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Studies on sustainability index for selecting stable genotypes of linseed (*Linum usitatissimum* L.) in south-eastern plain zone of Rajasthan

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Abstract

An experiment was conducted during *Rabi* (2014-2018) season to determine the sustainability index and genotypic stability of seven released linseed varieties under condition of South-Humid plane Zone of Rajasthan. The highest sustainability index (%) and high mean yield was recorded in variety PA-2 (92.35 % and 15.41 q/ha) followed by KB-3 (89.79% and 12.57 q/ha), KB-4 (88.88 % and 10.61 q/ha.) and PA-1 (82.36 % and 12.81 q/ha), whereas moderate sustainability index was observed in T-397 (74.06 %) and Meera (70.30%). Based on high yield performance and sustainability index, varieties *viz.*, PA-2 (Pratap Alsi-2), PA-1 (Pratap Alsi-1), KB-3 (Kota Barani Alsi-3) and KB-4 (Kota Barani Alsi-4) can be used as parent in future breeding programme.

Keywords: Sustainability index, genotypic stability, linseed, yield and standard deviation

Introduction

Linseed (*Linum usitatissimum* L.) is one of the most important *rabi* oilseeds after rapeseed mustard. The plant originated from the Mediterranean and the southwest Asian regions. Linseed (*Linum usitatissimum* L.) $2x=2n=30$ is an annual self-pollinated crop. It belongs to the order Malpighiales, genus *Linum* and family Linaceae. The botanical name *Linum usitatissimum* was given by Linnaeus in his book "Species Plantarum". It is an annual herbaceous plant within shallow root system. The Latin species name *usitatissimum* means "most useful".

Linseed is an important oilseed and fiber crop. The seed contains good percentage of oil varying from 33-45 and 24% crude protein in different varieties. Its medicinal and nutraceutical properties have paved the way for its diversified uses and value addition in various forms. Its seed comprises complete protein (Rich in eight essential amino acids), higher order linolenic acid (An essential poly unsaturated omega-3 fatty acid) highest in plant kingdom. Recent advances in neuro-biology have established that it is best herbal source of omega-3 and omega-6 fatty acid which helps in regulating the nervous system. About 20 per cent of the total linseed oil produced in India is used by the farmers and the rest about 80 per cent goes to industries for the manufacture of paints, varnish, oil- cloths, linoleum and printing ink.

It is commonly observed that the relative performance of different genotypes varies in different environments, i.e., there exists genotype-environment interaction. Presence of significant genotype by environment interaction due to the differential response of varieties in different environments represents a major challenge to plant breeders to fully understand and obtain the genetic control of variability (Luthra and Singh, 1974) [8]. In this case, measuring and understanding the Genotype by Environment Interaction (GEI) should be an essential component of variety evaluation. One of the main reasons of growing varieties in multi locations is to estimate their stability (Freeman, 1973) [5] as selection of superior varieties is mainly based on their yield potential and stable performance over a wide range of environments (Crossa *et al.*, 1989) [3] (Alem and Dessalegn, 2014) [2]. It is necessary in those areas where climatic conditions are highly unpredictable (Adugna, 2003) [1].

Yield is a complex quantitative character and is greatly influenced by environmental fluctuation; hence selection for superior genotype based on yield per se at a single location in a year may not be very effective. Thus, varietal stability is of paramount importance for stabilizing the production over region and seasons especially in decreased farm holdings and resource poor farmer conditions. This lays a heavy emphasis on developing technologies while keeping sustainability of small farmer and his resources as the top priority (Koli and Prakash 2013) [7].

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In subsistence agricultural system, yield per se may be less important than reaching a certain yield level (Fox *et al.*, 1997)^[4]. Therefore, development of varieties and hybrids with stable performance is gaining ground to help achieve sustainability in agricultural production. To achieve this, first concept is to select the genotype with the smallest deviation from its production potential.

The use of sustainability index in terms of varietal stability gives an indication about the stability of a variety across the location and over the years. In linseed, phenotypic stability has been studied by various workers (Vishnuvardhan and Rao 2014; Yadav *et al.*, 2014; Yadav *et al.*, 2017)^[11, 13, 12]. However, the information on the use of sustainability index for assessment of varietal stability is lacking in Linseed. Hence the present investigation was undertaken to determine the sustainability index of seven linseed genotypes evaluated for four consecutive years (2014-2018).

Materials and Methods

The experimental material consisted of six linseed varieties namely, Pratap Alsi-1, Pratap Alsi-2, Kota Barani Alsi-3, Kota Barani Alsi-4, Meera, T-397 and Padmini (T-397 and Padmini used as checks) were evaluated at Agricultural Research Station, Ummedganj, Kota, Rajasthan in completely randomized block design with three replications with row to row spacing of 30 cm. and plant to plant spacing of 10 cm. The grain yield was recorded on plot basis and was estimated in q/ha. The four year data on each variety were used for estimation of sustainability index. The sustainability index was estimated according to following formula used by other workers (Singh and Agarawal, 2003; Gangwar *et al.*, 2004 and Tuteja, 2006)^[9, 6, 10].

