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CHARACTERIZATION AND IDENTIFICATION OF SELECTION INDICES OF POLE TYPE DOLICHOS BEAN

Arup CHATTOPADHYAY, Subrata DUTTA
All India Coordinated Research Project on Vegetable Crops
Bidhan Chandra Krishi Viswavidyalaya
Kalyani-741235, Nadia, West Bengal, India

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Summary

Twelve genotypes of pole type dolichos bean (*Lablab purpureus* var. *typicus*) were evaluated for their genetic variability and character association among nine quantitative traits under the Gangetic plains of eastern India. The study revealed significant variation in days to 50% flowering (57-115), length of pod (7.15-15.05 cm), breadth of pod (1.44-3.11 cm), weight of pod (2.92-8.92 g), 100 seed weight (22.2-45.50 g), number of pods/plant (768.3-1897), protein content of pod (0.70-5.45%) and pod yield/plant (5.07-12.21 kg). Genotypes showed differential reaction against *Cercospora* leaf spot and dolichos yellow mosaic virus. High yielding genotypes generally showed fewer incidences of diseases than the poor yielding genotypes. Characters like number of protein content of pod, number of pods/plant, breadth of pod, weight of pod and pod yield/plant exhibited high GCV, PCV, heritability and genetic advance as percent of mean indicating that such situation may arise due to the action of additive genes controlling the characters. From the correlation and path coefficient analysis, it revealed that the top priority should be given to selection based on the weight of pod, 100 dry seed weight and number of pods per plant for green pod yield improvement and could be considered while formulating selection indices in the improvement of pole type dolichos bean.

key words: Dolichos bean, characterization, yield components, disease incidence

INTRODUCTION

The vegetarian populations in India consume large amounts of legumes, particularly, vegetable beans in their diet. The beans are naturally rich in carbohydrates, proteins, fat and fibers as well as minerals including calcium, phosphorus and iron (Naeem *et al*. 2009b). Among the legumes, dolichos bean constitutes an important source of therapeutic agents used in the modern as well as traditional systems of medicine (Morris 2003, Morris 2009). In fact, it is considered as a multipurpose crop since it is used for

Corresponding author:
e-mail: chattopadhyay.arup@gmail.com
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food, forage, soil improvement, soil protection and weed control (Shivashankar & Kulkarni, 1989; Pengelly & Maass 2001; Maass, 2006). The young pods and tender beans are used as vegetables in India and tropical and warm temperate Asia. It is also been known for its use as a green manure and produces edible young pods, dried seeds, leaves and flowers (Morris 1997, 2003). The seeds are used as a laxative, diuretic, anthelmintic, antispasmodic, aphrodisiac, anaphrodisiac, digestive, carminative, febrifuge and stomachic (Chopra *et al.* 1986; Kirtikar & Basu 1995). The bean contains the potential breast cancer fighting a flavonoid known as kievitone (Hoffman 1995). The flavonoid, genistein found in this bean may play a role in the prevention of cancer (Kobayashi *et al*. 2002) and as a chemotherapeutic and/or chemopreventive agent for head and neck cancer (Alhasan *et al*. 2001). Tyrosinase (polyphenol oxidase) is present in plant tissue and is important in fruit and vegetable processing as well as storage of processed foods. Prevention of browning of foods, enzymatic or non-enzymatic, has long been a concern of food scientists (Sanchez-Ferrer *et al*. 1995; Paul & Gowda 2000). The bean contains tyrosinase, which has potential for the treatment of hypertension in humans (Naeem *et al*. 2009a).

India being the center of origin, there is a great range of variability with different plant and pod characters of pole type dolichos bean (*Lablab purpureus* var. *typicus*) grown all over the country and that variability can be exploited for evolving a high yielding type. The evaluation of the potentialities of the existing varieties is very essential because it is the genetic diversity of the initial parental material, on which depends the promise for further crop improvement. The observed variability is a combined measure of genetic and environmental causes. The heritable variability and more particularly its genetic component, is clearly the most important aspect of the genetic constitution of the breeding material, which has a close bearing on its response to selection. However, a measure of heritability alone does not give an idea about the expected gain in the next generation, but it has to be considered in conjunction with genetic advance. Thus, high yield can be achieved by selection of those characters that have high heritability coupled with genetic advance. Besides this, the knowledge of association between yield and its contributing characters will be of great value in planning a breeding programme. But it does not give the exact position of the relative importance of direct and indirect effects of various yield attributes. Path analysis facilitates the partitioning of correlation coefficients into direct and indirect effects of various characters on yield or any other attributes. As this information on dolichos bean is scanty under the Gangetic Alluvium of West Bengal, an attempt has been made to know the extent of genetic variability present, association between pod yield and its attributing characters and the direct and indirect influences of these characters on pod yield in order to evolve an efficient selection criterion for dolichos bean.

