	58.4	39.5	42.6	55.1	48.9
IARI, Pusa	86.8	88.0	80.4	71.0	99.0	85.0
ICAR, Darbhanga	95.6	90.4	77.0	76.4	98.9	87.7
CPRS, Patna	92.5	97.1	85.6	79.6	103.8	91.7
KVK, Auraiya	38.0	45.6	28.5	29.4	45.3	37.4
KVK, Sitamarhi	60.0	54.4	46.9	39.7	67.8	53.8
KVK, Buxar	45.1	45.0	37.6	33.6	51.5	42.6
CD with location (± 5%)		6.97			5.69	4.02
Average	68.9	71.9	58.4	55.5	77.3	
CD (± 5%) (Variety × Location)			3.48			

Table 3 Seed yield (q/ha) of faba bean varieties at different locations under irrigated and rainfed environment

Location of evaluation	Yield (t/ha)						Average
	Developed varieties				Check variety		
	Swarana Suraksha		Swarana Gaurav		Vikrant		
	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	
ICAR, Patna	3.13	4.84	2.38	5.43	1.59	3.11	34.2
ICAR, Ranchi	2.16	3.16	1.83	3.51	1.25	2.06	23.3
IARI , Pusa	3.52	4.74	2.56	5.57	1.92	3.32	36.1
ICAR, Darbhanga	2.59	4.34	2.61	5.51	1.89	3.17	33.7
CPRS, Patna	3.33	4.44	2.44	5.43	1.87	3.41	34.9
KVK, Auraiya	3.24	4.57	2.23	4.78	1.97	3.37	33.6
KVK, Sitamarhi	3.19	4.35	2.3 2	4.55	1.95	3.22	34.5
KVK, Buxar	3.06	4.11	2.12	4.55	1.74	2.87	30.8
CD (± 5%)	Location × Variety × Environment = 5.66						2.31
Average	3.03	4.32	2.31	4.91	1.77	3.07	
CD (± 5%)			2.01				

variety Swarana Suraksha performed significantly better (2.16 t/ha) than other tested variety. Similarly, under semiarid and saline soil conditions of Auraiya, both the varieties Swarana Gaurav (4.78 t/ha) and Swarana Suraksha (3.24 t/ha) performed better under both irrigated and rainfed environment. Individually maximum seed yield (5.57 t/ha) was recorded at Pusa centre with Swarana Gaurav under irrigated condition (Singh *et al.* 2012a).

The multilocation evaluation of developed faba bean varieties, the Swarana Suraksha and Swarana Gaurav for different agro-ecological conditions revealed that the Swarana Suraksha is suitable for both rainfed as well as irrigated environment, whereas Swarana Gaurav is most suited for irrigated condition. Further, both the varieties were found suitable for its cultivation across the Eastern States of India.

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