Sustainability index = $\frac{\text{Average performance} - \text{Standard Deviation}}{\text{Best performance}} \times 100$

The value of sustainability index were arbitrarily divided in to five group viz. very low (up to 45%), low (46-60%), moderate (61-75%), high (76-90) and very high (above 90%).

Results and Discussion

The yield differences were found to be significant over the years, indicating genetic difference among the varieties studied. For drawing meaningful interference, the yield (best performance) and sustainability index could be divided into four groups as follows;

Yield (Best Performance)	Sustainability index	Remarks
High	High	Desirable
High	Low	Location specific
Low	High	Undesirable
Low	Low	Undesirable

In the present study (Fig-1), Pratap Alsi- 2 recorded highest grain yield and has highest sustainability index (15.41q/ha and 92.35% respectively), indicating the best performance of this variety. The high level of best performance coupled with high value of sustainability index could be taken as the indication of close proximity between the best performance and the average performance over the years. This explains the good stable performance of Pratap Alsi- 2 over the years. The second best genotype was Kota Barani Alsi-3 which recorded best performance of 12.57 q/ha and sustainability index of 89.79 percent. Although recorded high yield 12.41 q/ha for T-397 variety, however its sustainability index was moderate indicating its inconsistent performance over the years. This variety gave the highest performance during the year 2017, thus it was adaptable to specific situation only. The yield performance and sustainability index of remaining genotypes were poor to average indicating their unstable performance over the years. From the present investigation, it's concluded that the variety Pratap Alsi-2 was the most suitable followed by Kota Barani Alsi-3, Pratap Alsi-1, Kota Barani Alsi-4, T-397 and Meera. It is suggested that variety Pratap Alsi-2 and Kota Barani Alsi-3 can be used as a parent's in future breeding programme for evolving genotypes with high sustainability of grain yield.

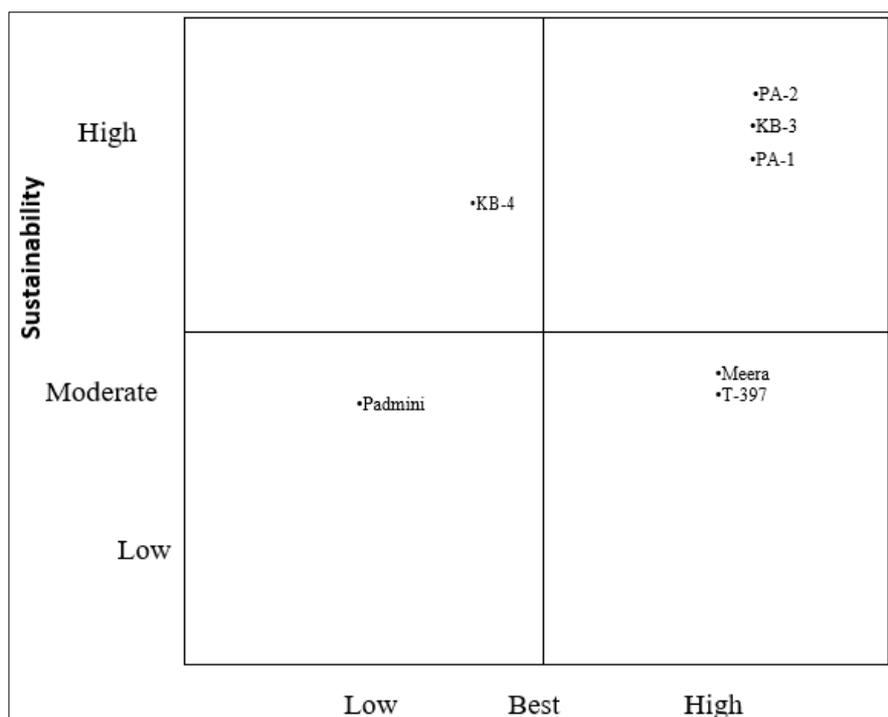


Fig 1: Grouping of genotypes as per their best performance and sustainability indices

Table 1: Estimation of sustainability index (%) for seven genotypes of Linseed

Particulars/Year	Grain Yield performance in different years (t/ha)						
	Pratap Alsi-1	Pratap Alsi-2	Kota Barani Alsi-3	Kota Barani Alsi-4	Meera	T-397	Padmini
2014-15	13.11	15.70	12.15	11.20	12.34	12.33	11.80
2015-16	12.89	13.94	12.65	10.22	9.93	9.84	8.12
2016-17	14.07	16.46	13.35	11.11	14.25	14.22	8.68
2017-18	11.15	15.54	12.11	9.89	11.00	13.25	9.50
Total	51.22	61.64	50.26	42.42	47.52	49.64	38.10
Mean yield (q/ha) over years	12.81	15.41	12.57	10.61	11.88	12.41	9.53
Standard deviation	1.22	1.06	0.58	0.65	1.86	1.88	1.62
Best performance (q/ha)	14.07	16.46	13.35	11.20	14.25	14.22	11.80
Sustainability index (%)	82.36	92.35	89.79	88.88	70.30	74.06	67.00

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