MATERIAL AND METHODS

Twelve diverse genotypes were grown in a Randomized Block Design with three replications during *Autumn-winter* season of 2008 and 2009 at C block Farm under the research field of All India Coordinated Research Project on Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India. Genotypes were sown during 1st week of August of each year in a plot size of 3.0 x 3.0 m with a spacing of 1.5 x 1.5 m accommodating four plants per plot. The farm was located at 23.5ºN latitude and 88ºE longitude, at an elevation of 7.8 m above mean sea level. The soil of experimental site was typical alluvial (Entisol) and sandy loam in texture having pH 6.5. The total organic C, total N, available P and K statuses were 0.69%, 0.080%, 14.50 $kg \cdot h^{-1}$ and 152.6 $kg \cdot h^{-1}$, respectively. The zone is classified as having a tropical humid climate with three distinct seasons divided into winter (November-February), summer (March-May) and rainy season (June-October). The mean minimum and maximum temperatures during the period of experimentation varied between 15.7ºC (February) and 38.2ºC (May). The annual rainfall receipt varied from 1400 to 1500 mm, most of which was received from June-August. The standard cultural practices were followed in time to obtain good phenotypic expression of the traits (Chattopadhyay *et al*. 2007). Each genotype was grown over trellises when they attain one month old. Characterization of the genotypes was done as per documented descriptors. The observations were recorded on five qualitative traits (plant type, flower colour, pod colour, pod curvature, seed colour) and nine quantitative traits viz., days to 50% flowering, length of pod (cm), breadth of pod (cm), weight of pod (g), pods/plant, number of seeds/pod, 100 dry seed wt. (g), protein content of pod (%), yield/plant (kg) from the four plants per replication. The protein content of fresh pod was analyzed on fresh weight basis as per the method of Lowry (1951). Periodical incidence of *Cercospora* leaf spot and dolichos yellow mosaic virus (DYMV) was recorded by using 1 to 9 rating scale given by Singh *et al*. (1988) and Singh *et al*. (1992), respectively.

Rating scale for *Cercospora* leaf spot

Rating	% disease intensity on leaves	Reaction
1	0.1-5.0	Resistant
3	5.1-15.0	Moderately resistant
5	15.1-30.0	Moderately susceptible
7	30.1-75.0	Susceptible
9	75.1-100.0	Highly susceptible

Rating scale for DYMV

Rating	% disease intensity on leaves	Reaction
1	No visible symptoms or minute yellow specks covering 0.1-5.0% leaf area	Resistant
3	Mottling of leaves covering 5.1-15.0% leaf area	Moderately resistant
5	Yellow mottling and discolouration covering 15.1-30.0 leaf area	Moderately susceptible
7	Pronounced yellow mottling and discolouration of leaves, pods, reducing in leaf size, stunting of plants 30.1-75.0% foliage affected	Susceptible
9	Severe yellow mottling and discolouration of leaves, stunting of plants, failure of flowering and fruit setting 75.1-100.0% foliage affected	Highly susceptible

The Genotypic Coefficient of Variation (GCV) and Phenotypic Coefficient of Variation (PCV) were calculated by the formula given by Burton (1952). For the estimate of heritability and Genetic Advance (GA), the method of Hanson *et al*. (1956) was followed. Later correlation coefficients at genotypic and phenotypic levels were calculated (Johnson *et al.* 1955). Path coefficient analysis was estimated as per Dewey and Lu (1959).

RESULTS AND DISCUSSION

a) Characterization of genotypes

There was a considerable variation among the twelve genotypes of dolichos bean in five qualitative characters. All the genotypes were pole type except Gomchi Green which was semi-pole type. The flower colour varied from white to violet or purple. The predominant pod colour was green except HADB-3 with creamy white colour and BCDB-1 having green pod with purple suture. The pod curvature of most of the genotypes was flat or slightly curved. The seed was either black or brown in colour (Table 1).

Observations taken on quantitative characters (Table 2) revealed that wide range of variation in days to 50% flowering (57-115), length of pod (7.15-15.05 cm), breadth of pod (1.44-3.11 cm), weight of pod (2.92-8.92 g), 100 seed weight (22.2-45.50 g), number of pods/plant (768.3-1897), protein content of pod (0.70-5.45%) and pod yield/plant (5.07-12.21 kg) have been observed. On the basis of pod yield/plant, four genotypes namely, BCDB-1, KDB-413, JIB (V)-16 and BCDB-2 were found most promising under the Gangetic plains of West Bengal.

The periodical observations on the tested genotypes revealed that most of the genotypes were moderately susceptible to *Cercospora* leaf spot. However, four genotypes (BCDB-1, RCMDL-1, SEMVER-8 and HADB-3) showed moderately resistant to this disease (Table 3). The intensity of dolichos yellow mosaic virus (DYMV) was highly severe in Swarna Utkrist and HADB-3, where as BCDB-1, BCDB-2, JIB (V)-16, KDB-413 and Pusa Early Prolific were shown mild severity for the disease. Singh *et al*. (2009) reported that DYMV incidence caused a huge loss (70.4%) in fruit yield and contributing traits such as 61.2% in fruit setting, 64.1% in pods per plant.

Table 1. Qualitative characters of different dolichos bean genotypes

Genotypes	Plant type	Flower colour	Pod colour	Pod curvature	Seed colour
Pusa Early Prolific	Pole	White	Light green	Intermediate	Red
BCDB – 2	Pole	Purple	Light green	Flat	Black
SEMVAR– 8	Pole	White	Green	Flat	Yellow
KDB – 413	Pole	White	Green	Slightly curved	Brown
JIB(V)16	Pole	Purple	Green	Flat	Brown
Swarna Utkrist	Pole	Purple	Light green	Flat	Brown
KDB – 415	Pole	Violet	Green	Slightly curved	Reddish
BCDB – 1	Pole	Purple	Purple	Flat	Black
RCMDL – 1	Pole	White	Light green	Slightly curved	Black
HADB – 4	Pole	Purple	Light green	Flat	Brown
HADB – 3	Pole	White	Creamy white	Flat	Brown
Gomchi Green	Semi pole	White	Green	Straight	Orange

Table 2. Quantitative characters of different dolichos bean genotypes (pooled over two years)

Genotypes	Days to 50% flower-ing	Length of pod (cm)	Breadth of pod (cm)	Weight of pod (g)	No. of seeds/ pod	100 seed wt. (g)	Pods/ plant	Protein content of pod (%)	Pod Yield/ plant (kg)
Pusa Early Prolific	78	10.36	1.85	4.36	4	27.2	1897.0	(17.4) 0.90	8.26
BCDB-2	87	12.26	2.91	7.15	4	31.4	1229.6	(18.4) 1.00	8.81
SEMVAR-8	115	15.05	2.56	8.92	4	32.3	768.3	(15.3) 0.70	6.86
KDB-413	108	14.16	1.52	5.37	5	45.5	1710.3	(17.4) 0.91	9.46
JIB(V)16	113	12.85	1.82	6.15	4	30.3	1458.3	(21.9) 1.40	8.97
Swarna Utkrist	92	10.66	2.12	5.74	4	34.2	1352.3	(47.5) 5.45	7.77
KDB-415	106	11.36	1.61	5.76	4	37.3	1259.0	(26.5) 2.05	7.36
BCDB-1	110	10.96	2.92	7.48	5	36.3	1632.6	(20.2) 1.20	12.21
RCMDL-1	75	7.15	1.44	2.92	4	28.6	1788.0	(33.2) 3.00	5.27
HADB-4	95	10.96	3.11	7.04	4	37.3	891.3	(18.5) 1.00	6.28
HADB-3	89	12.20	2.82	6.80	5	44.5	1008.6	(42.9) 4.65	6.86
Gomchi Green	57	7.71	1.87	5.67	4	22.2	892.6	(19.8) 1.15	5.07
C.D. at 5% level	1.05	0.41	0.09	0.26	0.28	3.52	40.28	0.382	0.368

Figures in parenthesis are angular transformed values

Table 3. Per cent incidence of diseases on dolichos bean genotypes (pooled over two years)

Genotypes	Intensity of *Cercospora* leaf spot (%)	Intensity of dolichos yellow mosaic virus (%)
Pusa Early Prolific	18.2	9.4
BCDB - 2	16.5	10.7
SEMVAR - 8	13.8	18.7
KDB - 413	17.6	11.6
JIB(V)16	21.5	12.4
Swarna Utkrist	26.3	78.5
KDB - 415	20.3	16.5
BCDB - 1	6.7	6.3
RCMDL - 1	12.4	18.3
HADB - 4	24.8	24.2
HADB - 3	14.8	80.3
Gomchi Green	21.7	8.7

b) Analysis of genetic variability and heritability

Analysis of variance revealed the presence of significant variability for all the characters studied (Table 4). Phenotypic co-efficient of variation (PCV) agreed closely with genotypic co-efficient of variation (GCV) but the magnitude of PCV was higher than GCV for almost all the characters. The results are in agreement with the previous workers (Basu *et al*. 1999). In the present study, the characters like protein content of pod, pods/plant, breadth of pod, weight of pod and pod yield/plant registered high values of PCV and GCV (Table 5). Such observations were also noted by earlier workers (Kabir & Sen 1987; Lal *et al*. 2005).

Heritability estimates (broad sense) were high for all the characters. High heritability values were associated with high value of expected genetic advance as percent of mean for protein content of pod, number of pods/plant, breadth of pod, weight of pod and pod yield/plant. High heritability accompanied by high genetic advance was more useful than heritability alone and considerable importance could be made in these characters by predicting the result and selecting the best individual (Johnson *et al*. 1955). High heritability along with high genetic gain indicated that these characters were controlled due to considerable additive gene effects (Panse 1957). Moderate to high expected genetic advance was recorded in case of days to 50% flowering, pods/plant, yield/plant, weight of pod and 100 seed weight. These observations find support from previous workers (Baswana *et al*. 1980; Desai *et al*. 1996; Nandi *et al*. 2000). However, the characters like, number of seeds/pod, days to 50% flowering and 100 seed weight registered comparatively low GA though their heritability values were high. Selection based on these characters will be ineffective as these characters were influenced by environment.

Table 4. Analysis of variance for nine quantitative characters of dolichos bean entries (pooled over two years)

Source	d.f	Length of pod (cm)	Breadth of pod (cm)	Weight of pod (g)	Days to 50% flowering	No. of seeds/pod	100 seed wt. (g)	Pod/plant	Protein content of pod (%)	Yield/ plant (kg)
Replication	2	0.072	0.002	0.013	1.08	0.02	2.16	1761.33	0.004	3.96
Treatment	11	15.82**	1.12**	7.21**	945.66**	0.99**	13834.15**	43679.25**	342.06**	248.71**
Error	22	0.05	0.003	0.02	0.38	0.02	4.31	565.81	0.05	1
S.Em ±		0.14	0.033	0.09	0.36	0.096	1.2	13.84	0.13	0.42

d.f. = Degree of freedom
** Significant at 1% level

Table 5. Mean and estimates of genetic parameters for different characters of dolichos bean genotypes

Characters	Range	Grand mean S.Em (±)	P.C.V.	G.C.V.	Heritability (%) in broad sense	GA as % of mean
Length of pod (cm)	7.15 - 15.05	11.311 ± 0.1419	20.38	20.26	99.88	41.51
Breadth of pod (cm)	1.44 - 3.11	2.215 ± 0.033	27.75	27.63	99.12	56.66
Weight of pod (g)	2.92 - 8.92	6.117 ± 0.090	25.43	25.31	98.94	51.87
Days to 50% flowering	57 - 115	93.83 ± 30.36	18.92	18.91	99.88	38.94
No. of seeds / pod	4 - 5	4.306 ± 0.096	17.76	13.20	92.09	26.1
100 seed weight (g)	22.2 - 45.5	339.4 ± 41.20	20.01	20.00	99.91	41.18
Pods /plant	768.3 - 1897	1324 ± 13.84	28.85	28.80	99.61	59.21
Protein content of pod (%)	0.70 - 5.45	2.4960 ± 0.131	42.78	42.77	99.96	88.1
Yield / plant (kg)	5.07 - 12.21	7.768 ± 0.426	25.55	25.40	98.8	52.01

c) Correlation coefficient analysis

Association analysis of different quantitative characters with green pod yield of dolichos bean varieties/lines and their inter relationships were investigated through the study of both phenotypic and genotypic correlation co-efficient (Table 6).

In general, the genotypic correlations were greater than the corresponding phenotypic correlations indicating the preponderance of genetic variation in the expression of most of the characters. Significant positive associationships with green pod yield per plant were observed with days to 50% flowering and number of seeds per pod. This is in agreement with the findings of earlier workers (Pandey & Assawa 1980; Desai *et al*. 1996). Though non-significant but a positive correlation with green pod yield/plant was observed in case of number of pods/plant, 100 dry seed weight and weight of pod. Such association was also noticed by Nandi *et al*. (2000) and Lal *et al*. (2005). Protein content of pod has shown a negative correlation with green pod yield/plant which is in agreement with the findings of Arunachala (1979). Interrelationship between component traits exhibited that days to 50% flowering was significantly and positively correlated with 100 dry seed weight and weight of pods was also found to be significantly correlated with days to 50% flowering. On the other hand, weight of pod exhibited significant negative interrelationship with pods/plant and protein content which agrees with the findings of Arunachala (1979).

d) Path coefficient analysis

In the present study, the phenotypic correlations were partitioned into direct and indirect effects to identify relative importance of yield components towards green pod yield of dolichos bean (Table 7). Among the eight yield component traits, weight of pod showed highly positive direct effect on green pod yield, which has been in confirmation with the earlier findings of Nandi *et al*. (2000) and Lal *et al*. (2005). Besides this, significant amount of positive effect of number of pods/plant and 100 dry seed weight towards pod yield per plant has also been observed, which agrees with the findings of Desai *et al*. (1996). Interestingly, the negative direct effects of days to 50% flowering and number of seeds/pod on pod yield have been observed. These observations find support from previous workers (Singh *et al*. 1979) for days to flowering. The highly positive and significant association ships of days to 50% flowering and number of seeds per fruit with green pod yield/plant was possible due to very high indirect effects via weight of pod and 100 dry seed weight. Further low residual value (0.14) revealed that maximum characters influencing yield has been taken care in the present study.

Table 6. Correlation co-efficient of nine quantitative characters of dolichos bean

Characters		Length of pod (cm)	Breadth of pod (cm)	Weight of pod (g)	Days to 50% flowering	No. of seeds/ pod	100 seed weight (g)	Pods/ plant	Protein content of pod	Yield/ plant (kg)
Length of pod (cm)	rg	1	0.269	0.665	0.802	0.222	0.567	– 0.211	– 0.266	0.444
	rp	1	0.269	0.662**	0.798**	0.21	0.565*	– 0.216	– 0.264	0.441
Breadth of pod (cm)	rg		1	0.759	0.176	0.284	0.233	– 0.516	– 0.065	0.22
	rp		1	0.753**	0.176	0.279	0.232	– 0.512	– 0.065	0.221
Weight of pod (g)	rg			1	0.542	0.227	0.263	– 0.68	– 0.266	0.291
	rp			1	0.540*	0.223	0.263	– 0.677	– 0.264	0.294
Days to 50% flowering	rg				1	0.332	0.562	0	– 0.169	0.595
	rp				1	0.318	0.562*	0	– 0.169	0.593*
No. of seeds/pod	rg					1	0.614	0.245	0.042	0.661
	rp					1	0.592*	0.237	0.039	0.642*
100 seed weight (g)	rg						1	– 0.015	0.241	0.341
	rp						1	– 0.016	0.241	0.339
Pods /plant	rg							1	0.014	0.463
	rp							1	0.013	0.462
Protein content of pod	rg								1	– 0.229
	rp								1	– 0.227

*, ** Significant at 5% and 1% level of significance, respectively
rg and rp are genotypic and phenotypic correlation coefficients

Table 7. Path coefficient analysis of nine quantitative characters of dolichos bean

Characters	Length of pod (cm)	Breadth of pod (cm)	Weight of pod (g)	Days to 50% flowering	No. of seeds/pod	100 seed weight (g)	Pods/plant	Protein content of pod	Phenotypic correlation with yield
Length of pod (cm)	– 0.615	– 0.136	1.583	– 0.272	– 0.058	0.317	– 0.373	– 0.0006	0.441
Breadth of pod (cm)	– 0.165	– 0.505	1.80	– 0.059	– 0.078	0.130	– 0.911	– 0.0001	0.221
Weight of pod (g)	– 0.409	– 0.383	2.38	– 0.184	– 0.06	0.147	– 1.200	– 0.0006	0.294
Days to 50% flowering	– 0.493	– 0.088	1.29	– 0.340	– 0.087	0.314	0.000	– 0.0004	0.593*
No. of seeds / pod	– 0.136	– 0.143	0.541	– 0.112	– 0.264	0.343	0.431	0.0001	0.642*
100 seed weight (g)	– 0.349	– 0.117	0.627	– 0.191	– 0.162	0.559	0.026	0.0005	0.339
Pods /plant	0.130	0.260	– 1.62	0.000	– 0.064	– 0.008	1.765	0.000	0.462
Protein content of pod	– 0.163	0.032	– 0.633	0.057	– 0.01	0.134	0.024	0.002	-0.227

Residual effect: 0.141, direct effect on main diagonal (bold)
** Significant at 1% level of significance

CONCLUSIONS

1. On the basis of pod yield/plant, four genotypes namely, BCDB-1, KDB-413, JIB (V)-16 and BCDB-2 were found most promising under the Gangetic plains of Eastern India.
2. Genotypes showed differential reaction against *Cercospora* leaf spot and dolichos yellow mosaic virus. However, high yielding genotypes showed lower incidence of diseases.
3. The information generated through this study will help the breeders to develop high yielding varieties tolerant to important diseases of this crop.
4. Top priority should be given to selection based on the weight of pod, 100 dry seed weight and number of pods per plant for green pod yield improvement and could be considered while formulating selection indices in the improvement of pole type dolichos bean.

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CHARAKTERYSTYKA I OKREŚLENIE WYBRANYCH CECH FASOLI TYCZKOWEJ *DOLICHOS*

Streszczenie

Oceniano dwanaście genotypów fasoli tyczkowej dolichos (*Lablab purpureus* var. *typicus*) (wspięga pospolita, fasolnik egipski), uprawianych na Równinie Gangesu w Indiach wschodnich, pod względem ich zróżnicowania genetycznego i powiązania cech wśród dziewięciu cech ilościowych. Badania wykazały istotne zróżnicowanie pod względem liczby dni do 50% kwitnienia (57-115), długości strąka (7,15-15,05 cm), szerokości strąka (1,44-3,11 cm), masy strąka (2,92-8,92 g), masy 100 nasion (22,2-45,5 g), liczby strąków/roślinę (768,3-1897), zawartości białka w strąku (0,70-5,45%) oraz wielkości plonu strąków/roślinę (5.07-12.21 kg). Badane genotypy wykazały zróżnicowaną odporność na grzyba *Cercospora* wywołującego plamistość liści i na wirusa żółtej mozaiki fasoli. Dobrze plonujące genotypy na ogół wykazywały mniejszą częstość występowania chorób niż genotypy słabo plonujące. Cechy takie jak zawartość białka w strąku, liczba strąków/roślinę, szerokość strąka, masa strąka oraz plon strąków/roślinę wykazywały wysokie współczynniki zmienności - genotypowy (GCV) i fenotypowy (PCV), dziedziczności i wskaźnik postępu genetycznego jako procent średniej, wskazując, że taka sytuacja może być spowodowana działaniem genów addytywnych, kontrolujących te cechy. Na podstawie analizy korelacji wykazano, że selekcja powinna odbywać się przede wszystkim na podstawie masy strąka, suchej masy 100 nasion oraz liczby strąków na roślinę, jeśli celem ma być poprawa plonów zielonych strąków, a cechy te mogłyby być również brane pod uwagę przy określaniu kryteriów selekcji przy doskonaleniu fasoli tyczkowej dolichos.